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## CONFERENCE PROCEEDINGS 46

# Women's Issues in Transportation

*Summary of the 4th International Conference*

VOLUME 2: TECHNICAL PAPERS

October 27–30, 2009  
Irvine, California

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United Kingdom Department for Transport  
University of California Transportation Center (Berkeley, Irvine, Los Angeles,  
Riverside, and Santa Barbara)  
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California State University, Long Beach  
New Mexico Department of Transportation  
University of California, Davis  
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Women's Transportation Seminar

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This report has been reviewed by a group other than the authors according to the procedures approved by a Report Review Committee consisting of members of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine.

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# Preface

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The Transportation Research Board (TRB) convened the 4th International Conference on Women's Issues in Transportation on October 27 to 30, 2009, at the Arnold and Mabel Beckman Center in Irvine, California. The contributions of the following organizations enabled this important conference to come to fruition: TRB and the Standing Committee on Women's Issues in Transportation; the Federal Highway Administration; the United Kingdom Department for Transport; the University of California Transportation Center; the Swedish Government Agency for Innovation Systems (VINNOVA); METRANS Transportation Center; the New Mexico Department of Transportation; the University of California, Davis; the Federal Transit Administration; and the Women's Transportation Seminar.

Some 140 international transportation researchers and practitioners from Africa, Asia, Europe, and the United States gathered to exchange information on a variety of factors and emerging issues affecting women's access to mobility, safety, personal security, and travel needs and patterns.

## BACKGROUND

This event marks the fourth in a series of conferences on women's issues in transportation, the first of which was sponsored by the U.S. Department of Transportation in 1978. Attendees of this groundbreaking conference were predominantly researchers and scholars. The second conference, held in 1996, was sponsored by the Drachman Institute of the University of Arizona and by Morgan State University. The program addressed concerns beyond the research community and expanded into policy-making issues and planning and engineering processes. The third conference, held in 2004, aimed to advance the understanding of women's issues in transportation and attracted a diverse audience of professionals from the national, state, regional, and local levels and from the public and private sectors and academia. This fourth international conference included researchers, aca-

demicians, practitioners, and students from more than a dozen countries. The program addressed longstanding issues relating to gender concerns in transportation that merit ongoing attention. It highlighted the latest research on changing demographics that affect transportation planning, programming, and policy making as well as the latest research on crash and injury prevention for different segments of the female population. Special attention was given to pregnant and elderly transportation users, efforts to better address and increase women's personal security when using various modes of transportation, and the impacts of extreme events such as hurricanes and earthquakes on women's mobility and that of those for whom they are responsible.

## CONFERENCE PLANNING

TRB assembled a conference planning committee appointed by the National Research Council to organize and develop the conference program. Susan Hanson of Clark University served as the committee chair. The members of the committee, who are listed on page ii, brought expertise in a variety of areas, including data analysis, traffic engineering, demographics, travel behavior, and transportation and mobility planning.

The conference's primary objective was to stimulate new research on women's issues in transportation to add to the existing body of literature and to increase awareness of safety, personal security, and mobility issues affecting female travelers as the population ages.

The committee selected five conference tracks: changing demographics and women's travel behavior, transportation policy considerations for female travelers, protecting the safety and personal security of female transportation users, and studying the impacts of extreme events on female travelers. These conference tracks were led by the following committee members:

- Demographics and Travel Behavior, Sandra Rosenbloom;
- Transportation Policy, Gloria Jeff;

- Safety, Lidia Kostyniuk;
- Personal Security, Jeanne Krieg; and
- Extreme Events, Marsha Anderson Bomar.

The conference program featured commissioned resource papers to address four of these topic areas. In addition, both keynote speakers in the conference's opening session produced resource papers, for a total of six papers, which are included in this volume together with an overview of the conference proceedings.

The committee issued a call for abstracts to attract additional research on these topic areas. Following a peer review of the abstracts submitted, the authors of approved abstracts were invited to submit papers for consideration for presentation at the conference. The submitted papers were then peer-reviewed, and those approved were included in the conference program.

## CONFERENCE FORMAT

The conference program was designed to showcase the latest international research to support the topic areas selected by the planning committee. The conference included a preconference workshop on the history of women in transportation followed by a poster session where 14 peer-reviewed papers were presented.

The following day, the conference's opening session included keynote presentations by Martin Wachs, the RAND Corporation, and Ananya Roy, University of California, Berkeley. The subsequent plenary sessions featured the remaining four commissioned resource papers. A choice of three breakout sessions was offered following each of the plenary sessions. The breakout sessions featured the presentation of 32 peer-reviewed research papers and were structured to allow more time for interaction and exchange of information between the presenters and participants.

### Plenary Sessions

The plenary sessions featured presentations by the author of each resource paper. These commissioned resource papers were designed to frame the issues within

the respective subject area, gauge the degree to which progress had been achieved since the previous TRB conference, introduce any new research findings or information, and identify topics for continued or further research.

### Breakout Sessions

Following each plenary session, a choice of three breakout sessions was offered, each of which included the presentation of three or four research papers. These sessions were designed to encourage the authors to interact with the attendees and to discuss specific research and policy implications arising from the information presented. The breakout sessions allowed for a comparison and contrast of issues affecting female travelers on different continents.

### Poster Session

The conference program included a poster session featuring 14 peer-reviewed papers. This format enabled authors and attendees to interface and exchange ideas and information in a more informal way.

## CONFERENCE PROCEEDINGS FORMAT

### Volume 1: Conference Overview and Plenary Papers

Volume 1 includes the conference overview prepared by Susan Herbel and Danena Gaines, Cambridge Systematics, and the six commissioned resource papers, including the two keynote presentations delivered by Wachs and Roy.

### Volume 2: Technical Papers

This volume includes 27 full peer-reviewed papers that were presented in the breakout sessions of the conference or in the poster session and approved for publication.

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# Female Involvement in U.S. Fatal Crashes Under a Three-Level Hierarchical Crash Model Mediating and Moderating Factors

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Eduardo Romano, Tara Kelley-Baker, and Pedro Torres, *Pacific Institute for Research and Evaluation (PIRE)*

Men have long held the lead in motor-vehicle crashes; however, research indicates that women are closing the gap. The reasons for this relative increase are unclear. To further investigate this problem, the authors applied a simplified version of the hierarchical levels of driving behavior (HLDB) model to investigate female involvement in fatal crashes in the United States. The HLDB model recognizes that decisions at higher levels affect decisions at lower levels. At the top level, the model assumes that the driver's condition (e.g., inattention, fatigue, impairment) has an effect on the next level (e.g., speeding or other failures to obey traffic laws), which subsequently affects the basic maneuvering skills (i.e., the lowest level). Data for this study were drawn from the Fatality Analysis Reporting System for the years 1982 to 2007. Single-vehicle crashes were used to indicate crash responsibility. Basic descriptive and multilevel analyses were applied to investigate female involvement at each level of the HLDB model. Compared with males, female drivers were less likely to be involved in crashes associated with the highest HLDB level, but more likely to be involved in the lowest level. The relative high prevalence of females in skill-related crashes, however, occurred only when associated with speeding. Variations in this finding due to age and gender were also found. Findings from this study should help to develop more efficient (better targeted) traffic safety prevention policies.

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**D**espite significant progress in traffic safety during the past decades, motor vehicle crashes (MVCs) remain a major source of injury. U.S. males account for most of the traffic fatalities—three times

that of females—and thus, have received most of the resources and focus (Beirness 1989; Cerrelli 1998). Current data show, however, that the prevalence of women in fatal MVCs is rising. Romano and colleagues (2008) have shown that female involvement in fatal crashes increased in the United States, albeit mostly due to young drivers. Although the National Highway Traffic Safety Administration (NHTSA) reported that the number of male drivers killed in fatal crashes dropped from 45,084 in 1975 to 39,739 in 1994, during the same period, the number of female drivers in fatal crashes increased from 9,356 to 13,430 (NHTSA 1995). Interestingly, the estimated involvement rate in fatal crashes per 100,000 licensed male drivers has continuously declined over the past 30 years (from 62 in 1975 to 42 in 2003), whereas it has remained unchanged for female drivers for about 15 years (NHTSA n.d.).

The reason for this increase in crash fatalities is often cited as being related to the different and richer roles modern women are playing in the society. Some explanations focus on household roles and their associated stresses, travel patterns, and driving skills. Other explanations go beyond exposure and argue that the development of changes in normative behaviors among women that occur over time translate into new, riskier driving behaviors (Pisarski 1992; Voas et al. 1998).

The driving skills of female drivers, particularly vehicle control and maneuvering, have received attention among researchers. McKenna et al. (1991) analyzed a survey of drivers in the United Kingdom and concluded that there is a significant difference between male and female personal assessments of driving skills,

with males rating themselves higher than females. In an examination of Finnish drivers, Laapotti et al. (2003) also found that female drivers tended to evaluate their own driving skills lower than did their male counterparts and that, although young female drivers were more safety oriented than male drivers, female drivers had more problems in vehicle handling and mastering traffic situations.

Changes in attitudes toward risk may have contributed to those findings. Stamatiadis and Deacon (1995), working with Michigan data, found that young drivers as a whole drive less safely now than the same age group did in previous years, with female drivers driving more safely, on average, than male drivers. Data from Michigan, however, show that the rate of aggressive, risky driving and speeding-related collisions among female drivers (particularly young women) is increasing (Kostyniuk et al. 1996; Waller et al. 2001). In a study on female driving by the Pacific Institute for Research and Evaluation, almost two-thirds (65%) of participants said they drove more than 15 mph over the speed limit occasionally or very often (NHTSA 2001). About half had been stopped for a traffic violation in the past 3 years, primarily for speeding. In 2000, however, an Internet-based, nonscientific survey of 400 clients of an Ohio insurance company reported that women stuck in summer traffic with children in their cars were four times more likely than men to speed, run a red light, or drive on the shoulder (Progressive Insurance 2000).

In an application of the hierarchical levels of driving behavior (HLDB) model to archival data, Laapotti and Keskinen (2004) examined changes over time in the MVC patterns of males and females in Finland. They noticed that female drivers had proportionally more accidents connected to vehicle maneuvering and control of traffic situations, such as reversing and loss-of-control accidents when not speeding. Laapotti and Keskinen (1998) also found that female drivers were more prone to lose control of their vehicles when the condition of the road surface was less than optimal (e.g., slippery).

Thus, the occurrence of MVCs among female drivers is rising, although MVCs are still much less prevalent among female drivers than among male drivers. Why? Unfortunately, very little is known about such apparent increase in risk. The main goal of this study was to add to the current literature by applying a simplified version of the HLDB model (Keskinen 1996) to investigate female involvement in fatal crashes in the United States caused by gender differences in three hierarchical levels (from top to bottom): driving context (e.g., impaired driving, fatigue, inattention), the mastering of traffic situations (e.g., red-light running, speeding), and vehicle maneuvering (e.g., loss of vehicle control).

## METHODS

### Data

Crash data for this study were obtained from the Fatality Analysis Reporting System (FARS) for the years 1982 to 2007. FARS is a record system for fatal crashes (defined as a crash on a public roadway causing a death within 30 days of the event) (NHTSA n.d.). FARS provides detailed information about fatally injured drivers' gender, age, level of alcohol consumption, and maneuvering skills. FARS also contains information about the number of vehicles involved in the crash. The data set provides a large representative source of information that allows the making of inferences confidently at the national level and the evaluation of changing trends over time.

There were 1,489,277 drivers in the FARS data for 1982 to 2007. To provide a measure of crash responsibility, only drivers involved in single-vehicle crashes were included in the data set. Drivers who presented a driver condition signaling a "mentally challenged" state, were involved in a police chase, were driving buses or farm equipment, or were parking vehicles were excluded. Finally, only fatally injured drivers with gender identification were kept in the data set. After these manipulations, 384,861 drivers remained in the data set and were used for most analyses. Because FARS began collecting information on race and ethnicity in 1999, only the FARS data for 1999 to 2007 were kept for analyses including this variable ( $n = 150,400$ ).

### Measures

#### *Driving Exposure*

As mentioned, driving exposure has been suggested as an explanation for the relative increase in crashes among female drivers. Driving exposure was addressed by applying the estimated vehicle miles traveled (VMT) for each relevant group (e.g., Braver 2001). A common method of normalizing crash fatality data, the VMT-based approach normalizes crash incidence by number of miles driven (thereby adjusting incidence by crash exposure). Estimates of the annual mileage driven by each of the four racial-ethnic groups were drawn from the 1995 and the 2001 National Household Travel Surveys (FHWA n.d.). The most recent survey available is for 2001; although the 2008 survey has been completed, it has still not been made available to the public. Because this measure was collected through a national survey that is conducted only once every 5 to 7 years, VMT data had to be estimated for nonsurvey years. In this study, the VMT data from 1995 were applied to the FARS period of 1982 to 1997, and the 2001 VMT data were applied to the FARS period of 1998

to 2007. The analytical limitations that such a generalization presents are obvious, but the benefits of providing some correction for female drivers' driving exposure outweigh the limitations of the measure.

### *HLDB Crash Levels*

Table 1 shows the FARS variables used and the criteria applied to build the condition variables at each of the three HLDB levels. At the top of the HLDB model is Level 3, which includes the factors of alcohol consumption, fatigue, and inattention. It is followed by Level 2, which includes red-light running, failing to obey a traffic signal, speeding, and other aggressive driving, and Level 1, which includes loss of vehicle control associated with improper vehicle maneuvering or bad weather or surface conditions. Alcohol consumption was established when the driver recorded a positive blood alcohol concentration (BAC) result, as determined by the actual BAC as measured and reported in FARS and the multiple imputation of BAC values when the actual BAC values were missing, as is currently done in FARS (Subramanian 2002). The other crash factors were assigned using information from the following FARS variables: the Driver Condition Factor (DR\_CF), the Person-Related Factor (P\_CF), the Condition Factor (CF), Violation Charge (VIOLCHG),

and the Vehicle Condition Factor (VEH\_CF) (NHTSA 2008). To inform about multiple crash conditions, FARS allows up to four entries of each of the individual conditions (e.g., DR\_CF1 to DR\_CF4). When multiple crash conditions were present, the presence of a targeted factor in any of these conditions (up to four levels) was sufficient for its identification. Table 1 shows the codes applied to the classification of drivers.

## Analyses

### *Conceptual Model*

Drinking-and-driving contexts can be viewed as decision-making situations requiring individuals to choose between riskier and safer courses of action (Labouvie and Pinsky 2001). This study follows a limited version of the HLDB model (Keskinen 1996), which recognizes that decisions at higher levels affect the decisions (and skills) at lower levels. At the top level, Keskinen's model assumes that the person's general goals and skills (e.g., the person's enthusiasm about cars and driving) affect the decisions at the second level (e.g., drinking and driving), which affect the next level (e.g., speeding or other failures to obey traffic laws), which subsequently affect the basic maneuvering skills (e.g., controlling the vehicle direction). Information

**TABLE 1 FARS Variables Used to Create Three Driving Conditions**

Level and Variable	DR_CF	P_CF	CF	VIOLCHG
Level 3				
Fatigue or inattention	1, 6	3, 10		4 (since 1997)
Alcohol <sup>a</sup>	93–98 (since 1991)			
Level 2				
Speeding	44 46 (since 1998)	44		2–3 (until 1996) 21–25 (since 1997) 29 (since 1997)
Failure to obey	38, 39 (and 19<TRA_CONT<22 or 0<TRA_CONT<7 )	33 38–41		31–39 (since 1997)
Other aggressive	8 (since 2003) 13 (since 2005) 46 (until 1994) 27, 36	36 (since 1995) 46		2–3 (since 1997) 4 (until 1996) 8 (since 2004)
Level 1				
Maneuver	26–36 47–48 52 58 18 (since 1995)	20 (2000 and 2001) 22 (until 2002) 36–37 (since 1994) 42–43, 47–49 50 (since 1994) 28, 34–35, 51 59 (since 1995)		41–69 (since 1997)
Weather or slippery road conditions	61, 77, 79, 87	60, 73, 75, 83	5	

<sup>a</sup> BAC > .00, tested or imputed (by NHTSA).

on drivers' general goals and skills (the top level of the HLDB model) is not available in the FARS data set. Thus, this study applied a simplified model based on the three lower levels of the HLDB model.

### Analytical Models

Basic statistical comparisons were applied to analyze the data. To investigate the gender contribution to each level and crash factor, multinomial (polytomous) logistic regression was applied. Two sets of regressions were applied: one modeling the occurrence of a Level 1 crash as a function of Level 2 factors and covariables, and another modeling the occurrence of a Level 2 crash as a function of Level 3 crash factors and covariables. The covariables considered included gender (male, female), age (<21, 21 to 34, 35 to 64, and 65 and older), race-ethnicity (non-Hispanic whites and other), time of day (6 a.m. to 9 p.m. and 10 p.m. to 5 a.m.), and the presence of passengers (none, 1, 2, or more). Although the analysis of main effect models was of interest, the focus was on the interaction between gender and all relevant factors and covariables. For instance, in modeling Level 1 crashes, the focus was on the interactions between gender and Level 2 factors. If these interactions were significant, it would mean that, as compared with males, the contribution of females to the likelihood of a Level 1 crash would partially depend on the occurrence of a Level 2 factor. Several sequential runs for each of the two sets of models described were performed to test the

significance and direction of interaction terms involving gender. In each of these series of models, the analysis began with a main-effects-only model and sequentially added the gender interactions to test for the separate and joint contributions of those additions.

### RESULTS

Table 2 shows the number of drivers in the file by gender, as well as the corresponding female-to-male (F–M) ratio. The F–M ratios and prevalence estimates (percent) in Table 2 are adjusted by driving exposure. Table 2 shows that overall, for each male driver in the file, there are 0.65 females. Table 2 also shows that the prevalence of Level 3 crashes is significantly larger among males (70.5%) than among females (50.9%) ( $p < .01$ ). The F–M ratio mimics this finding, showing a much smaller ratio (i.e., relatively less for females) for Level 3 crashes than for non-Level 3 crashes. Almost 90% of the level 3 crashes involved alcohol (78.1% alone, 11.6% in conjunction with fatigue or inattention). Largely, this finding is not surprising, for the sample studied included only single-vehicle crashes in an attempt to ensure the drivers' responsibility in the crash, and single-vehicles crashes (particularly at nighttime) have been used as a proxy for alcohol-related crashes. Not surprisingly, male drivers were more likely to be involved in alcohol-related crashes (81.2% of the Level 3 crashes alone, 11.5% in conjunction with fatigue or inattention) than female drivers (71.4% and 11.8%, respectively). For fatigue

TABLE 2 Number of Drivers, Their Distribution, and Female–Male Ratio by Crash Level

Level and Variable	Males (%) (N = 275,329)	Females (%) (N = 109,532)	Both (%) (N = 384,861)	Female–Male Ratio 0.65
Level 3				
No Level 3 present	29.5	49.1	37.2	1.07
Level 3 present	70.5	50.9	62.8	0.47
Alcohol	81.2	71.4	78.1	0.41
Fatigue or inattention	7.4	16.8	10.4	1.06
Joint <sup>a</sup>	11.5	11.8	11.6	0.48
Level 2				
No Level 2 present	55.5	47.4	50.6	0.75
Level 2 present	44.5	52.6	49.4	0.55
Speeding	66.6	52.2	61.5	0.43
Failure to obey	11.8	28.0	17.6	1.29
Other aggressive	10.8	12.5	11.4	0.64
Joint <sup>a</sup>	10.8	7.3	9.5	0.37
Level 1				
No Level 1 present	34.9	40.9	37.3	0.76
Level 1 present	65.1	59.1	62.7	0.59
Maneuver	94.8	90.9	93.4	0.56
Weather or surface conditions	2.1	3.3	2.5	0.94
Joint <sup>a</sup>	3.2	5.8	4.1	1.06

NOTE: N = nonweighted number of drivers in file. Female–male ratio is the ratio of female drivers to male drivers in each category. Percentages and female–male ratio are weighted by driving exposure.

<sup>a</sup> Joint denotes more than one factor in the level.

or inattention crashes in which alcohol was absent, the previously observed association reverses; more females (16.8%) than males (7.4%) were involved in this type of crash. The F–M ratios also allow for rapid visualization of this difference between alcohol-related and fatigue–inattention crashes, being much larger among the latter.

Female drivers are more prevalent than males among all Level 2 crashes ( $p < .01$ ). Speeding is the most frequent Level 2 crash factor (61.5%), albeit more predominantly among males (66.6%) than among females (52.2%). Interestingly, female drivers were observed more frequently in the crash category of “failure to obey.” Failure-to-obey crashes registered the highest F–M ratio (1.29) in Table 2. This finding is somewhat surprising, as failure-to-obey crashes include crashes associated with red-light running and other failures to obey traffic signals, which female drivers are usually regarded as being less prone to commit than their male counterparts.

Male drivers were more prevalent than female drivers among all Level 1 crashes ( $p < .01$ ). This is not surprising, given how the crash levels were constructed. Most Level 1 crashes involved “maneuver” crashes (93.4% overall), with only 2.5% of Level 1 crashes being due to weather or a slippery road surface. Although the relative involvement of female drivers in crashes involving weather or surface conditions was higher than that of male drivers (3.3% and 2.1%, respectively), almost no gender-related difference occurred for maneuver crashes. Finally, the overall F–M ratio decreased from Level 1 crashes to Level 3 crashes (0.59, 0.55, and 0.47, respectively), suggesting that compared with male drivers, female drivers tend to be more represented in Level 1 crashes than in Level 3 crashes.

Table 3 reproduces the outcome of the multinomial logistic regression models for the occurrence of the Level 1 crash factors (dependent variable) as a function of gender and age for each of the Level 2 crash factors under consideration. Model 1 in Table 3 reproduces the outcome of the main effects model. This model shows that the likelihood of a maneuver crash increases when the driver is a female, speeds or drives aggressively, is younger than 35 years old, is a non-Hispanic white, and drives alone. For a weather–slippery surface crash, the outcome of the main effects model is similar to that for a maneuver crash, with two exceptions: older drivers and minority drivers are more prone to be involved in weather–slippery surface crashes than younger and minority drivers, respectively.

Models 2 through 6 in Table 3 show the results of including the dual gender interaction terms. The analysis of these interactions reveals some interesting findings. For maneuver crashes, there is a significant and negative interaction between those age 65 and older and females. This result suggests that females tend to be relatively less involved in maneuver crashes when they are age 65 and

older. For crashes involving weather or slippery surface conditions, there is a significant and negative interaction between passengers and female drivers. In other words, having a passenger reduces the likelihood that a female driver will be involved in a weather–slippery surface crash. Perhaps most relevant for this study, for both maneuver and weather–slippery surface crashes, there is also a significant and positive interaction between females and speeding. When included in the model, such interaction makes the main effect nonsignificant. In other words, the outcome of Models 2 through 6 suggests that although females are more likely than males to be involved in maneuver or weather–slippery surface crashes, this result is particularly associated with speeding.

Table 4 shows the outcome of the multinomial logistic regression models for the occurrence of the Level 2 crash factors (dependent variable) as a function of gender and age for each of the Level 3 crash factors under consideration. Among the Level 3 factors, alcohol increases the likelihood of a speeding crash, although a driver who shows fatigue or inattention is less likely to speed. Of particular interest is the analysis of the role of females in speeding crashes, for such a role was relevant to the analysis of the occurrence of Level 1 crashes (Table 3). Table 4 shows that females consistently show a lower contribution to speeding crashes than males. Models 2, 3, and 4 in Table 4 show a negative interaction between females and alcohol, suggesting that when alcohol is consumed, female drivers are less likely to speed than male drivers. Once the gender and time interaction enters the model (Models 5 and 6), however, the female–alcohol interaction is no longer significant, suggesting that the association between alcohol, gender, and speeding is highly dependent on the time of day in which it occurs. The significance of the female–passenger interaction shows that for female drivers, the presence of a passenger reduces the likelihood of a speeding-related crash; that is, the significance of this interaction suggests again that compared with male drivers, female drivers tend to be “safer” when a passenger is present than when driving alone.

The somewhat surprising result in Table 4 is the positive and significant contribution of female drivers to failure-to-obey crashes. Females are usually viewed as deviating less from norms than males. Less surprising are the significant and negative interactions between female drivers and nighttime driving and between female drivers and the presence of one or more passengers. This finding suggests that female drivers are less likely to fail to obey when driving in the daytime with at least one passenger.

## DISCUSSION OF RESULTS

The results of the analyses performed in this study show the appropriateness of the HLDB model. The inclusion

TABLE 3 Multinomial Regression of Level 1 Factors on Level 2 Factors and Covariables

Variable	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Coeff.	P > z	Coeff.	P > z	Coeff.	P > z	Coeff.	P > z	Coeff.	P > z	Coeff.	P > z
<i>Maneuver</i>												
Female	0.057	.000	0.020	.263	0.040	.110	0.031	.416	0.039	.319	0.033	.409
Speeding	0.043	.007	-0.003	.882	0.002	.899	0.002	.904	0.001	.948	0.002	.933
Failure to obey	-2.811	.000	-2.760	.000	-2.769	.000	-2.769	.000	-2.767	.000	-2.767	.000
Other aggressive	3.966	.000	3.871	.000	3.873	.000	3.873	.000	3.872	.000	3.872	.000
All together	1.491	.000	1.506	.000	1.512	.000	1.511	.000	1.510	.000	1.511	.000
Female and speeding			0.135	.000	0.121	.000	0.121	.000	0.124	.000	0.124	.000
Female and failure to obey			-0.079	.354	-0.063	.461	-0.063	.461	-0.067	.434	-0.068	.426
Female and aggressive			0.269	.239	0.266	.244	0.266	.243	0.268	.240	0.268	.241
Female and all			-0.083	.403	-0.096	.336	-0.095	.337	-0.092	.356	-0.093	.349
<21	0.203	.000	0.203	.000	0.204	.000	0.203	.000	0.202	.000	0.204	.000
21-34	0.123	.000	0.124	.000	0.125	.000	0.125	.000	0.123	.000	0.123	.000
65+	-0.395	.000	-0.392	.000	-0.347	.000	-0.346	.000	-0.344	.000	-0.343	.000
Female * <21			0.001	.986	0.001	.984	0.001	.984	0.004	.933	0.001	.982
Female * 21-34			0.001	.978	0.002	.959	0.002	.959	0.007	.851	0.005	.887
Female * 65+			-0.092	.032	-0.093	.031	-0.093	.031	-0.099	.023	-0.098	.024
Nonwhites	-0.024	.160	-0.024	.157	-0.024	.154	-0.028	.177	-0.028	.180	-0.029	.171
Female * nonwhite					0.012	.737	0.012	.737	0.011	.755	0.013	.715
Nighttime	-0.258	.000	-0.256	.000	-0.254	.000	-0.254	.000	-0.245	.000	-0.245	.000
Female * nighttime									-0.026	.427	-0.026	.440
1 Passenger	-0.060	.001	-0.059	.002	-0.060	.001	-0.060	.001	-0.060	.001	-0.067	.005
1+ Passengers	-0.070	.005	-0.069	.006	-0.070	.005	-0.070	.005	-0.071	.005	-0.079	.017
Female * 1 passenger											0.017	.647
Female * 1+ passengers											0.019	.710
Constant	0.292	.000	0.306	.000	0.297	.000	0.300	.000	0.297	.000	0.298	.000
<i>Weather or Slippery Surface</i>												
Female	0.354	.000	0.170	.039	0.124	.228	0.137	.359	0.154	.312	0.249	.110
Speeding	1.163	.000	0.985	.000	1.021	.000	1.021	.000	1.018	.000	1.012	.000
Failure to obey	-1.523	.000	-1.243	.000	-1.273	.000	-1.273	.000	-1.270	.000	-1.284	.000
All together	-0.016	.953	-0.300	.421	-0.257	.491	-0.257	.492	-0.260	.486	-0.272	.466
Female and speeding			0.401	.000	0.324	.004	0.324	.004	0.331	.003	0.336	.003
Female and failure to obey			-0.436	.113	-0.384	.166	-0.384	.166	-0.392	.158	-0.367	.186
Female and all			0.610	.264	0.530	.332	0.530	.333	0.539	.325	0.558	.307
<21	0.003	.965	0.004	.959	-0.152	.159	-0.152	.159	-0.155	.152	-0.188	.085
21-34	0.061	.345	0.065	.310	-0.021	.804	-0.021	.811	-0.026	.760	-0.044	.615
65+	-0.336	.000	-0.328	.000	-0.240	.042	-0.241	.042	-0.235	.048	-0.241	.043
Female * <21					0.328	.033	0.328	.033	0.335	.030	0.387	.013
Female * 21-34					0.189	.135	0.188	.138	0.200	.119	0.231	.073
Female * 65+					-0.161	.332	-0.160	.337	-0.172	.305	-0.177	.293
Nonwhites	0.179	.006	0.177	.007	0.176	.007	0.184	.032	0.185	.032	0.196	.023
Female * nonwhite							-0.016	.906	-0.017	.895	-0.049	.711
Nighttime	-0.667	.000	-0.657	.000	-0.648	.000	-0.648	.000	-0.622	.000	-0.620	.000
Female * nighttime									-0.069	.578	-0.076	.535

1 passenger	0.059	.373	0.063	.344	0.062	.346	0.062	.347	0.062	.349	0.195	.026
1+ passengers	-0.052	.573	-0.047	.608	-0.045	.630	-0.045	.628	-0.046	.620	0.128	.309
Female * 1 passenger											-0.293	.029
Female * 1+ passengers											-0.359	.054
Constant	-3.713	.000	-3.624	.000	-3.604	.000	-3.610	.000	-3.618	.000	-3.654	.000
<i>Maneuver and Weather</i>												
Female	0.440	.000	0.389	.000	0.359	.000	0.142	.272	0.176	.178	0.177	.187
Speeding	0.895	.000	0.804	.000	0.842	.000	0.839	.000	0.830	.000	0.830	.000
Failure to obey	-4.622	.000	-3.841	.000	-3.881	.000	-3.881	.000	-3.873	.000	-3.872	.000
Other aggressive	2.965	.000	3.080	.000	3.092	.000	3.089	.000	3.083	.000	3.083	.000
All together	0.719	.000	0.986	.000	1.030	.000	1.023	.000	1.013	.000	1.013	.000
Female and speeding			0.215	.019	0.141	.136	0.146	.123	0.164	.086	0.163	.086
Female and failure to obey			-1.508	.134	-1.444	.152	-1.445	.151	-1.463	.146	-1.465	.146
Female and aggressive			-0.198	.560	-0.221	.515	-0.214	.529	-0.203	.551	-0.202	.553
Female and all			-0.997	.011	-1.073	.006	-1.065	.006	-1.042	.008	-1.043	.008
<21	0.264	.000	0.264	.000	0.199	.023	0.198	.024	0.190	.030	0.189	.033
21-34	0.113	.042	0.114	.040	-0.018	.816	-0.028	.725	-0.046	.562	-0.046	.558
65+	-0.618	.000	-0.613	.000	-0.469	.000	-0.458	.000	-0.443	.000	-0.441	.000
Female * <21					0.128	.304	0.128	.303	0.144	.246	0.146	.246
Female * 21-34					0.269	.014	0.286	.009	0.319	.004	0.321	.004
Female * 65+					-0.259	.082	-0.281	.060	-0.308	.039	-0.313	.037
Nonwhites	0.298	.000	0.298	.000	0.296	.000	0.182	.017	0.182	.017	0.184	.016
Female * nonwhite							0.258	.028	0.254	.030	0.250	.034
Nighttime	0.000	.000	0.000	.000	0.000	.000	0.000	.000	-1.178	.000	-1.178	.000
Female * nighttime									-0.244	.043	-0.245	.042
1 passenger	0.101	.074	0.104	.067	0.101	.075	0.103	.071	0.102	.073	0.079	.325
1+ passengers	0.119	.107	0.122	.099	0.118	.112	0.121	.103	0.118	.112	0.152	.160
Female * 1 passenger											0.044	.696
Female * 1+ passengers											-0.062	.676
Constant	-3.276	.000	-3.253	.000	-3.237	.000	-3.144	.000	-3.161	.000	-3.161	.000

NOTE: Reference dependent level is "No Level 1 crash." Model 1 includes main effects only. Models 2 through 6 progressively include dual gender interactions.



TABLE 4 Multinomial Regression of Level 2 Factors on Level 3 Factors and Covariables

Variable	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Coeff.	P > z	Coeff.	P > z	Coeff.	P > z	Coeff.	P > z	Coeff.	P > z	Coeff.	P > z
<i>Speeding</i>												
Female	-0.260	.000	-0.225	.000	-0.164	.000	-0.221	.000	-0.207	.000	-0.125	.008
Alcohol	0.540	.000	0.571	.000	0.570	.000	0.570	.000	0.556	.000	0.558	.000
Fatigue or inattention	-0.415	.000	-0.459	.000	-0.459	.000	-0.459	.000	-0.460	.000	-0.462	.000
Alcohol and fatigue	-0.074	.020	-0.055	.151	-0.057	.139	-0.058	.129	-0.071	.065	-0.070	.071
Female * alcohol			-0.083	.018	-0.080	.026	-0.079	.028	-0.042	.278	-0.048	.218
Female * fatigue			0.091	.185	0.091	.185	0.092	.180	0.094	.171	0.107	.118
Female * (alcohol and fatigue)			-0.041	.534	-0.036	.582	-0.033	.622	0.004	.951	0.004	.957
<21	0.769	.000	0.770	.000	0.785	.000	0.785	.000	0.780	.000	0.762	.000
21-34	0.462	.000	0.461	.000	0.512	.000	0.510	.000	0.503	.000	0.494	.000
65+	-0.895	.000	-0.895	.000	-0.840	.000	-0.837	.000	-0.830	.000	-0.833	.000
Female * <21					-0.035	.437	-0.035	.436	-0.022	.634	0.014	.766
Female * 21-34					-0.139	.000	-0.134	.000	-0.119	.002	-0.097	.012
Female * 65+					-0.131	.034	-0.139	.025	-0.155	.013	-0.162	.010
Nonwhites	-0.082	.000	-0.081	.000	-0.081	.000	-0.106	.000	-0.106	.000	-0.099	.000
Female * nonwhite							0.072	.061	0.069	.069	0.043	.262
Nighttime	0.235	.000	0.234	.000	0.233	.000	0.233	.000	0.268	.000	0.269	.000
Female * nighttime									-0.102	.007	-0.110	.003
1 passenger	0.195	.000	0.195	.000	0.194	.000	0.194	.000	0.194	.000	0.285	.000
1+ passengers	0.210	.000	0.209	.000	0.209	.000	0.210	.000	0.209	.000	0.307	.000
Female * 1 passenger											-0.253	.000
Female * 1+ passengers											-0.248	.000
Constant	-1.005	.000	-1.022	.000	-1.046	.000	-1.027	.000	-1.033	.000	-1.058	.000
<i>Failure to Obey</i>												
Female	0.329	.000	0.362	.000	0.485	.000	0.348	.000	0.379	.000	0.442	.000
Alcohol	-0.445	.000	-0.391	.000	-0.384	.000	-0.387	.000	-0.422	.000	-0.418	.000
Fatigue or inattention	-0.631	.000	-0.616	.000	-0.616	.000	-0.615	.000	-0.616	.000	-0.620	.000
Alcohol and fatigue	-1.236	.000	-1.204	.000	-1.198	.000	-1.203	.000	-1.234	.000	-1.233	.000
Female * alcohol			-0.116	.037	-0.126	.027	-0.122	.033	-0.050	.400	-0.056	.341
Female * fatigue			-0.024	.788	-0.026	.767	-0.026	.769	-0.024	.787	-0.013	.882
Female * (alcohol and fatigue)			-0.059	.688	-0.070	.635	-0.062	.671	0.004	.981	0.004	.979
<21	0.151	.000	0.152	.000	0.183	.002	0.182	.002	0.165	.006	0.147	.015
21-34	-0.118	.001	-0.119	.001	0.001	.979	-0.006	.913	-0.029	.582	-0.039	.464
65+	1.019	.000	1.019	.000	1.123	.000	1.132	.000	1.148	.000	1.149	.000
Female * <21					-0.046	.567	-0.046	.568	-0.015	.857	0.011	.888
Female * 21-34					-0.234	.001	-0.223	.002	-0.185	.011	-0.167	.022
Female * 65+					-0.182	.001	-0.200	.000	-0.228	.000	-0.237	.000
Nonwhites	0.005	.868	0.006	.846	0.006	.835	-0.077	.076	-0.076	.084	-0.065	.135
Female * nonwhite							0.171	.006	0.165	.008	0.143	.021
Nighttime	-0.777	.000	-0.781	.000	-0.780	.000	-0.780	.000	-0.642	.000	-0.640	.000
Female * nighttime									-0.338	.000	-0.344	.000
1 passenger	0.453	.000	0.454	.000	0.450	.000	0.451	.000	0.450	.000	0.509	.000
1+ passengers	0.391	.000	0.391	.000	0.389	.000	0.391	.000	0.389	.000	0.543	.000
Female * 1 passenger											-0.121	.032
Female * 1+ passengers											-0.277	.001
Constant	-1.912	.000	-1.933	.000	-2.002	.000	-1.937	.000	-1.952	.000	-1.981	.000

<i>Other Aggressive</i>												
Female	-0.118	.000	-0.100	.019	-0.144	.011	-0.130	.091	-0.123	.113	-0.135	.094
Alcohol	0.240	.000	0.255	.000	0.246	.000	0.246	.000	0.239	.000	0.239	.000
Fatigue or inattention	-0.982	.000	-0.840	.000	-0.839	.000	-0.839	.000	-0.839	.000	-0.839	.000
Alcohol and fatigue	-0.921	.000	-0.959	.000	-0.968	.000	-0.967	.000	-0.974	.000	-0.974	.000
Female * alcohol			-0.033	.589	-0.011	.856	-0.012	.852	0.005	.943	0.006	.926
Female * fatigue			-0.309	.042	-0.310	.041	-0.310	.041	-0.309	.042	-0.312	.040
Female * (alcohol and fatigue)			0.127	.412	0.145	.354	0.144	.357	0.160	.310	0.160	.309
<21	0.241	.000	0.240	.000	0.173	.001	0.173	.001	0.170	.002	0.175	.001
21-34	0.150	.000	0.149	.000	0.156	.000	0.157	.000	0.153	.000	0.155	.000
65+	-0.314	.000	-0.314	.000	-0.344	.000	-0.344	.000	-0.341	.000	-0.345	.000
Female * <21			0.179	.037	0.178	.037	0.178	.037	0.184	.032	0.176	.042
Female * 21-34			-0.018	.792	-0.020	.774	-0.020	.774	-0.013	.854	-0.019	.790
Female * 65+			0.070	.432	0.073	.417	0.073	.417	0.066	.467	0.076	.403
Nonwhites	-0.138	.000	-0.138	.000	-0.139	.000	-0.134	.001	-0.134	.001	-0.137	.001
Female * nonwhite			0.000	.000	0.000	.000	0.000	.781	-0.020	.769	-0.010	.887
Nighttime	0.000	.000	0.000	.000	0.000	.000	0.000	.000	0.133	.001	0.133	.001
Female * nighttime									-0.049	.476	-0.047	.500
1 passenger	0.145	.000	0.145	.000	0.147	.000	0.147	.000	0.146	.000	0.179	.000
1+ passengers	0.230	.000	0.230	.000	0.235	.000	0.235	.000	0.234	.000	0.178	.007
Female * 1 passenger											-0.071	.346
Female * 1+ passengers											0.138	.155
Constant	-2.151	.000	-2.160	.000	-2.143	.000	-2.146	.000	-2.149	.000	-2.148	.000
<i>All Together</i>												
Female	-0.534	.000	-0.560	.000	-0.432	.000	-0.660	.000	-0.664	.000	-0.610	.000
Alcohol	0.575	.000	0.573	.000	0.564	.000	0.561	.000	0.562	.000	0.564	.000
Fatigue or inattention	-1.203	.000	-1.325	.000	-1.331	.000	-1.331	.000	-1.331	.000	-1.334	.000
Alcohol and fatigue	-0.911	.000	-0.947	.000	-0.959	.000	-0.964	.000	-0.963	.000	-0.963	.000
Female * alcohol			0.010	.902	0.042	.606	0.045	.578	0.032	.718	0.025	.777
Female * fatigue			0.295	.193	0.313	.167	0.318	.160	0.317	.161	0.329	.146
Female * (alcohol and fatigue)			0.147	.488	0.193	.364	0.209	.326	0.198	.357	0.197	.359
<21	0.961	.000	0.961	.000	1.049	.000	1.047	.000	1.047	.000	1.036	.000
21-34	0.594	.000	0.594	.000	0.680	.000	0.674	.000	0.674	.000	0.668	.000
65+	-0.846	.000	-0.845	.000	-1.045	.000	-1.037	.000	-1.037	.000	-1.037	.000
Female * <21			-0.318	.002	-0.319	.002	-0.319	.002	-0.325	.002	-0.304	.004
Female * 21-34			-0.280	.002	-0.261	.003	-0.266	.003	-0.266	.003	-0.251	.005
Female * 65+			0.440	.006	0.407	.011	0.413	.011	0.413	.011	0.401	.013
Nonwhites	-0.174	.000	-0.173	.000	-0.172	.000	-0.243	.000	-0.242	.000	-0.236	.000
Female * nonwhite							0.291	.001	0.292	.001	0.269	.003
Nighttime	0.297	.000	0.296	.000	0.290	.000	0.291	.000	0.292	.000	0.294	.000
Female * nighttime									0.024	.783	0.016	.853
1 passenger	0.411	.000	0.411	.000	0.410	.000	0.411	.000	0.411	.000	0.447	.000
1+ passengers	0.385	.000	0.384	.000	0.381	.000	0.385	.000	0.385	.000	0.477	.000
Female * 1 passenger											-0.064	.478
Female * 1+ passengers											-0.273	.025
Constant	-2.945	.000	-2.938	.000	-2.979	.000	-2.926	.000	-2.926	.000	-2.942	.000

NOTE: Reference dependent level is "No Level 2 crash." Model 1 includes main effects only. Models 2 through 6 progressively include dual gender interactions.

of higher-level factor conditions in analytical models explains the occurrence of crashes at lower levels. These results also reveal the implicit complexity of the HLDB model and the analytical difficulties such a model presents. The HLDB model proposed here could be analytically visualized as a multilevel model with multinomial categorical dependent variables, both continuous and categorical independent terms with weights adjusting for driving exposure, and the inclusion of interaction terms. To the authors' knowledge, none of the statistical packages currently available (e.g., Mplus, STATA-Gllamm, SAS) satisfactorily deals with all of these analytical complexities, particularly in a situation like this, in which the need to model interaction terms of meaningful interpretation was highly relevant. To address this limitation, the analyses were separated into two parts to look independently at the contribution of Level 3 to the Level 2 crashes and of the Level 2 crashes to the Level 1 crashes. Although this approach did not allow for a full integration of the three-level factors, it did provide some meaningful results.

Focusing on the gender-related interaction terms and going from Level 1 to Level 3 showed that, compared with males, female drivers were overrepresented in fatal maneuver and weather–slippery surface (i.e., Level 1 factor) crashes, but mostly when they were speeding. That is, although female drivers are not more prone to skill-related crashes than males, they seem to be more vulnerable to these crashes than males when speeding (a Level 2 crash factor) is involved. This overall finding is moderated by the presence of passengers and the time of day in which the crash occurs, for female drivers are less likely to speed than males when carrying a passenger during the daytime. Interestingly, although speeding seems to induce more “loss of control” crashes (i.e., Level 1 crashes) among female drivers than among males, the study shows that females are less likely to speed than males. Moreover, even when alcohol (a Level 3 crash factor that induces speeding) is present, female drivers are less likely to speed than their male counterparts.

Although female drivers are less likely to be involved in alcohol-related crashes, they are overrepresented in the other Level 3 crash factor under consideration: fatigue or inattention. The overrepresentation of females in this Level 3 factor did not, however, affect the involvement of female drivers in either Level 2 or Level 1 crashes. Perhaps the most surprising finding of this study is the overrepresentation of female drivers in failure-to-obey crashes, for which this paper does not offer an explanation.

In summary, this study presents new evidence against the popular belief that female drivers are more prone to be involved in skill-related crashes than males. At least such evidence is strong under “normal” traffic conditions. It might not be the case, however, when speeding is involved. Nevertheless, the finding that females are less

likely to speed than males tends to compensate for such negative outcome, at least at the aggregated level.

Despite its interesting results, this study is not free of shortcomings. Data for this study include only fatal crashes. Further, to maximize the likelihood that drivers included in this study were responsible for the crash, only single-vehicle crashes were included in the data set. It is very likely that the application of the HLDB model to nonfatal crashes might have yielded very different results. Another shortcoming of this study involves the construction of the levels and factors applied. Such a construction unavoidably implies some degree of arbitrariness; however, to minimize such arbitrariness in building these variables, the FARS instructions were followed to the degree possible.

Another weakness of the study involves the data used to adjust for driving exposure. As mentioned, estimates of VMT are currently available only for the years 1995 and 2001. Extrapolating those estimates to other years may have led to sudden or recent changes, or both, in driving patterns being ignored in the analyses. Finally, another limitation to this study (perhaps the most relevant) involves the possibility of bias on the part of the officers who coded the crashes. Police officers may have been more prone to assign different codes to females than males (e.g., by assigning a maneuver code to females more frequently than to males). Nevertheless, the study only found an association between female drivers and maneuver crashes in situations in which speeding was involved. If there was gender-related bias in the way that these types of crashes were registered, then such an association between speeding and maneuver crashes should be revisited.

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# Spatial Variation in Motor Vehicle Crashes by Gender in the Houston, Texas, Metropolitan Area

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This study examines spatial variation in motor vehicle crashes by gender within the Houston, Texas, metropolitan area. Examination of data on 252,240 crashes that occurred in the Houston metropolitan area between 1999 and 2001 showed that substantial behavioral differences between male and female drivers contributed to the crashes. Males had more severe crashes than females and showed riskier driving behavior for every crash type. Crash risk varied throughout the metropolitan area, however, being much higher in the central city than in the suburbs. Because male drivers were more likely to be involved in crashes in the central city than female drivers, part of the gender differential in crashes appears to be the result of men driving in riskier locations. A negative binomial regression model, estimated with the Markov Chain Monte Carlo method, was tested on road segments and showed gender differentials controlling for the volume-to-capacity ratio, the distance from downtown, and functional road classification. The general pattern of women making more frequent but shorter trips was associated with driving to less risky destinations. It is argued that lack of information on driver residences prevents a more detailed analysis of crash risk and that exposure to crashes needs to be understood in terms of behavior and not just relative to travel distance.

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**T**his paper examines gender differences in motor vehicle crashes within the Houston, Texas, metropolitan area with respect to spatial location. In particular, the study shows that part of the differential in crash risk between women and men is due to differences in the spatial location of the crashes, most likely the result of different driving patterns.

It has long been known that there are substantial differences in crash likelihood between women and men, and that, whether the total number of crashes or crash rates (relative to population or to travel exposure) are examined, men far exceed women in the number and severity of crashes. Gender is the second strongest predictor of crash likelihood, after age.

For example, the National Safety Council showed that in 2003, men incurred more deaths from unintentional injuries for all age groups from 0 to 82 (National Safety Council 2007a, pp. 16–17). In terms of fatalities caused by motor vehicle crashes, men exceeded women by a ratio of 2.2 to 1 in 2003 (National Safety Council 2007a, p. 20). The National Highway Traffic Safety Administration (NHTSA) documented that men accounted for 68% of all motor vehicle fatalities between 1996 and 2005, with female fatalities decreasing by 0.7% per year while male fatalities were increasing by 0.8% per year over the period (NHTSA 2007a).

On a per capita basis, males had higher motor vehicle fatality rates per 100,000 population for every age group from 1 through 85 and above from 1950 through 2005 (U.S. Department of Health and Human Services 2008). This held for every ethnic group documented. In 2007, the fatality rate per 100,000 persons was higher for males than for females in every age group (NHTSA 2007b).

## FACTORS AFFECTING GENDER DIFFERENCES IN CRASHES

### Driving Exposure

Some differences are due to differential driving exposure. Three simple measures of exposure are found in the lit-

erature. First, there is the number of driver's licenses issued for men and women as a simple indicator of ability to drive. Licensing, however, is more or less balanced by gender within the United States (Federal Highway Administration 2006).

Second, there are differences in aggregate driving distance, usually measured as vehicle miles traveled (VMT) or vehicle kilometers traveled (VKT). Historically, men have driven more than women, which partly explains the gender differentials in crashes. In 2001, for example, the National Household Travel Survey indicated that men traveled by personal vehicle an average of 39 mi per day while women traveled an average of 31 mi per day, a ratio of 1.25 to 1 (Bureau of Transportation Statistics 2004). Nevertheless, the differential by gender in driving has been decreasing over time, and while still not at equal levels, is starting to balance out (National Safety Council 2000, p. 93). Not surprisingly, some of the gender differences in crashes have decreased as this driving differential has narrowed (Kostyniuk et al. 2000).

Third, there are differences in individual trip length. In theory, longer trips should be associated with greater crash risk, all other things being equal, and some support for this has been found (Moellering 1974). Unfortunately, there is no information that is publically available for identifying trip length by drivers involved in crashes, nor even information released that could allow synthetic trips from the driver residence to the crash location to be constructed. In Texas, as in most other states, the location of the residence of a driver involved in a crash is not provided in publically accessible databases. Although this information is collected in the crash report, it is not released to the public, researchers, or local government agencies. Consequently, trip length cannot be used as a baseline for measuring crash risk.

### Risky Driving Behavior

By far the strongest factor accounting for the large male-to-female ratios in severe crashes is riskier driving behavior by men (or, more accurately, a proportion of men showing risky behavior that is greater than the proportion of women showing risky behavior). For example, in 1999, the National Safety Council estimated that the ratio of fatalities per 1 billion vehicle miles driven for men to women was 1.5, although for all crashes, the ratio was 0.85. In other words, men were involved in more severe crashes and women were involved in less severe crashes (National Safety Council 2000, p. 93). This result has been shown for individual states (Michigan Department of State Police 2007). Even among older drivers (age 70 or older), males exceed females in fatalities by a ratio of 2 to 1 (Baker et al. 2003).

Kim (2000) found that in Hawaii, a higher proportion of males involved in crashes were killed compared

with women, who, in turn, were injured proportionately more. Examining risk factors, he found that men significantly exceeded women in crashes involving driving while intoxicated (DWI), speeding, driving at nighttime, and being involved in head-on collisions. Also, men were less likely to have used a seat belt. On the other hand, women were more involved in crashes at intersections and in failing to yield the right of way.

Kostyniuk et al. (2000) examined crashes in Michigan between 1987 and 1994 and found that, while certain risky driving behavior had increased among women drivers (e.g., following too closely, speeding), other behaviors decreased (e.g., DWI). Men showed higher risk in driving than women for all risky behaviors. Of those women who showed an increase in risky behavior, most were younger women.

The differential in risk applies to specific types of crashes as well. For example, in a study of Baltimore, Maryland, from 2000 to 2002, women were involved in fewer pedestrian crashes overall and, when involved, exhibited fewer risk-taking behaviors such as consuming alcohol or violating traffic laws (Clifton et al. 2005). In other words, in general, male drivers take more risks than female drivers, resulting in higher fatality rates and severe injury rates (Social Issues Research Centre 2007).

### Other Factors Affecting Gender Differences in Crashes

Although risky driving behavior is the dominant factor, there are other factors that affect gender differences in crashes. First, women are less likely to drive on freeways and more likely to drive on arterial roads than men. Because freeways have a much lower crash risk than arterial roads, women are exposing themselves to higher risk. This behavior would run counter to the general tendency of males taking more risks; however, when crashes occur on freeways, they tend to be more severe, on average, than crashes on arterials.

The differences in driving patterns between men and women constitute a second factor. A large number of studies has shown that women travel shorter distances than men, on average, but make more trips (Giuliano 1979; Gordon et al. 1989; Hanson and Johnston 1985; Madden 1981; Michelson 1983; Nobis and Lenz 2005; Pickup 1985; Rosenbloom 2000; Rosenbloom and Burns 1993; Rutherford and Wekerle 1989; Skinner and Borlaug 1980; Wachs 1997). This behavior would be expected to result in fewer crashes because women are less likely to drive in high-risk areas. Levine et al. (1995a, 1995b) showed that crash risk increased substantially toward the center of downtown Honolulu. Driving trips that are more local would be less likely to encounter the high-risk roads of the central city.

Therefore, two hypotheses are proposed to partially explain differences in crash likelihoods between men and women:

1. There are spatial differences in the crash likelihoods of men and women.
2. Men are more likely than women to be involved in crashes in areas at high risk for crashes, implying an untested hypothesis that men drive more to risky environments than women.

## METHODOLOGY

This study examines gender differentials in crash risk by spatial location within the Houston metropolitan region, an eight-county area that surrounds the City of Houston and that encompassed a population of around 5 million in 2000. Between 1999 and 2001, there were 252,241 serious crashes in the eight-county region, an average of 84,080 a year. In these crashes, 1,882 persons were killed and 281,914 persons were injured. The crashes accounted for 26% of all serious crashes in Texas during that period compared with the region's 22% share of the state's population and 21% share of the state's VMT (Levine 2009).

The likelihood of a driver in the region being involved in a fatal or injury crash in the region was 36% higher than the Texas average and 149% higher than the U.S. average. The region led the state of Texas in virtually every type of crash and led the nation in alcohol-related fatalities per capita (NHTSA 2008; *Houston Chronicle* 2009).<sup>1</sup>

## Data Sources

The data were compiled by the Crash Records Bureau of the Texas Department of Public Safety, the agency that was vested at the time with compiling crash information for every jurisdiction in Texas (Texas Department of Public Safety 2007). The agency collected data on crashes involving fatalities, injuries, and serious property damage (defined as one or more vehicles being towed from the crash scene). These data represent the most severe crashes, as nonserious property-damage-only crashes are not included. Because of delays in releasing information, data were obtained only for crashes that occurred between 1999 and 2001.

## Driver 1

In the Texas crash report, fault is not determined by the investigating police officer, as it is in some other states

<sup>1</sup> Special compilation by the National Highway Traffic Safety Administration, Region 6.

(see Kim 2000). This is a function of the courts. Police officers are trained, however, to list vehicles in the order in which responsibility for the crash is assumed to lie. With one exception, the first driver listed (Unit 1 or Driver 1) is generally the individual seen as most responsible for causing the crash.

Additional information on behavioral factors associated with the crash (called contributing factors) is also listed. By analyzing these contributing factors for Driver 1, the causes of the crash can be assessed. For example, 82% of DWI crashes, 97% of speeding crashes, 93% of following-too-closely crashes, and 74% of failure-to-stop crashes were attributed to Driver 1. On the other hand, only 32% of failure-to-yield crashes were attributed to Driver 1.<sup>2</sup> Thus, an analysis of the factors associated with Driver 1 provides a reasonably accurate picture of crashes associated with DWI, speeding, failure to stop, and following too closely, but not of crashes associated with failure to yield.

Characteristics of the vehicle of the driver were listed on the form, including the driver's gender, age, and race. Gender was recorded for Driver 1 in 239,946 of the 252,241 crash records.

## Spatial Location

For the crash location, the data were geocoded according to a methodology that was developed initially in Honolulu (Levine and Kim 1999; Levine et al. 1995a, 1995b). Approximately 82% of the crashes were geocoded, with accuracy being around 91%. Of the 252,241 crash records, 206,577 had spatial locations assigned.

## Male-to-Female Crash Ratios

Without understanding both the trip origin and the trip distance, it is difficult to analyze the extent to which crashes reflect driving exposure. Consequently, the approach used by Kim (2000) was used, namely, to analyze the ratio of male-to-female crashes for different geographical levels. Establishing a baseline ratio for all crashes allows comparisons of risk by males relative to females as well as comparisons by location. In doing this, it is assumed that behavioral differences in risk taken by males and females are independent of spatial location.

<sup>2</sup> Of the 49,542 failure-to-yield crashes, 34,315 were assigned to Driver 2. For those crashes, Driver 1 was attributed with speeding in 1,142 of the cases and also with failure to yield in 394 of the cases, failure to stop in 228 of the cases, and making a passing error in 147 of the cases.

## Spatial Analysis

Spatial analysis was conducted for three geographical levels:

1. The metropolitan area by individual crashes. The entire database was used.
2. By distance from downtown Houston. A series of 40 one-mi bands was overlaid on the study area, centered on downtown Houston, and crashes within each band were calibrated. All crashes were analyzed, as were crashes by severity.
3. By individual segments on major roadways. A modeling network was obtained from the Houston-Galveston Area Council, the metropolitan planning organization for the Houston area. The modeling network has 10,911 segments, including all major roads (freeways, principal arterials), most minor arterials, and some collector roads. The data had information on functional road classification, traffic volume, number of lanes, segment length, VMT, roadway capacity, and the volume-to-capacity (V-C) ratio. The network includes the vast majority of the region's VMT. Crashes that occurred on or very close to the modeled road segments were allocated to the nearest road segment.<sup>3</sup> The direct distance of the segment midpoint to downtown Houston in miles was calculated.

## RESULTS

### Gender Differences for the Metropolitan Area

#### *Severity of Injury*

Of the 239,946 crashes for which the gender of Driver 1 was known, 152,719 (or 64%) were by males. Furthermore, consistent with other studies, males were involved in a higher proportion of the most severe crashes—those involving fatalities (79%)—and of crashes involving incapacitating injuries (68%), probable injuries (63%), possible injuries (61%), and serious property damage only (66%).

Using the National Safety Council methodology for monetizing the comprehensive costs of crashes for the year 2000 (National Safety Council 2007b), it was estimated that the average cost per crash involving a male Driver 1 was \$44,119, while the average cost per crash

involving a female Driver 1 was \$29,623 (both in year 2000 dollars).<sup>4</sup>

These results are partly consistent with prior research. The higher proportion of males being involved in serious crashes is consistent. The higher proportion of males involved in less serious injury crashes is not consistent, however, nor is the higher proportion of males involved in property-damage-only crashes. As mentioned above, this database only included the most serious property damage crashes, so that the general conclusions might apply if a full record were available. The excess of less serious injuries by males is different from the national data and studies conducted elsewhere. Houston has a severe traffic safety problem in general and crash rates are among the worst for metropolitan areas in the country.

#### *Risky Driving Behavior*

Again, consistent with other studies, males were more involved in crashes involving risky driving behavior. Table 1 presents the numbers and ratios of male-to-female crashes for different types of behaviors documented on the “contributing factors” field of the Texas crash report. The data are for Driver 1.

For all contributing factors documented, males exceeded females on every single type, including the use of cell phones. For this latter factor, data were only collected in 2001 and, because the numbers are small, conclusions are uncertain. For all crashes, the ratio of male to female crashes was 1.75 to 1. Unfortunately, estimates of VMT by gender are unknown for the Houston metropolitan area. If VMT by gender does follow the 2001 national rate, however, then it would be expected that this ratio should be 1.25 to 1 (Bureau of Transportation Statistics 2004). Consequently, two chi-square tests of the observed frequencies relative to expected frequencies were conducted (Kanji 1993, p. 69): first, whether the ratio differed from the regional average of 1.75 to 1, and, second, whether the ratio differed from an expected ratio of 1.25 to 1 based on the national estimate of driving exposure.

Factors with ratios significantly higher than the regional average include DWI, speeding, driving in the wrong direction, passing errors, making a bad turn or start, and poor signaling. At the other end, factors with lower ratios than the regional average include failure to yield the right-of-way, following too closely, and failure to stop at a traffic light or stop sign (slightly below the

<sup>3</sup> The geocoding assigned crashes to the nearest intersection, regardless of whether they actually occurred in an intersection or not (43% had). The crashes were then assigned to the midpoint of the segment, most of which were one block long. Because all intersections link two to four road segments, there is a slight local bias in the allocation, as a crash is assigned to the segment to which it is closest (i.e., the shortest segment).

<sup>4</sup> The National Safety Council estimates both economic (direct) and comprehensive (lifetime) costs. This paper considers only the comprehensive costs. For the year 2000, these were fatality (\$3.1 million), incapacitating injury (\$159,449), probable injury (\$41,027), possible injury (\$19,528), and property damage only (\$6,400).



TABLE 1 Behavioral Factors Associated with Crashes for Driver 1

Contributing Factor	Driver 1		Male/Female Ratio	<i>p</i> to Average <sup>a</sup>	<i>p</i> to 1.25 <sup>a</sup>
	Male	Female			
All crashes	152,719	87,227	1.75	—	***
Speeding	59,999	29,968	2.00	***	***
Failure to yield right of way	8,535	7,126	1.20	***	**
Failure to stop at stop sign or traffic light	12,101	7,101	1.70	NS	***
Driving while intoxicated	11,541	2,499	4.62	***	***
Following too closely	3,779	2,348	1.61	**	***
Passing error	1,562	712	2.19	***	***
Bad turn or start	907	440	2.06	**	***
Driving the wrong way	614	257	2.39	***	***
Cell phone use <sup>b</sup>	114	95	1.20	**	NS
Poor signaling	54	27	2.00	NS	*

<sup>a</sup>  $\chi^2$  test of difference between observed and expected frequencies (Kanji 1993, p. 69): — = not applicable; NS = not significant.

<sup>b</sup> For 2001 only.

\*  $p \leq .05$ , \*\*  $p \leq .01$ , \*\*\*  $p \leq .001$ .

average). All ratios were significantly different from both the regional average and what was expected on the basis of the national exposure rate, with two exceptions. First, the ratio for failure to stop at traffic lights or stop signs was not different from the regional average, although it was significantly higher than the ratio that would be expected if national driving exposure ratios held.

Second, cell phone use was not different from the ratio expected if the national driving exposure ratios held, but was significantly lower than the regional average. Nonetheless, the data indicate that with these two exceptions, men were more likely to be involved in crashes than would be expected based on national exposure. Further, for the most dangerous types of driving behavior—DWI, speeding, and driving in the wrong direction—men far exceeded women.

Figure 1 shows Driver 1 by gender for all crashes in 5-year age groups up to age 85 or older. For every behavioral factor listed, with only one exception, males exceeded females in every age group up to age 85 or older (analysis not shown). The exception was for the group age 80 to 84 years on failure-to-stop crashes, where women slightly exceeded men (ratio = 0.94).

### Gender Differences in Crash Risk by Distance from Downtown Houston

Some of these differences can be explained by spatial variation in crashes by males and crashes by females. Crash risk is much higher in the central city than in the suburbs in Houston as in other cities (Levine et al.

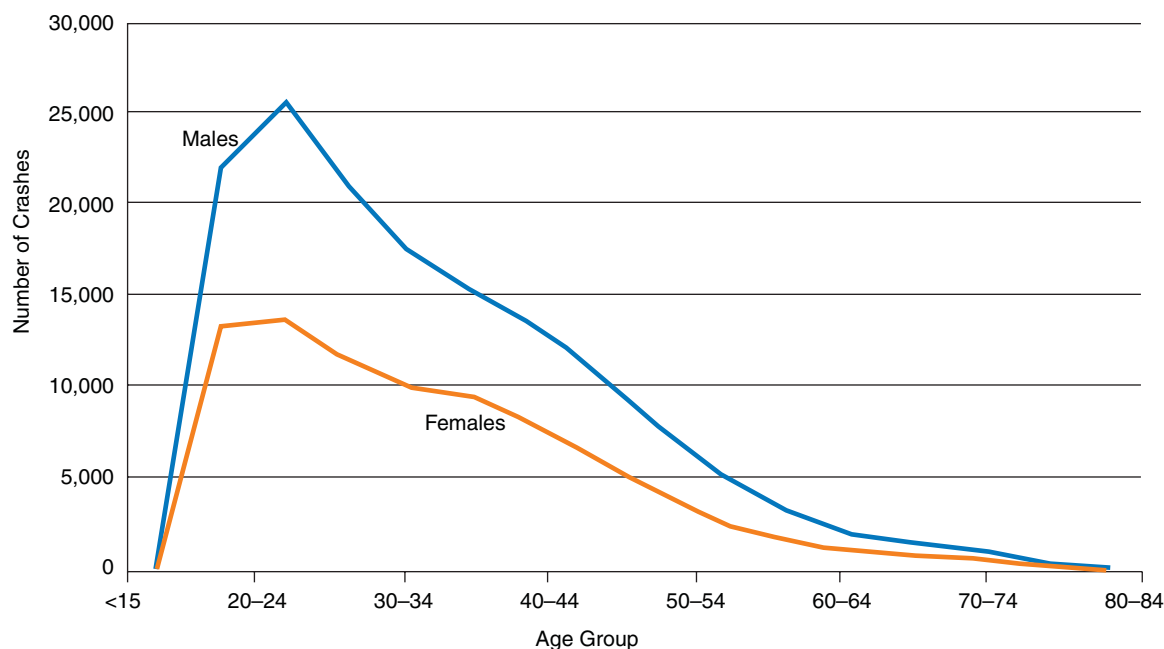


FIGURE 1 Gender differences in all crashes in Houston, by age group: 1999–2001.

1995a). To examine this, 40 one-mile-wide bands were overlaid in a geographic information system on the geocoded crash data, and the annual number of crashes in each band was calculated.

Figure 2 shows the number of fatal crashes per mile as a function of distance from downtown Houston, while Figure 3 shows the number of injury and serious prop-

erty damage crashes per mile. Since the area of each band increases with distance, the raw numbers are somewhat misleading. Even though fatal crashes and, to a lesser extent, serious property-damage-only crashes are more dispersed, the majority of fatal, injury, and serious property damage crashes did occur centrally. For example, 12% of fatalities and 18% of injuries occurred within a

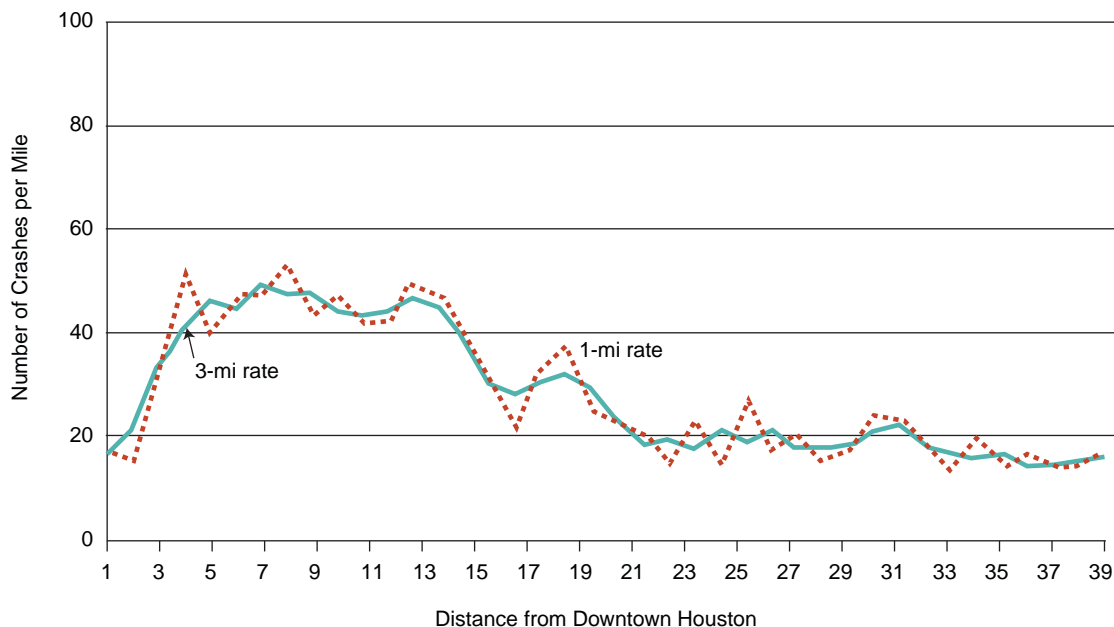


FIGURE 2 Fatal crashes per mile, by distance from downtown Houston: 1999–2001.

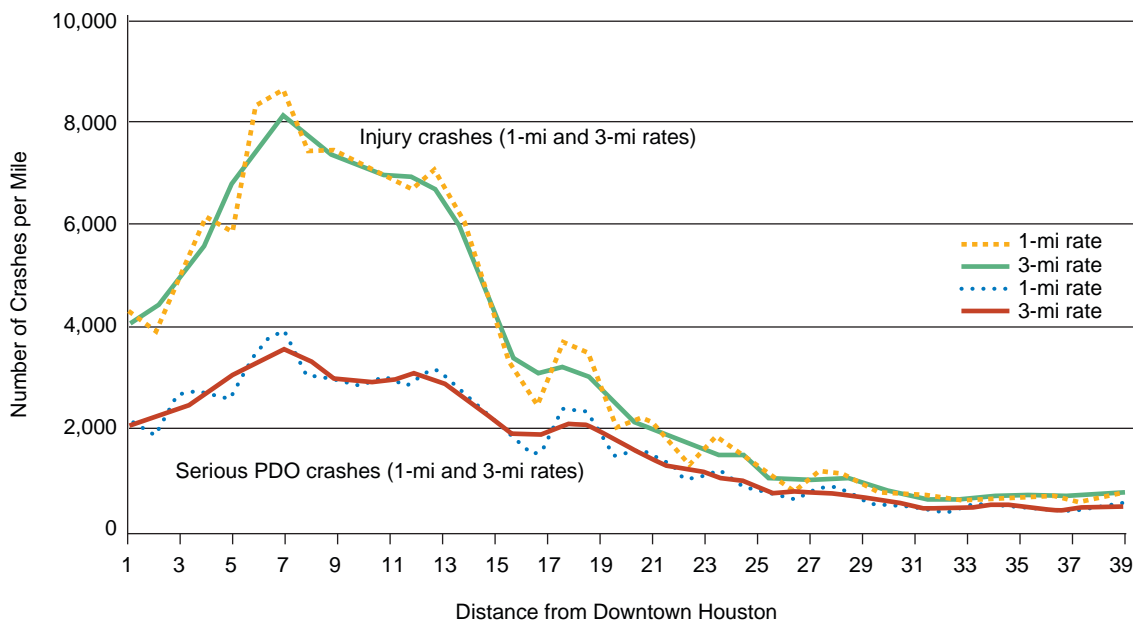


FIGURE 3 Injury and serious property damage crashes per mile, by distance from downtown Houston: 1999–2001. (NOTE: PDO = property damage only.)

5-mi radius of downtown Houston, and 31% of fatalities and 47% of injuries occurred within a 10-mi radius (out of a 40-mi radius for the region).

To estimate VMT, the same bands were overlaid on the modeling network and the daily VMT within each band was also calculated. Using these calculations, crash risk was calculated as annual crashes per 100 million VMT per band.<sup>5</sup> Relating crashes to VMT eliminates the bias of increasing area in each sequential band moving away from downtown Houston. Figure 4 shows the variation in crash risk by distance from downtown Houston; the dashed line is the 1-mi rate, while the solid line is a moving 3-mi spatial average. As seen, crash risk is much higher in downtown Houston than in suburban areas.

### *Crash Risk by Distance from Downtown Houston*

For the region, crash risk was estimated at 167 crashes per 100 million VMT.<sup>6</sup> For downtown Houston, crash risk averaged almost 300 crashes per 100 million VMT. It dropped off rapidly until about 17 mi from the city center (the suburbs that have been built since the 1980s),

<sup>5</sup> The crashes were annualized by dividing by three (for the 1999 to 2001 data). The daily VMT estimated by the Houston–Galveston Area Council was converted into annual VMT by multiplying by 365. Finally, for each band, crash risk was calculated by dividing the annual number of crashes by the annual VMT and multiplying the result by 100 million.

<sup>6</sup> The regional crash risk ratio includes all crashes in the region but only VMT estimated from the modeling network. The index is therefore upwardly biased.

where it maintained a relatively stable rate of about 150 crashes per 100 million VMT for the rest of the region. In other words, crash risk in the central city, particularly in downtown Houston, was about double the risk of that in the suburbs.

To examine the severity of crashes by location, the crashes in each band were monetized using the National Safety Council methodology and related to VMT (National Safety Council 2007b). Figure 5 shows the annual cost of crashes (in year 2000 dollars) per 100 million VMT by distance from downtown Houston. As seen, the costs in the central city and in the far suburbs are much higher than in the new suburbs.

### *Gender Differences in Crashes by Distance from Downtown Houston*

Gender differences in crashes by location appear to mirror this trend. For each distance band, the ratio of male Driver 1 to female Driver 1 was calculated. Figure 6 shows the variation in this index by distance from downtown Houston. Again, the dashed line is the 1-mi ratio and the solid line is a moving 3-mi average. In downtown Houston, the ratio was close to 1.9 (compared with the regional average of 1.75) but dropped to a low of 1.5 at about 20 mi out (the newer suburbs), whereupon it increased again to the edge of the region.

It is very clear that there is variation of about 25% in the ratio of male-to-female crashes by Driver 1. It also appears that this ratio follows the spatial trend of crash risk to some extent. The increase in male-to-female

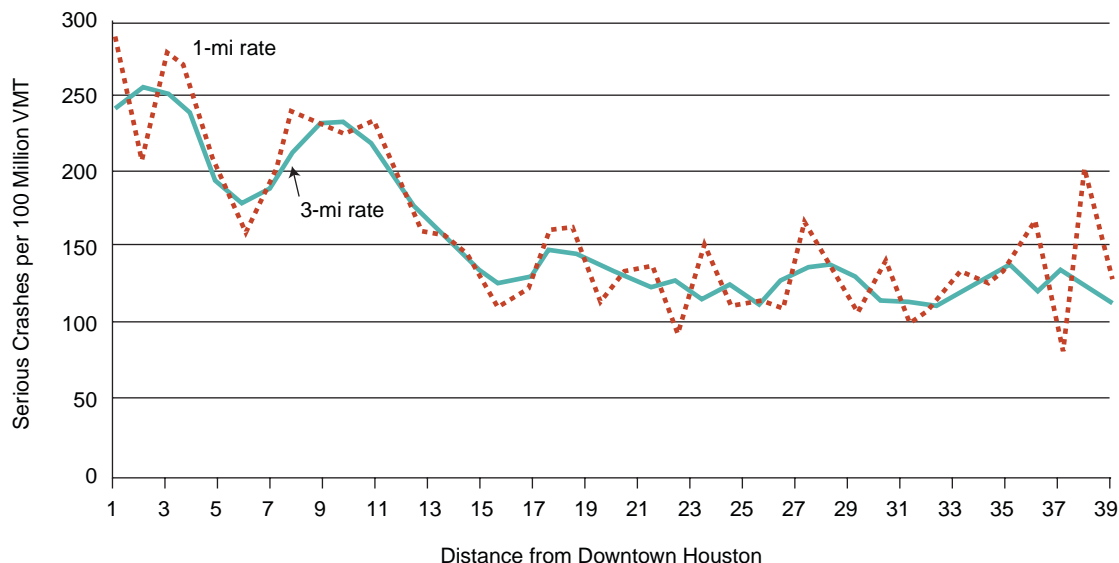


FIGURE 4 Annual crash risk, by distance from downtown Houston: 1999–2001.

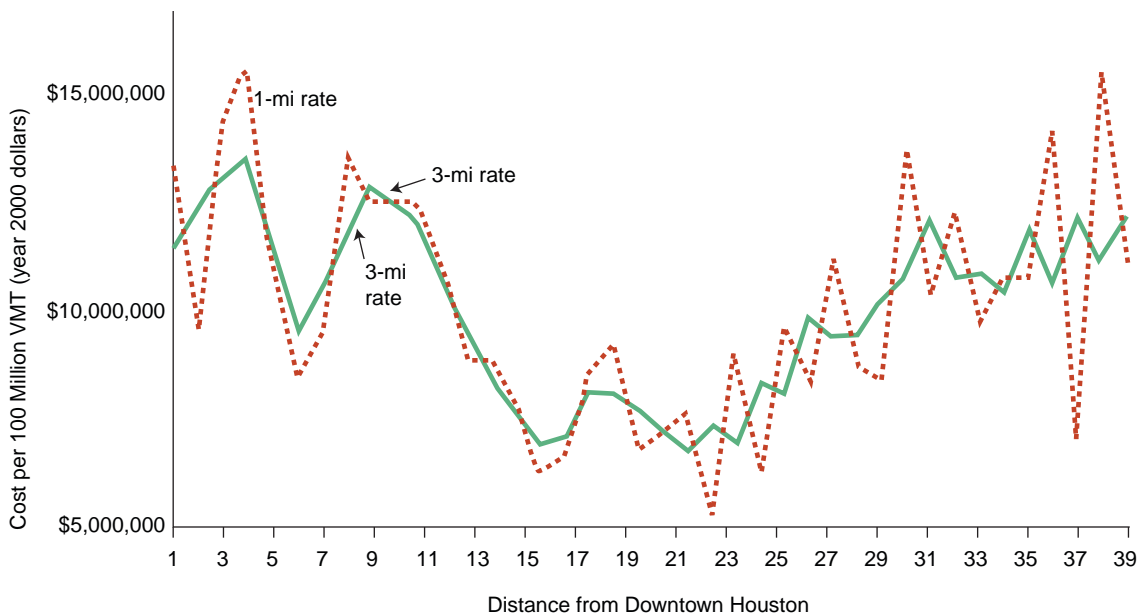


FIGURE 5 Annual cost of crashes per 100 million VMT, by distance from downtown Houston: 1999–2001.

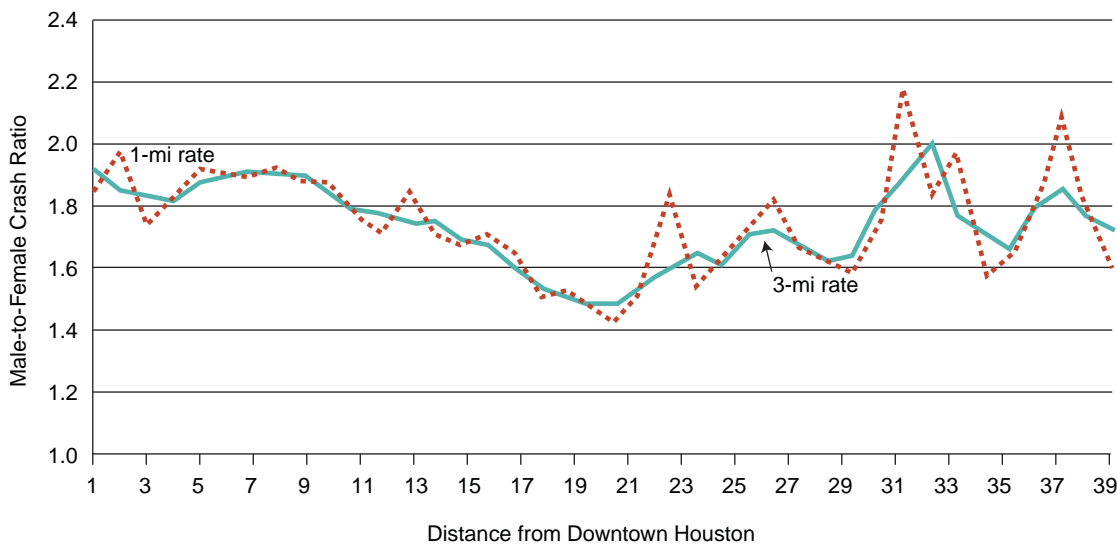


FIGURE 6 Ratio of male crashes to female crashes in Houston for Driver 1: 1999–2001.

crashes at the more suburban and rural parts of the area are, however, a function of other factors (probably increased speeds and an absolute predominance of adult males over adult females in three of the seven suburban counties).

**Gender Differences by Road Segments**

There were substantial differences in male-to-female ratios for different road classes. Table 2 presents the

crash risk for each functional road class and the number and ratio of male-to-female crashes. As seen, the crash risk for the modeled network is lower than the regional average, mostly the result of not including crash and VMT data for non-network segments. Freeways had, by far, the lowest crash risk, and minor arterials had the highest (excluding the category “other,” for which the numbers are low). The ratio of male-to-female crashes was significantly higher on the freeway segments and significantly lower on the principal and minor arterial segments.

TABLE 2 Functional Road Classes Associated with Crashes for Driver 1

Road Class	Crash Risk	Driver 1		Male/Female Ratio <sup>a</sup>
		Male	Female	
All network crashes	120.8	30,216	17,166	1.76
Freeway	50.0	6,879	3,430	2.01***
Principal arterial	99.6	6,813	4,141	1.65***
Minor arterial	221.9	14,056	8,228	1.71*
Collector	140.2	2,002	1,118	1.79NS
Other	3,405.6	466	249	1.87 NS

NOTE: Annual number of crashes.

<sup>a</sup>  $\chi^2$  test of difference between observed and expected frequencies (Kanji 1993, p. 69); NS = not significant.

\*  $p \leq .05$ , \*\*  $p \leq .01$ , \*\*\*  $p \leq .001$ .

In other words, these data indicate that while men are more likely to be involved in crashes on all road types, women are proportionately more likely to be involved in crashes on principal or minor arterial roads and much less likely to be involved in crashes on freeways. This is consistent with the general travel patterns of women making shorter, but more frequent trips than men. Freeways are designed for longer trips, particularly to the central city. Because principal arterials have a higher crash risk than freeways, women are exposed to higher risk by their road choices. Still, the increased risk is small compared with the variation within the metropolitan area discussed above, namely, that men appear to drive to the central city more often than women.

### Negative Binomial Regression Model with Spatial Location

To examine the interaction between roadway characteristics, spatial location relative to downtown Houston, and crashes, two multivariate models were developed to predict (a) the crash risk and (b) the male-to-female crash ratio for Driver 1.<sup>7</sup> The models were applied to the road segments of the modeling network.

The model has two properties that apply to these data. First, it has a Poisson mean, which is appropriate for highly skewed data such as motor vehicle crashes (Cameron and Trivedi 1998). Second, it allows for extreme dispersion in the degree of skewness and is modeled by a Gamma function (Cameron and Trivedi 1998; Lord 2006). This type of Poisson–Gamma model is known as a negative binomial.

Because the dependent variables are ratios (crashes relative to VMT and male crashes relative to female crashes), the formulation used is that of Besag et al. (1995). The dependent variable,  $Y_i$ , is modeled as a Poisson function of the mean,  $\mu_i$ :

$$Y_i = \text{Poisson}(\mu_i) \tag{1}$$

In turn, the mean of the Poisson is modeled as

$$\mu_i = v_i \lambda_i \tag{2}$$

where  $v_i$  is an exposure measure and  $\lambda_i$  is the rate (or risk). For the crash risk model, the exposure variable is VMT and the rate variable is crash risk. In the case of the male-to-female crash ratios, the exposure variable is the number of female crashes and the rate is the male-to-female crash ratio.

The rate is further structured as follows (Cameron and Trivedi 1998; Lord 2006):

$$\lambda_i = \exp(\beta_0 + \Sigma(\beta_k X_k) \times \xi_i) \tag{3}$$

where

- $\beta_0$  = constant,
- $X_k$  = one of  $k$  variables,
- $\beta_k$  = coefficient of variable  $X_k$ , and
- $\xi_i$  = error term distributed as a Gamma function with a mean equal to 1 and a variance equal to  $1/\alpha$ , where  $\alpha > 0$ .

With the exposure term, the full model is estimated as a log-linear function:

$$Y_i = \beta_i * \exp[\beta_0 + \Sigma(\beta_k X_k)] * \xi_i \tag{4}$$

$$\ln(Y_i) = \ln(v_i) + \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_k X_k + \ln(\xi_i) \tag{5}$$

In the case of crash risk, the term on the left is the number of crashes while the terms on the right include traffic volume multiplied by a function of other variables (which are linear predictors but in an exponential form). In the case of the male-to-female crash ratio, the term on the left is the number of male crashes and the terms on the right include the number of female crashes—the exposure variable, multiplied by a linear combination of

<sup>7</sup> It is not possible to use the male-to-female crash ratio to predict crash risk (or vice versa), as there would be extreme multicollinearity.

additional factors in exponential form. Note that there is no coefficient of the exposure variable (i.e., it is 1.0) because it is the denominator of the rate or ratio.

This particular equation was estimated by a process called a Markov Chain Monte Carlo (MCMC) simulation (Besag et al. 1995; Denison et al. 2002). Although it could have been estimated with maximum likelihoods, the MCMC simulation was used because it produces an actual sampling distribution, which might be non-normal.

The implementation of the function is part of CrimeStat IV, which is currently under development (Levine in press). The function is estimated with two algorithms. First, the model itself is estimated by a sequential set of samples drawn from equations that approximate the model using the actual data (the MCMC part of the algorithm). Because of potential bias in the initial selection, the first 10,000 samples are dropped (the “burn in” period). The actual estimates come from an additional 90,000 samples. Second, to speed up calculation because of a large number of records (10,911 road segments), a block sampling methodology was adopted. A series of 30 samples of approximately 400 cases each was drawn and the MCMC algorithm was run on the sample cases. The final estimates are based on the mean of the 30 samples. Significance is usually tested by examining the 2.5th and 97.5th percentiles of the distribution, producing an approximate 95% confidence interval (Guo et al. 2010).

tiles of the distribution, producing an approximate 95% confidence interval (Guo et al. 2010).

**Predictors of Crash Risk**

Table 3 presents the results of the model for predicting crash risk.<sup>8</sup> In addition to the V-C ratio and distance to downtown, functional road classifications were included. Two models were tested: one that included all functional road types and one with only freeway and collector road segments included. The 95% confidence interval is shown but significance is also presented for the 99% confidence interval. In the second (reduced form) model, there were four variables that were significantly correlated with crash risk. The first is the V-C ratio. This indicates that on road segments in which the volume is very high relative to the capacity of the road, crash risk is much higher. That is, more congested roadway segments are associated with more crashes. This result has been

<sup>8</sup> The Akaike information criterion (AIC) and the Bayesian information criterion (BIC) are log likelihoods adjusted for degrees of freedom. The Monte Carlo error (MC error) is an error estimate for the simulation. A common practice is to accept the simulation if the ratio of the MC error to the standard error is less than 5%. The Gelman-Rubin (G-R) statistic is another indicator of convergence in the simulation if the ratio is less than 1.2.

**TABLE 3 Predictors of Crash Risk, by Road Segment**

	Full Model Coefficient	95% Confidence Interval		Reduced Model Coefficient	95% Confidence Interval	
		2.5%	97.5%		2.5%	97.5%
Exposure: VMT	1.0	—	—	1.0	—	—
Linear predictor						
Intercept	-5.559**	-7.16	-3.64	-4.998**	-5.71	-4.28
V-C ratio	1.310**	0.44	2.20	1.308**	0.44	2.22
Distance to downtown (mi)	-0.053	-0.07	-0.03	-0.053**	-0.07	-0.03
Freeway	1.532	-0.55	3.41	1.056*	0.16	2.06
Principal arterial	0.962	-1.07	2.73	—	—	—
Minor arterial	0.282	-1.66	1.94	—	—	—
Collector	-0.408	-2.38	1.34	-1.112**	-1.81	-0.37

NOTE: N = 10,911 road segments; dependent variable = annual crashes 1999–2001; — = not applicable.

	Full Model	Reduced Model
N	10,911	10,911
Degrees of freedom	10,903	10,905
Number of iterations	100,000	100,000
Number of “burn in” iterations	10,000	10,000
Number of samples	30	30
Average sample size	397.3	400.6
Log likelihood	-28,962.2	-28,866.4
Likelihood ratio	65,763.0	68,278.8
p-value of likelihood ratio	.0001	.0001
AIC	57,940.4	57,744.7
BIC-Schwarz criterion	57,998.7	57,788.5
Dispersion multiplier	0.20	0.19
Inverse dispersion multiplier	5.08	5.21

\*p ≤ .05, \*\*p ≤ .01.

frequently found in the literature (Frantzeskakis and Iordanis 1987; Zhou and Sisiopiku 1997).

Second, the closer to downtown Houston (in miles), the greater is the crash risk on the segment. The reason probably reflects a number of factors associated with adjacency to the central city: convergence of freeways and major arterials, the greater likelihood of a roadway intersecting a higher-capacity road, shorter blocks between intersecting roadways, more commercial driveways providing a greater number of conflict points, and greater numbers of pedestrians and bicyclists. The result is consistent with higher crash risk in the central city, as shown in Figure 1 above.

Third, when VMT, the V-C ratio, and distance from downtown are controlled for, there are more crashes on freeway segments, contrary to the simple tables, and fewer crashes on collector road segments. It is probable that there are effects associated with freeways that are not the result of the existing variables in the equation. One of these is the high volume of truck traffic that uses the freeways and the potential crashes that can occur from that use. Houston has the second largest port in the United States and generates a large amount of local and intercity truck traffic. Much of the truck traffic, in turn, is routed to the freeways. During the period of 1999 to 2001, there were 15,369 crashes involving commercial

motor vehicles, about half of which occurred on freeway segments (Levine 2009). In addition, the Houston area has a weak arterial system in which many principal arterial roads are discontinuous. This tends to force traffic to the freeways, thereby adding to the congestion. The entry and exit ramps tend to have a high number of crashes, an effect that is not necessarily captured by the V-C ratio. There may be other effects associated with the design of freeway segments. More research is clearly needed on this point. The lower number of crashes occurring on collector road segments is, however, probably due to the lack of conflict points with major traffic volumes.

Therefore, independent of the VMT, there are more crashes when the roadway segments are congested, when the segments are closer to downtown Houston, and when the segments are on freeways. Conversely, when these variables are controlled for, crashes are less frequent when the roadway segments are collector roads.

### *Predictors of Male-to-Female Crash Ratios*

Table 4 presents the results of the best model predicting the male-to-female crash ratio. In addition to the V-C ratio and distance to downtown, functional road classifications were included. Two models were tested: one

**TABLE 4 Predictors of Crashes for Male and Female Drivers, by Road Segment**

	Full Model Coefficient	95% Confidence Interval		Reduced Model Coefficient	95% Confidence Interval	
		2.5%	97.5%		2.5%	97.5%
Exposure: Female crashes	1.0	—	—	1.0	—	—
Linear predictor						
Intercept	1.713**	1.007	2.573	1.526**	1.228	1.832
V-C ratio	1.293**	0.901	1.829	1.340**	0.971	1.714
Distance to downtown (mi)	-0.026**	-0.035	-0.014	-0.023**	-0.031	-0.014
Freeway	0.688	-0.266	1.749	0.871**	0.453	1.318
Principal arterial	0.231	-0.692	1.204	—	—	—
Minor arterial	-0.199	-1.070	0.708	—	—	—
Collector	-0.669	-1.576	0.279	-0.602**	-0.926	-0.269

NOTE:  $N = 10,911$  road segments; dependent variable = male crashes 1999–2001; — = not applicable.

	<i>Full Model</i>	<i>Reduced Model</i>
N	10,911	10,911
Degrees of freedom	10,903	10,905
Number of iterations	100,000	100,000
Number of "burn in" iterations	10,000	10,000
Number of samples	30	30
Average sample size	398.2	401.5
Log likelihood	-34,657.7	-34,770.7
Likelihood ratio	7,282.6	7,421.5
p-value of likelihood ratio	.0001	.0001
AIC	69,331.4	69,553.5
BIC-Schwarz criterion	69,389.8	69,597.3
Dispersion multiplier	0.78	0.78
Inverse dispersion multiplier	1.29	1.28

\* $p \leq .05$ , \*\* $p \leq .01$ .

that included all functional road types and one with only freeway and collector road segments included.

The same variables that predict crash risk also predict the male-to-female crash ratio. First, there is a sizeable correlation with the V-C ratio. Second, there is a sizeable correlation with closeness to downtown Houston. Third, there is a positive correlation with freeway segments. Fourth, in addition, there is a negative relationship with collector roads.

On roadway segments that are congested, closer to downtown Houston, and on freeways, there are more male crashes relative to female crashes. Conversely, on roadway segments that are less congested and further from downtown and on collector roads, there are fewer male crashes relative to female crashes.

In other words, while there is much overlap in their spatial location, male crashes and female crashes are occurring in slightly different locations, with male crashes being more centrally located while female crashes are more peripherally located. Further, male crashes are more likely to occur on roadway segments that have higher crash risk. In short, some of the differentials in crashes between men and women are the result of the risk associated with trip destinations.

### *Predictors of Male-to-Female Crash Ratios for Different Driver Behaviors*

Male-to-female ratios were tested with specific crash types involving speeding, DWI, failure to stop, failure to yield, and following too closely (analysis not shown). The results confirmed the model presented above, although the coefficients varied slightly. For example, the coefficient for the V-C ratio was stronger for DWI and speeding crashes than for the other behaviors. The coefficient for the distance-to-downtown variable was stronger for speeding crashes than for other types but was not significant for crashes caused by following too closely. The coefficient for freeways was strongest for DWI crashes and speeding crashes, respectively, but not significant for failure-to-stop crashes. The coefficient for collector roads was not significant for failure-to-stop crashes. The general results held, however. That is, crashes involving male drivers occurred in slightly different locations from those involving female drivers, regardless of the behavior involved.

### CONCLUSION

Overall, there is no question that proportionately more males exhibit riskier driving behavior than females. This is true in the Houston area as in most other areas that have been studied. What has been shown here, however,

is that males also are more likely to have crashes in areas that have higher risk associated with them, namely, in downtown Houston and in the central city more generally. The general gender differences in trip patterns that have been documented (i.e., women make more frequent, but shorter, trips) is consistent with driving in areas that differ in terms of safety. Local trips, particularly in the suburbs, occur in safer environments than long-distance commuter trips to the central city. This is partly a by-product of the congestion that occurs in the central city because of the concentration of employment and the convergence of roads.

From a policy perspective, there are a few implications. First, in spite of large behavioral differences between male drivers and female drivers in terms of risky driving, law enforcement efforts cannot discriminate on the basis of gender. Even though males are more likely to show aggressive and dangerous driving behavior than females, officers have to respond to the behavior of the driver, not to the driver's gender. The same would be true of characteristics associated with dangerous driving, such as youth (young drivers have much higher crash likelihoods than older drivers) or driving a pickup truck (e.g., 35% of all crashes in Houston involve at least one pickup truck). Enforcement has to be even handed and directed at specific behavior, not at characteristics of the individual. This is an obvious point, but one that bears repeating.

Second, the lack of information on where drivers live prevents a more detailed intra-urban analysis of trip length in relation to crashes and thereby precludes a more precise measure of driving exposure from being used. Further, if such information were available, preventive actions could be aimed at neighborhoods or communities where a disproportionate number of drivers who have been involved in serious crashes reside. Unfortunately, in Texas and in most other states, the agency authorized to compile and release crash information (either the state police or the state department of transportation) does not release information on the location of drivers' residences. This makes it very difficult to identify neighborhoods with higher driving risk or even to analyze the length of a trip that ends in a crash. The National Highway Traffic Safety Administration and the Federal Highway Administration should seriously consider requiring states to provide residence information on drivers involved in crashes in order to further safety goals.

Third, exposure to crashes needs to be understood in a broader context. Simply measuring the VMT of a cohort of drivers or even the trip length for individual drivers involved in crashes (should this information be made available) begs the question of what risks drivers are taking. Short trips that are home-based, as many women appear to make, are much less risky than longer trips to



the central city. The two types of trips are not identical, even if their distance may be the same. One occurs in a safer environment while the other is in a much riskier environment.

Similarly, risky behavior on the part of a driver is a much more critical predictor of crash likelihood than distance, per se. For example, a driver who has been drinking, who drives at nighttime, who travels with passengers who are also drunk, who speeds, and who travels on less well-lit roads has a much riskier trip than a single driver making a daytime trip who stays in the local area, who has not been drinking, and who does not speed, even if the distance covered by both trips is equal. This should be obvious. Risk has to be understood as a complex interaction of driving exposure, the behavior of the driver, the driving conditions affecting the trip, and the destination of the trip. Future research needs to develop better measures of driving exposure than heretofore have been used.

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# Investigation of Differences in Crash Characteristics Between Males and Females Involved in Fatigue-Related Crashes or Close-Call Events

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There is consensus among community and road safety agencies that driver fatigue is a major road safety issue, and it is well known that excessive fatigue is linked with an increased risk of a motor vehicle crash. Previous research has implicated a wide variety of factors involved in fatigue-related crashes, and the effects of these various factors in regard to crash risk can be interpreted as causal (e.g., alcohol or drugs may induce fatigue states) or additive (e.g., where a lack of sleep is combined with alcohol). This investigation examined self-report data to determine whether there are any differences in the prevalence, crash characteristics, and travel patterns of males and females involved in fatigue-related crashes or close-call events. A representative sample of residents ( $N = 1,600$ ) living in the Australian Capital Territory and New South Wales, Australia, were surveyed regarding their experience of fatigue and their involvement in fatigue-related crashes and close-call incidents. Results revealed that more than 35% of the participants reported having had a close call or crash caused by driving when tired in the 5 years prior to the study. In addition, the results obtained revealed a number of interesting characteristics that provide preliminary evidence that gender differences do exist in the prevalence, crash characteristics, and travel patterns of males and females involved in fatigue-related crashes or close-call events. It is argued that the results obtained can provide particularly useful information for the refinement and further development of appropriate countermeasures that better target this complex issue.

It has been well established nationally and internationally that sleep- and fatigue-related driving is an important contributory factor in fatal and serious injury crashes. Fatigue and sleepiness are seen to be the largest identifiable and preventable causes of transport crashes (15% to 20% of all crashes), surpassing alcohol or drug-related crashes (1, 2). It is estimated that fatigue may be a leading cause of accidents in anywhere up to 25% of cases reported in the aviation industry (3, 4). Additionally, fatigue is purported to contribute to approximately 35% and 16% of personal injury and vessel accidents, respectively, in the maritime industry (5). In the rail industry, fatigue was implicated as a contributing factor in 112 train accidents and near misses that occurred in Australia over a 3-year period (6). Studies in the motor vehicle industry suggest that 20% of all motorists on the road have fallen asleep at least once while driving and that one-third of fatal crashes involving truck drivers is due to fatigue (7). Excessive fatigue has been linked with an increased risk of a motor vehicle crash, either because the motorist falls asleep while driving or because he or she experiences reduced attention to road events and driving tasks because of fatigue or sleepiness (1, 8). These studies highlight the pervasive and problematic nature of fatigue across all areas of the transport industry.

The causes of sleepiness while driving and driver fatigue are numerous and interact in complex ways. Factors that may contribute to driver sleepiness and associated crashes include sleep debt, shift work, prolonged work hours, time of day, time spent awake, time on

task, type of road, risk-taking behavior, age and gender, sleep disorders, alcohol and other drugs, and familiarity with the road environment (1, 9, 10). Most significant, though, is that sleep-related crashes are likely to be more severe than other crashes (because of high speed) and to result in higher fatalities (1, 11). As such, there is little doubt that sleepiness or fatigue while driving represents a significant social and economic cost to the community in relation to road crashes, especially fatal road crashes.

Sleep loss is one area of fatigue research that has been vigorously studied across many disciplines, which is testament to the strong links that are purported to exist between lack of sleep and fatigue. Over the years, researchers have devoted much attention to investigating fatigue by focusing on the deleterious effects that sleep deprivation can have on cognitive performance and motor skills. Research suggests that a lack of sleep (e.g., 4.5 h compared with 7.5 h) can lead to significant impairment in driving performance (12), with individuals who obtained less than 6 h of sleep being twice as likely to be involved in a dangerous event while driving (13, 14). Other more recent studies also revealed that moderate amounts of sleep deprivation can result in impairments to cognitive and motor skill performance that are equal to or greater than those found at the legal blood alcohol concentration (BAC) driving limit in many jurisdictions (15–19). As little as 17 h of extended wakefulness can generate deterioration in driving performance equivalent to a BAC of 0.05%, the legal limit in many jurisdictions (20, 21).

Numerous investigations have also revealed that when fatigued or sleepy drivers consume even small amounts of alcohol, they experience greater impairment in their driving performance (10, 22). For example, in one investigation that combined partial sleep deprivation and BAC, Banks et al. found that drivers experienced impaired driving (when driving in a simulator) and more microsleep events (short episodes of unintentional sleep onset during driving) and reported poor ability to predict crash risk (22). When partially sleep deprived, women appeared to be either more perceptive of increased crash risk or more willing to admit to their driving limitations than the men studied. Neither men nor women, however, were capable of accurately predicting crash risk when they were both sleep deprived and alcohol impaired. Traditionally, vehicle crashes in which illegal BACs were detected had alcohol intoxication identified as the major cause (9); however, such research indicates that fatigue and alcohol interact, even at legal levels, resulting in greater impairment to driving performance than caused by fatigue or alcohol alone (10, 22).

Other investigations have focused on time of day and monotonous driving conditions. For example, Horne and Reyner found falling asleep at the wheel to be a common cause of road crashes on dull and monotonous

roads, with 16% of all police-attended vehicle crashes on major roads and 20% of police-attended vehicle crashes on motorways being attributed to fatigue (2). Further, major peaks in road crashes were found at around 2 a.m., 6 a.m., and 4 p.m. The police reports noted that half the drivers in these crashes were men under 30 years of age. In a later investigation, Reyner and Horne found that as subjective sleepiness in drivers worsened, so did the number of incidents (23, 24). In their investigation, drivers had modest sleep restrictions imposed on the night prior to their drive, which intensified the natural midafternoon circadian peak in sleepiness. Further, when drivers were fighting sleepiness, both minor and, especially, major incidents worsened markedly.

A study by Smith et al. found a late-night and early-morning increase in crash risk that was most pronounced for serious and fatal crashes, young drivers (three times the odds) and male drivers (more than twice the odds) (25). In contrast, older age groups had a lower risk of crash at night than during the morning. The increased risk of crash for fatal crashes among 17- to 24-year-old males was more than nine times the odds of that for young females. Both absolute and relative risk estimates supported an overrepresentation of males (particularly young males) in early morning crashes, a risk that is consistent with other studies (26).

Similar results have been observed in an investigation of vehicle crashes attributed to fatigue or falling asleep in low-speed urban environments of 60 km/h or less in Queensland, Australia (27). Even though much research points to young male drivers (ages 16 to 24 years) being most at risk for fatigue or sleep-related vehicle crashes, research also shows that older drivers are more likely to be involved in afternoon fatigue-related crashes. As people grow older, the after-lunch drop in circadian rhythm becomes more apparent, affecting performance and, therefore, increasing the risk of fatigue-related crashes (2, 9, 11, 28).

An alarming trend found in a recent Australian survey is that almost half of those who reported having ever fallen asleep had done so more than once, and 13% had fallen asleep while driving on three or more occasions (29). In 12% of recent incidents of having fallen asleep while driving, a road crash resulted. Again males were significantly more likely than females to report having ever fallen asleep while driving. Overall, it was found that drivers are generally more likely to fall asleep on trips of more than 2 h duration when driving on country roads and highways as well as between midnight and 6 a.m. (29).

Sleep does not happen spontaneously without warning. Drivers falling asleep are not likely to recall having done so, but will be aware of increasing sleepiness and will most likely reach a stage of fighting off sleep before

a crash (23). Most drivers involved in sleep-related vehicle crashes usually deny having fallen asleep, with evidence pointing to the crash being sleep-related coming from other sources. Possible reasons for the denial could include fear of prosecution and loss of insurance indemnity. It is possible, however, that the person genuinely had no memory of having fallen asleep, with studies showing that drivers who fall asleep typically deny having been asleep if awoken within a minute or two (30). It is very likely, however, that drivers falling asleep at the wheel were aware of the precursory feeling of sleepiness, even though they may also not remember this after the crash (30).

In one Norwegian study, for example, Nordbakke and Sagberg reported that most drivers experience a variety of symptoms of sleepiness before they fall asleep during driving (31). These symptoms include subjective feelings of drowsiness, difficulty keeping eyes open, yawning, recurrent eye blinking, difficulty concentrating, changing position, slower reaction times, increased speed variation, a dreamlike state of consciousness, impaired performance, misjudgements of the road or traffic, decision-making impairment, and freezing (20, 29). There were only minor differences between men and women in the symptoms they recognized as sleepiness, with men encountering more difficulties keeping their eyes open than women. Also, women reported more freezing and variation in speed than men as symptoms of their sleepiness (31). Further, microsleep events pose concerns for sleepy drivers, with typical signs being prolonged eyelid closures, roving eye movements, reduced muscle tone (e.g., head rolling), and relaxation of foot pressure on the accelerator, together with major driving incidents (such as running into a vehicle in front, or weaving or drifting off the carriageway, or both) (32, 33).

There is some concern that symptoms experienced by sleepy or fatigued drivers are not taken seriously enough. This may be, in part, the result of a state of altered perception in which the driver may underestimate the relationship between the various physiological and behavioral signals on the one hand and the risk of falling asleep on the other hand (33). Also, it is possible that sleepiness affects mood, making drivers more optimistic, less cautious, and even more reckless with their driving (10, 33). Additionally, people with a high risk propensity may perceive risk differently and therefore engage in more risky driving behavior that leads to a crash resulting in injury or death (34). Reyner and Horne argue that when a situation is made intrinsically safer, people may behave in a riskier manner because the overall risk they are willing to accept remains the same (24).

Drivers continue to drive when sleepy or fatigued for various reasons, including work demands, pressure to reach a destination, and short journey length. This, together with a poor understanding of fatigue-related

crash risk, can lead drivers to underestimate the shift from sleepiness to sleep (9, 11, 31). Research suggests that many drivers are aware that they are sleepy when driving but do not act accordingly (11, 23); however, drivers experiencing fatigue may only be vaguely aware of the withdrawal of attention and decline in their own cognitive processing (20). Finally, even though fatigue and sleepiness at the wheel are well-known risk factors for traffic crashes, this knowledge does not discourage many drivers from combining sleep deprivation and driving (23, 35, 36).

Although there is little doubt that fatigue represents a significant social and economic cost to the community in relation to road crashes, especially fatal road crashes, there has been a lack of research examining any differences in the type of fatigue-related crashes experienced by men and women. In one of the few studies to directly examine the effects of gender, fatigue, and driving performance and perception, Baulk et al. found that when exposed to extended wakefulness, females responded more slowly in visual reaction tasks and rated their driving worse than males (37). This could be one (of many) explanations for why men are over-represented in fatigue-related crash statistics as compared with women. The reason males consistently emerge with a higher fatigue-related crash rate may be the product of several commonly assumed factors (e.g., men driving more often and driving longer distances), but it also may be because they consider the impact of sleep deprivation on their driving ability to be less detrimental than women do.

The purpose of the current investigation was to add to the literature regarding gender differences in the experience of driving when tired. This research explores such gender differences in detail by examining a sample of responses from both males and females who had experienced a close call or crash as a result of driving when tired. Such research is important to understanding how fatigue-related incidents occur within the typical driving patterns of men and women, and it provides a starting point for exploring whether males and females experience and understand the risk of driving when tired in the same way. This has implications for educational campaigns and interventions aimed at reducing the incidence of fatigue-related road crashes.

## METHOD

### Participants

The study participants were 1,609 drivers residing in New South Wales, Australia, and the Australian Capital Territory. Eligible respondents were ages 17 years or over, held a current drivers license, and drove more than 1 h per week. There were 805 males and 804 females.

Ages ranged from 17 to 90 years. For males, the mean age was 38.35 years, the standard deviation (SD) was 18.63 years, and the median was 30 years; for females the mean age was 36.97 years, the SD was 16.58 years, and the median was 29 years.

## Procedure

A telephone survey methodology was used to randomly sample drivers residing in the catchment area. The survey used a predominately forced-choice format and contained a number of questions relating to general demographics, symptoms of tiredness experienced while driving, and commonly employed countermeasures. Also included were items designed to measure the prevalence and proportion of incidents of fatigue-related driving, the context in which the incident occurred, the circumstances involved in the incident, and contributing factors.

## RESULTS

A similar proportion of males (68.9%) and females (64.9%) reported having felt sleepy while driving in the past 5 years. However, a significantly greater proportion of males [20.8%,  $n = 158$ , adjusted standardized residual (ASR) = 4.2] than females (12.7%,  $n = 96$ , ASR = -4.2) reported having had a close-call crash when driving tired ( $\chi^2 = 17.79$ ,  $p < .001$ ).

The majority of both females and males who had experienced a close-call crash had experienced fewer

than two such incidents; around 20% of both genders had experienced three or more close calls. Females were slightly more likely to have experienced only one close call, whereas males were slightly more likely to have experienced five or more close calls (Table 1).

A small but significantly greater proportion of males (3.4%, ASR = 2.5) than females (1.5%, ASR = -2.5) reported having had a crash caused by driving when tired ( $\chi^2 = 6.15$ ,  $p = .013$ ) in the past 5 years. No significant gender differences emerged in the outcome of crashes caused by driving when tired (Table 2).

The age range of both males (mean = 37.66 years, SD = 16.82 years) and females (mean = 35.91 years, SD = 14.85 years) reporting either a close call or crash was 17 to 83 years. No significant gender differences emerged (Table 3).

A small difference in the purpose of the journey was observed ( $\chi^2 = 20.719$ ,  $p = .036$ ), with females more likely to report that they were dropping off or picking up children from child care (Table 4). Further, females were more likely than males to report that the close call or crash was within 5 km of their home ( $\chi^2$  (5 degrees of freedom [df]) = 11,  $p = .049$ ) (Table 5) and that they had been driving for a shorter time (less than 30 minutes) when the incident occurred ( $\chi^2$  (5 df) = 11,  $p = .049$ ) (Table 6).

Significant differences were not observed when the intended distance of the journey was examined, with 42% of participants reporting that the close call or crash occurred when undertaking a short journey of under 50 km and 49% reporting the incident occurred when undertaking a journey of greater than 100 km.

TABLE 1 Number of Close-Call Events Reported by Males and Females

Close Call Events	Males			Females		
	Percentage	<i>n</i>	ASR	Percentage	<i>n</i>	ASR
1	51.3	81	-1.9	63.5	61	1.9
2	24.1	38	1.2	17.7	17	-1.2
3	12.7	20	1.3	7.3	7	-1.3
4	2.5	4	-0.7	4.2	4	0.7
5	2.5	4	-0.7	4.2	4	0.7
>5	6.9	11	1.7	3.0	3	-1.7

TABLE 2 Outcomes of Crashes Caused by Driving When Tired for Males and Females

Outcome of Crash	Males Who Reported Having Had a Crash		Females Who Reported Having Had a Crash	
	Number	Percent	Number	Percent
Collided with center lane divider	2	7.7	2	18.2
Head-on crash with stationary object	10	38.5	3	27.3
Swipe crash with stationary object	3	11.5	2	18.2
Swipe crash with other road user	3	11.5	2	18.2
Rear-end crash	4	15.4	0	0
Other	4	15.4	2	18.2

**TABLE 3** Age of Males and Females Reporting a Close Call or Crash Caused by Driving When Tired

Age (years)	Males		Females	
	Number	Percent	Number	Percent
17–25	48	28.9	21	21.9
26–40	54	32.5	41	40.7
41–65	55	33.1	30	32.4
>65	9	5.4	4	5.0

When alcohol consumption was examined, it was found that only 9.3% of males and 6.4% females reported consuming any alcohol in the 12 h prior to their involvement in a close call or crash event. Females (16.7%,  $n = 13$ , ASR = 2.4) were more likely than males (6.2%,  $n = 8$ ) to have taken a prescription medication in the 12 h prior to their crash or close call ( $\chi^2$  (2 df) = 7.97,  $p = .019$ ). Of those, 46% of females ( $n = 6$ , ASR = 2.3) reported taking the medication within 1 h before the crash ( $\chi^2$  (1 df) = 5.12,  $p = .023$ ).

Males and females reported experiencing similar symptoms prior to the close call or crash, the most common being yawning (93%), difficulty concentrating (74%), changing position frequently (74%), eye blinks (70%), difficulty keeping the eyes open (66%), and slower reaction times (57%). A slightly greater proportion of males (86%, ASR = 1.6) than females (79%, ASR = -1.6) reported continuing driving after experiencing these symptoms of tiredness. Finally, males and females reported employing similar countermeasures in order to stay alert. These included stopping the vehicle (60%), getting out of the car and stretching (35%), having something to eat or drink (34%), taking a nap (12%), and changing drivers (7%). Of those who choose to continue driving, both males and females reported that they employed a number of countermeasures to increase their alertness, including lowering the vehicle window (40%), turning on the radio (15%), increasing the volume of the radio (34%), or changing the temperature in the car (15%).

**TABLE 5** Distance from Destination for Males and Females Reporting a Close Call or Crash Caused by Driving When Tired

Distance from Destination (km)	Males			Females		
	Number	Percent	ASR	Number	Percent	ASR
<5 <sup>a</sup>	20	15.5	-2.4	23	29.0	
5–10	22	17.1	0.1	13	16.7	
11–20	18	14.0	0.5	9	11.5	
21–50	16	12.4	0.2	9	11.5	
51–80	6	4.7	-0.5	5	6.4	
81–100	11	8.5	1.3	3	3.8	
101–200	17	13.2	0.9	7	9.0	
201–300	10	7.8	0.7	4	5.1	
>300	9	7.0	0.2	5	6.4	

<sup>a</sup> ASR for females = -2.4.**TABLE 4** Purpose of Journey for Males and Females Reporting a Close Call or Crash Caused by Driving When Tired

Purpose of Journey	Males		Females	
	Number	Percent	Number	Percent
Commuting to work	40	31.0	18	23.1 <sup>a</sup>
Work-related trip	15	11.6	6	7.7
Social activities or leisure	33	24.7	21	29.5
Holiday travel	26	20.2	15	19.2
Shopping	1	0.8	3	3.8
Childcare	0	0.0	6	7.7 <sup>b</sup>
Personal care or education	8	6.2	7	8.9
Other	5	4.7	0	0.0

<sup>a</sup> ASR = -1.2.<sup>b</sup> ASR = 3.2.

## DISCUSSION OF RESULTS

This investigation involved a large-scale telephone interview of a random sample of drivers from New South Wales and the Australian Capital Territory to determine whether gender differences exist in self-reported crashes or close-call events caused by driving when tired. The results obtained revealed a number of characteristics that provide preliminary evidence that gender differences do exist in the prevalence, crash characteristics, and travel patterns of males and females involved in fatigue-related crashes or close-call events.

Out of a total of 1,609 interviews, more than 35% of the respondents reported having had a close call or crash due to driving when tired. This percentage is higher than other self-report investigations (14, 23, 29); however, it serves to reiterate that sleepy or fatigued driving is a major road safety issue that still requires a great deal of empirical investigation.

Consistent with previous investigations (29, 38), males (24%) emerged as more likely to report being involved in a crash or close-call event caused by driving when tired than females (14%). In the current investigation, the population was weighted evenly by sex, so it is clear that any gender differences emerging are not the result of sample bias. Conversely, however, significant differences in age groups were not observed between men's and women's

**TABLE 6** Approximate Driving Time for Males and Females Reporting a Close Call or Crash Caused by Driving When Tired

Driving Time (h)	Males			Females		
	Number	Percent	ASR	Number	Percent	ASR
≤0.5 <sup>a</sup>	33	25.6	-2.4	33	42.3	
>0.5≤1	22	17.1	0.4	15	19.2	
>1≤2	27	20.9	1.5	10	12.8	
>2≤3	16	12.4	0.1	10	12.8	
>3	31	24.0	2.0	10	12.8	

<sup>a</sup> ASR for females = -2.4.

self-reporting of such incidents. Specifically, the current investigation found that males' reporting of crashes or close calls caused by driving when tired was spread evenly for those younger than 65 years of age, whereas females in the 26- to 40-year-old age group reported more close call events or crashes than younger cohorts.

When the purpose of journey in which the close call or crash occurred was examined, some gender differences did emerge. For example, females were less likely to have experienced the incident when commuting to work, but more likely than males to be on their way to pick up or drop off children from child care. This raises questions of tiredness related to child-care responsibilities for the 26- to 40-year-old age group, the one most likely to have child-care responsibilities. It is arguable that further research into this possible connection would provide clearer data on this issue.

Females were more likely to be closer to home and driving for a shorter time than males at the time of the close call or crash. This suggests there may be a different pattern and possible different underlying causes or incidents caused by driving when tired for females. As many of the interventions targeting driving when tired focus on longer trips and monotonous stretches of road, this finding suggests that females may be more likely to experience fatigue-related incidents closer to home. This in turn has important implications for targeting future interventions (for example advertising campaigns on the dangers of driving when fatigued).

Examination of the symptoms of tiredness when driving revealed that males and females experience similar symptoms. The most common symptoms reported by the current sample are similar to those commonly reported in the literature (20, 28) and include yawning (93%), difficulty concentrating (74%), changing position frequently (74%), eye blinks (70%), difficulty keeping eyes open (66%), and slower reaction times (57%); however, a slightly greater proportion of males reported continuing driving after feeling symptoms of tiredness. Further, males and females also reported similar use of various countermeasures for staying alert after experiencing symptoms of tiredness when driving. These were stopping the vehicle (60%), getting out of the car and stretching (35%), having something to eat or drink (34%), taking a nap (12%), and changing drivers (7%). Interestingly, while half of both males and females chose to continue driving, they also reported engaging in other activities to increase their alertness, such as winding down the car window (40%), turning on the radio (15%), increasing the volume of the radio (34%), or changing the temperature in the car (15%). Again these are similar to the common countermeasures reported in the literature (15). Given that the safest countermeasure is for a person to stop driving (2, 10), the fact that half the sample continued driving indicates more education in this area is necessary.

In conclusion, the current investigation examined gender differences in the experience of driving when fatigued in a large gender-balanced sample of drivers and followed up in detail the 300 drivers who had experienced a close call or crash caused by driving when tired. The results indicated that there were no gender differences in the symptoms of tiredness experienced or in the types of countermeasures engaged in to combat tiredness. There were, however, some key gender differences in the purpose of the trip, time of driving, and trip distance from home when the incident occurred. These differences suggest that females were more likely to be driving short distances close to home when they experienced an incident. This has implications for awareness campaigns, which tend to focus more on fatigue as a long-distance issue. It is arguable that further research is required to examine the beliefs and attitudes of males and females in regard to what is considered risky practice when driving tired. Such research has the potential to provide particularly useful information for the refinement and further development of appropriate countermeasures that better target this complex issue.

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# Postpartum Fatigue and Driving

## Relating Experiences, Thoughts, and Opinions 12 Weeks After Birth

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Fatigue in the postnatal period is such a common experience for most mothers that the term “postpartum fatigue” (PPF) has been coined to describe it. When new mothers experience extreme fatigue, it follows that their physical health, mental health, and social wellbeing are negatively affected. It is interesting to note that there is a distinct lack of empirical investigations focusing on the link between PPF and increased risk of injury, particularly when the links between fatigue and increased risk of road crashes are well documented. The purpose of this investigation was to undertake pilot research to develop an understanding of the duration of PPF and the performance impairments experienced by new mothers when involved in safety-sensitive activities such as driving a motor vehicle. Semistructured interviews were undertaken with women ( $N = 24$ ) living in Southeast Queensland, Australia, at 12 weeks after they had given birth. Key themes were identified, with a particular emphasis on understanding the link between the participants’ experience of PPF and the impact this had on their overall cognitive and physiological functioning as well as their experience of the driving task. Sleep–wake data were also collected, and the Karolinska Sleepiness Scale was used to evaluate the potential crash risk for this group of mothers. It is proposed that the findings of this investigation could be used to improve current knowledge among new mothers and practitioners regarding the mechanisms and consequences of fatigue and to inform interventions that lead to a decreased risk of injury associated with PPF.

Sleep- and fatigue-related driving is well documented as being a significant contributory factor in fatal and serious injury crashes (1, 2). Fatigue and sleepiness are seen to be the largest identifiable and preventable causes of injury within the transport industry, surpassing the rate of drug- and alcohol-related incidents (1). Studies suggest that 20% of all motorists on the road have fallen asleep at least once while driving (3). Factors that may contribute to driver sleepiness and crashes include sleep debt, shift work, prolonged work hours, time of day, time spent awake, time on task, type of road, risk-taking behavior, age, gender, sleep disorders, alcohol and other drugs, and monotonous road conditions (1, 4).

Sleep, alertness, and performance are linked to the body’s 24-h biological clock (1). The effects of the following conditions often result in sleepiness, tiredness, drowsiness, and fatigue: being awake when biologically programmed for sleep, restricted sleep over a period of time, and extended wakefulness (1, 5). Sleepiness can be defined as difficulty remaining awake even while carrying out activities and is related to circadian and homeostatic influences (6). Estimates of the proportion of crashes attributable to sleepiness vary considerably, with some research suggesting that sleepiness is a factor in 1% to 3% of crashes in the United States (4), whereas research in Australia estimates that sleepiness is a contributing factor in up to 33% of crashes (7). Research suggests that lack of sleep (e.g., 4.5 h compared with 7.5 h of sleep), can lead to significant impairment of driving performance (8), with individuals who obtained less than 6 h of sleep being twice as likely to be involved in a dangerous event while driving (9). Similarly, Connor et al. found a strong association

between levels of acute driver sleepiness and the risk of an injury crash (10). They found that participants who identified any degree of sleepiness were 11 times more likely to be involved in an injury crash when compared with drivers in the most alert group.

Fatigue is reported as the most common complaint of women following childbirth (11–16). To quantify the scale of the problem, the Australian Bureau of Statistics recorded 280,000 mothers in 2007 who gave birth to 285,000 babies (17). This fatigue experienced by mothers is generally known as postpartum fatigue (PPF). Researchers have described it as the exhaustion and diminished ability to perform mental and physical activities that mothers experience in the postnatal period (15, 18–20). Although fatigue was originally intended as a formal expression of tiredness (21, 22), efforts have since been made to demarcate these terms along with the commonly used synonym “exhaustion” as separate but related concepts. Despite efforts to conceptually distinguish fatigue from other labels that hold similar connotations, the terms “exhaustion” and “tiredness” frequently appear as descriptors of fatigue in the literature. Although it is important to make note of the language used in this area, it is not the intention of this paper to further the debate regarding the definitions of fatigue.

Women often believe that PPF is a temporary condition that subsides as routine activities are reestablished (23). Research has shown, however, that PPF becomes progressively worse within the first 6 weeks after childbirth (12, 20, 24–26). These and similar findings have defined PPF as occurring in the first 3 months after childbirth (27), and it has been suggested that symptoms of fatigue may persist for as long as 18 months after childbirth for more than 50% of women (28).

PPF is frequently portrayed in terms of physiological and psychological dimensions (15, 25). The physiological factors discussed can be classified as normal or pathological in nature and include labor and delivery issues, anemia, and hemorrhaging (29). Mode of delivery is a commonly examined physiological factor in this area of research, with evidence suggesting that women who have caesarean sections as opposed to vaginal births experience higher levels of PPF (30, 31). Anemia is defined as a reduction in the blood concentration of hemoglobin and is characterized in the postpartum period by a deficiency of iron in the blood (32). Anemia can be caused or made worse by blood loss (hemorrhaging) experienced during or after giving birth (33). Although some studies have found no evidence that iron deficiency anemia or postbirth hemorrhaging contribute to PPF in the first few months after delivery (34), anemia has been linked to women experiencing PPF 3 months after childbirth (35). Other physiological factors that are flagged in the literature as potential contributors to PPF include postpartum infection, thyroid dysfunction, and pain (32, 36).

Within the psychological factors, depression is the predominant factor studied in PPF research. The relationship between fatigue and depression in general has been a source of contention in scientific communities for decades and has spilled over into postpartum research. Postpartum depression (PPD) is considered a separate but related concept to PPF; however the degree of overlap and causal relationship between these conditions remains unclear. Past research has implicated PPF as both a cause and effect of PPD (37); yet there appears to be some consensus among researchers that PPF is one of a number of contributing factors to PPD (38, 39). Milligan et al. conclude that PPF and PPD are distinct concepts that at times overlap in meaning and measurement (23, 27); however, they expanded on this assertion by revealing that women in the postpartum period only felt depressed when they experienced high levels of fatigue. This suggests that the relationship between these conditions may resemble more of a stage rather than a continuous model.

Another area that has been explored is the impact of situational factors such as demographics, social support, and breastfeeding. Considerable work has been devoted to investigating these factors; however, the findings have not been consistent across any of the studies or variables studied. For example, research regarding maternal age has produced mixed results, with some studies reporting no relationship between age and PPF (34–36), whereas other research has found that more mature women reported lower levels of PPF (40). This conflicting result has also been reported for number of children. Gardner reported that mothers with two to three children reported higher levels of fatigue (40), whereas Larsen (41) and Hoffman (42) reported that mothers with one child recorded more fatigue responses than mothers who had three or more children.

A key area of research relating to the contributing factors to PPF is the sleep loss that mothers experience as a result of recurrent infant night waking. Over the years, researchers have devoted much attention to investigating fatigue by focusing on the harmful effects that sleep deprivation can have on cognitive performance and motor skills. For instance, Krueger reported a 25% to 40% drop in cognitive performance after one and two nights of total sleep deprivation, respectively (43). Other research has examined the effects of continuous sleep loss and found that performance on tasks requiring cognitive skills, vigilance, and psychomotor skills significantly deteriorated in stages over 36 to 42 h and then 66 to 72 h of sleep deprivation (44). In light of the studies highlighting the link between sleep loss and psychomotor performance, it is noteworthy that an extensive search of the literature found no studies specifically addressing PPF and crash risk.

Researchers have attempted to quantify the harmful effects of fatigue by drawing comparisons between per-

formance impairments induced by total sleep deprivation and those induced by alcohol intoxication (45). For instance, Dawson and Reid conducted an experiment in which participants either remained awake for 28 continuous hours or consumed 10 to 15 g of alcohol at 30-min intervals until their mean blood alcohol concentration (BAC) reached 0.10% (46). In both conditions, cognitive psychomotor performance was measured by way of an unpredictable tracking task at 30-min intervals from the start of the session. The results indicated that after 17 h of sustained wakefulness, cognitive psychomotor performance had deteriorated to a level equivalent to a BAC of 0.05%. Further findings revealed that 24 h of sustained wakefulness resulted in performance decrements equivalent to a BAC of 0.10%. This research (46) and more recent work (47–49) concluded that moderate amounts of sleep deprivation can result in impairments to cognitive and motor skill performance that are equal to or greater than the legal BAC limit for driving.

Fatigue researchers across other disciplines have shown that partial sleep deprivation, which results in cumulative sleep debt over time (50), can lead to fatigue and impaired performance under various types of conditions. For instance, in one study, sleep was limited to approximately 5 h per night for seven consecutive nights for 16 adults (51). Participants showed significant performance and mood deterioration over this period, with scores for fatigue, confusion, tension, mental exhaustion, and stress steadily increasing and vigilance performance scores steadily decreasing. The overall findings indicated that there was a cumulative effect on performance and mood. Similar research has shown that accumulative sleep debt can cause significant reductions in cognitive, vigilance, and memory tasks over shorter periods, as evidenced when sleep time for participants was restricted to 4 h per night over 2 and 4 days (52, 53).

The link between road crashes and sleepiness or fatigue, or both, is well established (2, 10). Research has also demonstrated that driving between 2 a.m. and 5 a.m. increases a driver's risk of a crash by 5.6 times and that less than 5 h sleep during the past 24 h increases crash risk by a factor of 2.7 (10). Further, Åkerstedt et al. investigated whether retrospective sleep-wake data could predict actual road crashes (54). The predicted sleepiness values were transformed to a scale with nine steps analogous to the Karolinska Sleepiness Scale (KSS), which were used in logistic regression analyses. Åkerstedt et al. found a highly significant odds ratio for each incremental step of sleepiness on the output sleepiness scale. These researchers place normal alertness levels during the day between Levels 3 and 4 on the sleepiness scale, and from their data, it can be seen that a driver with a score of 6 is approximately five times more likely to be involved in an injury crash and that a driver with a sleepiness score of 9 is 24 times more likely to be involved in an injury crash.

The current study investigates performance impairments in postpartum women when undertaking safety-sensitive activities and, particularly, what these decrements represent in relation to the driving task. The obvious implications for driving are that fatigue and sleepiness can lead to decreased attention, which in turn can lead to falling asleep while driving. Thus, the researchers felt it was important to include a separate measure of the participants' level of sleepiness while driving. The KSS was chosen for two reasons: first, it has been demonstrated that falling asleep at the wheel in a driving simulator is always preceded by an increased KSS score (55), and second, previous research allows for the 9-point scale to be converted to an odds ratio of the associated crash risk, which allows inferences to be made regarding the crash risk of potential drivers.

This research comprises an initial exploration of PPF, and it is not the intention of this paper to fully explore the wide variety of factors indicated in the literature. Rather, the research team focused on the duration of PPF and the mother's individual experience of PPF. The literature on PPF highlights problems within the first 6 weeks of the postpartum period; the present research collected data at 6, 12, and 18 weeks to further explore the duration of PPF. The interviews conducted with participants were done at week 12. The selection of this period was to determine whether PPF persisted past the initial 6 weeks; it was decided not to wait until 18 weeks after birth in case PPF had waned or disappeared entirely.

## METHOD

### Participants

The participants were mothers who had just given birth to a baby and met the following criteria: had not given birth via caesarean section; had not ever been diagnosed with hypothyroidism; had not at any time in their life experienced a depressed mood or a loss of interest in pleasure that lasted for 2 weeks or more; and had not developed within the first 6 weeks iron deficiency anemia or any other postpartum infection or inflammation. Participants were recruited either through a Queensland University of Technology electronic noticeboard or via advertisements placed on various parenting websites. A total of 25 mothers were recruited; however, one withdrew from the study. Interviews were conducted with 24 participants whose ages ranged from 22 to 39 years, with a mean age of 30.25 years [standard deviation (SD) = 4.86].

### Materials

The interviews were guided by a semistructured interview developed by the research team and designed to

explore the issues related to PPF. As there was no known previous research on PPF, the researchers were unable to draw on previous questionnaires.

The KSS is a measure of instantaneous sleepiness and is measured on a 9-point Likert scale, as follows: 1 equals very alert, 3 equals alert, 4 to 6 equals neither alert nor sleepy, 7 equals sleepy, and 9 equals very sleepy. Participants recorded their level of sleepiness for each driving episode at week 12 after birth for 7 days.

## Procedure

Ethical clearance was granted from the University Human Research Ethics Committee. Participants were screened to ensure they met the inclusion criteria for the study. Both qualitative and quantitative data collection methods were used. The data discussed in this paper came from a qualitative semistructured interview conducted at 12 weeks after birth. The purpose of the interview was to discuss the participant's thoughts and experiences of sleepiness and fatigue since giving birth. The interview also asked participants to talk about the differences, if any, they saw between sleepiness and fatigue; the causes of fatigue; the impact that having a baby had on their daily routine; and strategies they might be using to cope better with sleepiness and fatigue. The interview did not explicitly ask participants about transport-related issues; however, these issues were highlighted in topics concerning how PPF had affected their daily life. All interviews were audio recorded.

The quantitative method consisted of both a sleep-wake diary for participants to use in recording their sleep patterns and those of any children and a questionnaire that asked participants about themselves, their overall sleepiness and well-being, and any incidents. The sleep-wake diary and questionnaire were sent to the participants and completed at 6, 12, and 18 weeks after birth; however, the diary and questionnaire data are not the focus of this paper and will be reported elsewhere. Participants were compensated with a \$20.00 department store gift card for completing each of the four data collection points.

## Data Analysis

The audiotape discussions were transcribed verbatim by the interviewer and were analyzed and coded using thematic analysis. Concepts were identified as themes if they were expressed with frequency, extensiveness, or intensity (56). The first author, who conducted the semistructured interviews, also performed the analysis; however, she held frequent consultations with the other authors to improve the validity and reliability of the coding. The coauthors

were particularly useful in identifying themes and interpretations that needed further clarification or explanation. The authors' combined efforts have resulted in a thorough and well-justified analysis that provides a comprehensive and accurate reflection of the data received.

The KSS data were compiled from one question in the sleep-wake diary that related to the respondent's level of sleepiness while driving at week 12 after birth.

## RESULTS

### Qualitative Data

The interviews conducted with participants ranged from 9 to 46 min (mean = 22.35 min, SD = 8.91 min). The interviewer noted that when answering the questions, some participants displayed disorganised thinking patterns, which was apparent in the indirect manner in which they answered the questions. A number of participants commented, "not sure if that answers your question." To deal with the indirect nature of the data collection, the interviewer often interrupted the participant and paraphrased the pertinent information relating to the question asked, with the intention of eliciting a yes or no response, and then moved on to ask the next question. The process of interviewing participants using a semistructured interview can often lead to tangential conversations. In the case of the mothers interviewed in this study, it is unclear whether the disorganised thinking patterns observed were connected with the experience of tiredness or fatigue in the postpartum period. It is possible, given the range of interview times, that there may have been preexisting individual differences in the communication styles of the participants.

The primary focus of this paper was centered on a thematic analysis of the performance impairment experienced by postpartum women. It is not the intention of this paper to further the debate regarding either the academic or theoretical definitions or the mechanisms of fatigue. It is important, however, to contextualize participants' comments by discussing the difficulty the mothers found in defining and differentiating tiredness, sleepiness, and fatigue, and the general impact of fatigue on this cohort.

### *Fatigue Is More Than Sleepiness*

Many participants commented that while fatigue is linked with sleep, it is more than the feeling of sleepiness or tiredness alone. Participants reported that while a nap during the day alleviated their immediate feeling of sleepiness, it failed to lessen their overall feeling of fatigue. For example:

Lack of sleep is more mechanical, when the body just says 'that's it.' Sleep could be likened to hunger or thirst, just a certain point where the body will just shut down. With fatigue, all sorts of an emotional spectrum of feelings . . . where the thought of having to get up to brush my teeth is agonizing, overwhelming, all sorts of irrational emotions, no coping mechanisms, extreme irritability, overwhelmed a lot. (Participant 4)

I find that if I have a day nap I feel okay for the afternoon; short-term solution really, but I still just feel exhausted—fixes the next 12 hours but not the whole situation. I wouldn't feel so sleepy but I would still feel fatigued. (Participant 17)

In terms of fatigue, I need something more than sleep; my body is wanting something deeper than sleep, a real sense of rest. (Participant 4)

The theme of fatigue being something that can be fixed by sleep alone was echoed in the participants' comments about the impact fatigue had on their daily routines. Several mothers expressed that they did not have a daily routine and it was difficult to know from one day to the next how much their day would vary. There was a real sense when speaking with these mothers that the fatigue was more than sleepiness and was the result of the level of tasks that needed to be completed in their day. For example, for many of the mothers, simple housework activities such as vacuuming the floor or planning and cooking an evening meal became complex and required more cognitive resources than they had at the time.

Furthermore, this group of mothers expressed that the high level of unpredictability in the type of tasks and the length of time to complete a task was fatiguing. Moreover, this was a particular issue for the mothers during the night, and the impact on "normal" sleep patterns appeared to have the most effect on the mothers' levels of fatigue. For instance, the frequency of feedings varies based on the age of the baby, and many of the mothers in this study were subject to four-hour feedings. When the time the mother needs to feed the baby, settle the baby, and then get back to sleep herself is taken into account, in most cases there is not much time for quality sleep before the next round of night feedings is due to begin. It appears that the existence of this high level of unpredictability in the number and timing of tasks is in and of itself fatiguing for this group of mothers. For instance, one mother described it as "physically doing too much during the day, and mentally trying to concentrate on too many things" (Participant 23). It perhaps can be summed up as the cumulative effect of lifestyle changes, plus a lack of routine, plus a high level of unpredictability in tasks that equates to the feeling of fatigue.

The content of this theme highlights that the mothers in this study see fatigue as something that is deeper than a physical need for sleep. The comments expressed draw attention to the impact fatigue has on every aspect of their daily life functioning and raises several concerns. Tasks that were once automatic and did not require large amounts of cognitive resources (e.g., preparing meals) have now become complex tasks. The major concern that this raises is how it affects the driving task, which for an experienced driver is largely an automatic process.

### *Cognitive and Physiological Impact of Fatigue*

Another theme that emerged from the interviews was the cognitive and physiological impact of fatigue. Some of the following comments outline this group of mothers' experience:

It's hard to predict until you are in it; it can be debilitating sometimes and have an effect on normal mental functioning. (Participant 4)

Fatigue is that point where you are so tired you don't make sense when you talk to people or it's difficult to have a conversation. (Participant 11)

Realizing that I'm not functioning very well because of fatigue and lack of sleep. . . . There is a sense of getting worse and not coping—physical feelings like an endless hangover and a flu-like feeling. (Participant 4)

It was really exhausting. I really couldn't perform any task or anything. (Participant 3)

It is emotionally and physically draining, but if I had more sleep I would be able to better cope with everything. (Participant 2)

The biggest difference was the snappiness, the length of it. You know that you will have lack of sleep; there have been times that I have been so fatigued that I have felt faint. (Participant 17)

These comments illustrate that for new mothers, there is an overwhelmingly negative effect from the cumulative impact of sleep deprivation and fatigue on their normal life functioning. It appears that fatigue is both the physiological and cognitive lack, whereas sleepiness is a transient state.

While the interviews raised the cognitive aspect of PPF, a notable subtheme that was repeated often across the interviews was the inability to concentrate

and the impact this had on the mothers' life functioning. It appears that new mothers have difficulty in concentrating; one mother described it as the "fuzziness in your head" (Participant 2). Another mother described it as "Not having that mental sharpness . . . not thinking ahead clearly, not being able to plan, being vague" (Participant 17). One mother also stated that "the level of confusion in the first 6 weeks is quite extreme. I can remember thinking 'what am I supposed to be doing?'" (Participant 18). Another interesting statement combined aspects of concentration, memory, and cognition to highlight that these processes are closely intertwined and that when an individual experiences negative functioning in one area, it affects the overall system of cognition. This mother expressed it as follows: "I have really noticed the effect on my memory and cognition" (Participant 12). Another mother described it as the inability to "juggle as many tasks" (Participant 19).

Several of the mothers also reported that they had problems in following a conversation when they were feeling fatigued, and if they were the speaker, that they would often forget what they were saying and be unable to complete their sentence. Further comments described their thinking as disorganized; for example, "don't feel like thoughts are coherent" (Participant 17). In line with the previous discussion regarding the increased workload of mothers, one of the new mothers made this observation: "You do become more forgetful, but not sure if it is because you have a newborn in the house and there are a million and one things to do or if I'm just more tired" (Participant 7).

Regardless of how these mothers describe their experience, it is apparent from the statements that the impact of fatigue on the study participants did have a considerable cognitive component that negatively influenced their life functioning. Furthermore, an alarming aspect of the statements made by this group of mothers suggested a decrease in their awareness of their environment and that instead of resting, they pushed on because tasks still needed to be done and the baby still had needs to be met. For example, one mother said, "If you are tired during the daytime, and something needs to be done, you don't sit down and have a rest, you continue to do it in the haze" (Participant 16).

Some mothers talked about how their lack of concentration translated to the driving environment; for example, "I guess when you are out and about driving . . . you almost feel like you are on autopilot" (Participant 18). This participant went on to comment that she had experienced this just recently, in an instance where she had no recollection of the journey home. She said, "I was driving home and luckily all the lights were green, because all of a sudden I thought 'how did I get here?' So I had just cruised along all the way home and

all the lights had been green and I just followed the traffic and I drove" (Participant 18).

### *Impact of Fatigue on the Driving Task*

The statements in the previous section relating to the driving task highlight that driving requires a high level of attentional resources that for many new mothers is lacking. It appears that because of both the cognitive and physical impact of fatigue, driving becomes an automatic process, which often means they have no recall of their interaction within the road environment. One of the most disturbing findings from these interviews came from one participant who made statements that suggested a disconnection between mind and body. Her comments intimate that regardless of their intention to drive in a safe manner, new mothers may be unable to control the actions of their body. Following are some statements illustrating these sentiments:

Inability to control what the body is doing; for instance, when driving the other day I thought I was braking when I was accelerating. (Participant 4)

Mentally it didn't matter how much I so passionately told myself to focus. I could not control my eyes. They were wandering everywhere, my heart was pounding, and while I was really focused I just couldn't control it. I think it had to do with lack of sleep. I was alert, mentally saying to myself "stay awake," but I really couldn't, it was really out of my control. (Participant 4)

At other times, the participants commented that their level of confusion and decision-making ability made the driving environment an extremely complex task. For example, one mother stated:

It is the confusion that comes with it, and I can remember driving around a car park and it was almost empty and still not being able to choose which park I wanted—do I want to be close to the shops, which exit do I want to be closer to, do I want to be under the shade or out of the shade, do I want to drive in or reverse out? (Participant 18)

In addition to this general feeling of not being able to concentrate, this group of mothers talked about how driving had been different since giving birth and that it was harder to cope with everyday occurrences such as having children in the car or listening to the radio. For example:

The driving has been different. I am more tired . . . and I have children talking in the background so it



really knocks my concentration. I wish I could have a glass screen up so I couldn't hear them. Having added noise and stresses makes it hard. (Participant 16)

I find that I have to turn off the radio when driving. I can't concentrate. (Participant 15)

An unexpected but noteworthy finding was that this group of mothers appeared to be self-regulating their driving exposure without being aware that doing so was a protective driving behavior. The behaviors described include choosing to drive less, avoiding the driving task when tired, and choosing to walk or catch public transport. For example, one mother stated “. . . before the baby was born I would do things like drop off videos or pop down to the shops to buy bread or milk. I really don't do that now” (Participant 9).

An interesting theme that came out of the interviews was that if they had more knowledge about the level of fatigue and tiredness they would experience after giving birth, many mothers would have done more planning and preparation prior to the arrival of their baby to reduce their need to leave the house. For example, “If I had of thought more about it, I would have had lots of things sorted like meals, breastfeeding bras and tops, because I didn't want to drive” (Participant 4). Further, many of the mothers also planned when their driving tasks occurred. Following is a statement that illustrates this finding:

I was careful with long drives and generally did them early in the day. I would have a lot of strategies. I would pick the time of day—not after lunch—have food to eat in the car. I would also want another adult in the car who was going to be awake. . . . I would choose better times and days to take a long journey. (Participant 13)

The final theme that emerged from the interviews concerned the influence that the study exerted on this group of mothers' awareness of the safety aspect involved in driving. For example:

When I started the Week 6 data collection, it made me more alert while driving. (Participant 22)

Doing the study has made me realize how little sleep I am actually getting, and it makes me think about the safety and driving on the road. (Participant 17)

The diary and questionnaire made me realize and think about how many mothers are on the road—you know, school pick-up time, that is a bad time of the afternoon for mothers and kids to be sleepy

and fatigued. It is also really congested around schools. (Participant 4)

## Quantitative Data

The KSS data were compiled for all participants and comprised the number of times they had driven within a 7-day recording period, the duration of their driving time, and, finally, the associated KSS score for each driving episode. There were two participants who did not record any driving episodes at week 12 after birth. On average, participants ( $n = 22$ ) drove 8.35 times ( $SD = 4.35$ ) for approximately 40 min ( $SD = 16.38$ ; range, 18 to 96 min). There were a total of 192 driving episodes across all participants; of these, 35 driving episodes (18.2%) occurred with a KSS rating of 6, 21 driving episodes (10.9%) occurred with a rating of 7; five driving episodes (2.6%) occurred with a rating of 8; and one driving episode occurred with a rating of 9 (0.5%). Overall, 32% of the driving episodes were rated by participants as occurring at a KSS score of 6 or above.

## DISCUSSION OF RESULTS

This research explored the performance impairments experienced among a cohort of postpartum women when undertaking safety-sensitive activities, particularly driving a motor vehicle. The interviews highlighted that within this group of participants, PPF persists longer than the initial 6 weeks after giving birth. The thematic analysis showed that the fatigue the participants experienced was more than sleepiness and tiredness and could be characterized as being deeper than a physical need for sleep. Furthermore, the impact that fatigue had on their everyday life functioning was dramatic, manifesting itself as difficulties in their cognitive processing and physiological performance. The mothers interviewed noted that they were often unable to concentrate, which affected their ability to plan and organize simple tasks such as preparing the family meal.

The particularly concerning aspect of this group of mothers' experience of PPF related to the impact it had on their driving. The statements made by participants suggested that their concentration levels had dropped to such a degree that they could not recall their interaction within the driving environment. It also appeared that they experienced a level of confusion that affected their decision making and ability to deal with additional stimuli while driving, such as the radio or children talking in the background. Perhaps the most disturbing comment related to the driving task came from one participant who experienced a disconnection between mind and body, an “inability to control what the body is doing.” This participant said, “I thought I was braking when I was accelerating.”

Research conducted by Krueger suggests that an individual's cognitive performance drops by up to 40% after one or two nights of total sleep deprivation (43). Other research that reports that continuous sleep loss significantly affects tasks requiring vigilance and psychomotor skills (44) has serious implications for mothers suffering from interrupted sleep patterns. Statements implying that the mothers in this study continue to do safety-sensitive tasks, such as driving, when they are sleep deprived means that there is a cohort of drivers on the road who lack the necessary cognitive and attentional resources required for the task to be carried out in an optimal manner.

The sleep-wake predictor scores recorded for the participants in this study while driving found that 32% of the driving episodes undertaken occurred at a KSS score of 6 or above. Åkerstedt et al. deemed that a KSS score of 3 was equivalent to normal daytime alertness and an odds ratio for an injury crash marginally above zero (54). That is, an individual with a KSS sleepiness score of 6 is five times more likely to be involved in an injury crash; an individual with a KSS score of 7 is eight times more likely; one with a KSS score of 8 is 15 times more likely; and one with a KSS score of 9 is 25 times more likely to be involved in an injury crash (54). Within this sample, there were 62 driving episodes where the odds of being involved in an injury crash were between five and 25 times more likely than if the individual had recorded a sleepiness score of 1 to 5.

The KSS results found in this cohort of postpartum mothers provide an opportunity to estimate the scale of the crash risk associated with PPF in the Australian population. In 2007, 280,000 women gave birth. Assuming that approximately 80% of these women hold a valid driver's licence, and given the average of eight driving episodes per week carried out by the current cohort of mothers, there are potentially 1.8 million driving episodes per week performed by postpartum mothers. In this study, 32% of the driving episodes were undertaken with the associated risk of an injury crash being between five and 25 times more likely. Therefore, it could be proposed that there are potentially 575,000 driving episodes per week performed by postpartum mothers in Australia that may be between five and 25 times more likely to involve an injury crash.

Researchers in the area acknowledge that fatigue affects attention and vigilance and is associated with difficulty in maintaining "skilled performance" on tasks such as driving (57). It has also been suggested that fatigue is a major contributor to driver error and that activities such as driving require sustained performance over time and involve greater cognitive effort than physical effort (58, 59). Activities requiring complex cognitive processes include sustained vigilance, selective attention, and complex decision making (58, 59). Thus, the research suggests that fatigue and sleepiness contribute to deterioration in performance (58). Therefore, it is apparent that new mothers represent an "at risk" group who are worthy of further research to

develop interventions specifically aimed at addressing their concerns and needs. Together, the qualitative and quantitative data for week 12 suggest that fatigue leads to decreased attention and concentration, which in turn lead to errors while driving and substantially increase new mothers' chances of being involved in an injury crash.

It should be noted that some of the participants in this study self-regulated their driving exposure by avoiding driving entirely, using alternative modes of transport, or choosing the best times to drive (e.g., time of day or type of road). This demonstrates that some of the mothers in this study were aware that their ability to drive safely was impaired at certain points in time. While this self-regulation was not mentioned by all of the participants, it is possible that they all may have self-regulated their driving exposure. What is interesting is that none of the participants identified it as a protective driving behavior or strategy. Therefore, it would be useful to develop an intervention aimed at increasing new mothers' awareness of how debilitating PPF really is and their accuracy in determining their level of PPF. The intervention would need to focus heavily on a variety of factors, including the following:

- The vast difference between fatigue and sleepiness;
- The physical and cognitive limitations of fatigue (e.g., practical examples of the relationship between physical and cognitive symptoms and the driving task);
- Strategies to assist mothers in coping with both the physical and cognitive limitations of PPF and to help them decrease their risk of injury on the road (e.g., alternative modes of transportation or driving at times when they are more alert); and,
- Ways of informing new mothers that these symptoms extend well past the initial 6-week period that exists in the published literature.

While the findings of this research are important, it should be acknowledged that the data collected did not take into consideration a variety of sociodemographic factors that were discussed in the literature. These factors all appear to be important influences on a mother's experience of PPF; however, because of the preliminary nature of the study, it was outside the scope of resources to include all of these variables. It is recommended that further research address these factors. Finally, the data collected from the participants represent a limited sample of their driving and was not exhaustive of the driving task outside of the 7-day recording period at week 12.

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# Older Women's Travel Patterns and Road Accident Involvement in Britain

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This paper uses British data as its primary source, supplemented with data from Sweden and the United States, to analyze the mobility and safety of female and male car drivers and pedestrians. In European countries and in North America, fewer women than men are killed or injured in traffic accidents as pedestrians or car drivers. In terms of casualty rates per population, where appropriate per driving license, per distance driven, and per journey, women younger than 60 have a lower risk than men of both injuring themselves and of injuring other road users. At all adult ages, women travel more than men as car passengers, less as car drivers, and make more journeys by local public transport. Women make more journeys as pedestrians than men below the age of 65, but men make more journeys than women in older age. Younger women are significantly safer drivers than men, but women cease to be safer drivers over the age of 60 or 70. The same applies to the risk they pose to other road users, as measured by their risk of killing a pedestrian. There is some evidence that older women voluntarily restrict the amount of driving they do at younger ages than men, but there is no evidence that in Britain they surrender driving licenses at a younger age than male drivers. The fatality rate per journey as a pedestrian is higher than that as a car driver. Any policy that caused trips by those age 70 and over to transfer from being made by car to being made on foot would increase the total fatalities and serious injuries in traffic accidents.

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In European countries and in North America, fewer women than men are killed or injured in traffic accidents as pedestrians, cyclists, or car drivers. In terms of casualty rates per population, and where appropriate per driving license and per distance driven, women younger than 60 have a lower risk rate than men.

Older female drivers reduce the number of car driver journeys they make at younger ages than male drivers, and there is some evidence that before they stop driving, aging women restrict their driving more severely than do men. There have been suggestions that men should do more to encourage women to drive more, particularly when men and women are traveling together, both to maintain their driving competence and because they are safer drivers.

This paper analyzes the mobility and safety of male and female road users in Britain, with particular emphasis on older car drivers. The patterns that are found are similar in general terms to those found in other European countries and the United States, although the precise values of trips per year, driving license holding, and so on, do vary in detail between countries.

## MOBILITY

### Number of Journeys and Distance Traveled

Younger women make more journeys per day or per year than men, but older men make more journeys than women (Figure 1a). At all ages, men travel further than women (Figure 1b). For Britain, these data come from

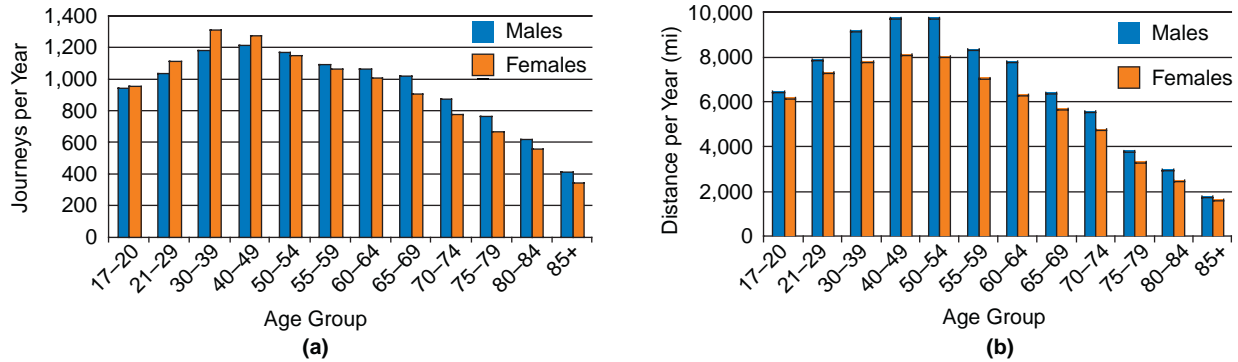


FIGURE 1 Graphs showing (a) journeys and (b) distance per person per year by age and gender: Britain, 2005 (National Travel Survey).

the National Travel Survey (1); for the United States, from the National Household Travel Survey (2); and for Sweden, from RES, The National Travel Survey (3).

**Purposes of Travel**

The purposes for which people travel vary between men and women, as well as with age (Figure 2). For both women and men, journeys to work and education decrease with increasing age—for women particularly after age 60 and for men particularly after age 65 (the qualifying ages for state pensions in Britain). Women make more journeys than men to escort others. Some of these escort journeys are for school journeys, but the majority are not; only women ages 30 to 39 make more escort journeys for education than for other purposes.

Visiting friends is a significant purpose for both genders, and the number of journeys remains fairly constant to age 75 or above. For men, shopping and personal business journeys (health care, visiting the bank, and other similar activities) increase after age 60 and remain high to age 80. For women, the increase after age 60 is smaller and only lasts to age 70.

For both women and men, there is an increase in the number of journeys for nonwork activities after retirement that lasts into the 70s for women and the 80s for men. Although there are undoubtedly some older individuals whose activities are limited by transport problems, the increase in nonwork journeys between the ages of 60 and 75 suggests that for many people, transport difficulties are not reducing activities. Reports on the transport needs of older people (4) and on social exclusion in Britain (5) do identify transport as a significant problem.

**Mode of Travel**

Men make more of their journeys as car drivers, while women are more likely to travel as car passengers (Figure 3). Almost all the reduction in the number of journeys people make over the age of 70 (for men) or 50 (for women) is a result of making fewer journeys as car driver.

Men ages 65 to 69 increase the number of journeys they make as pedestrians, and those ages 70 to 85 increase the number of journeys by bus. Women ages 65 to 85 increase their journeys by bus.

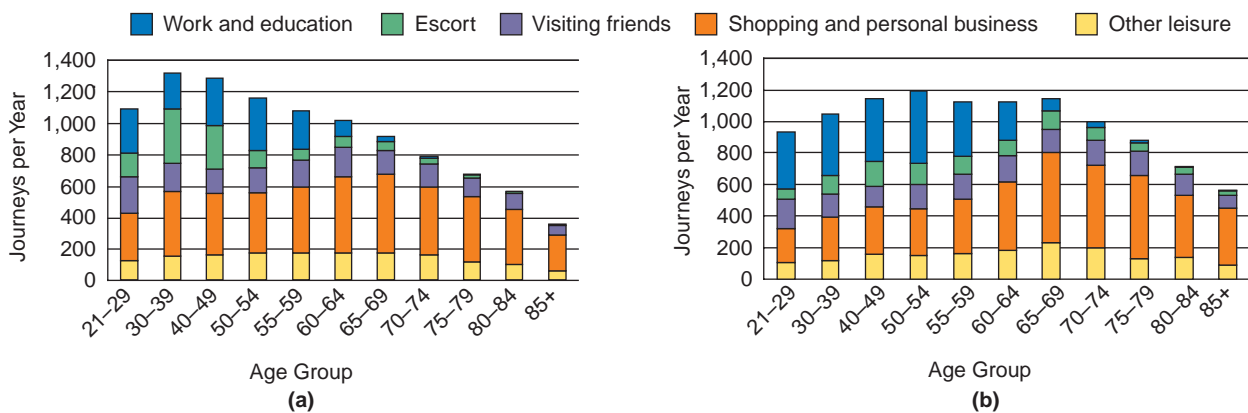


FIGURE 2 Journeys per year by age and purpose for (a) women and (b) men: Britain, 2005.

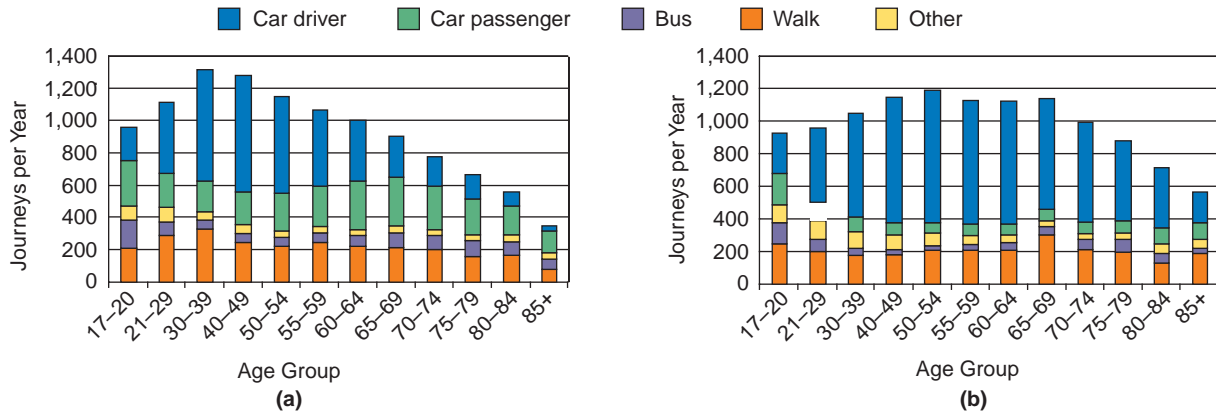


FIGURE 3 Journeys per person per year by mode for (a) women and (b) men: Britain, 2005.

The tendency at all ages for men to drive cars and women to travel as car passengers appears in every country for which data are available (6). The United States is more car dependent than European countries, with about 90% of all journeys by car, 8% as pedestrians and 2% by transit. Also, in the United States, the percentage of journeys by noncar modes does not increase with age above 60 years, as it does in Britain and other European countries.

### Travel by Holders of Car Driver's Licenses

The reduction in journeys as car drivers with increasing age is partly because of the decreasing percentage of the older population holding driver's licenses and partly because those with driver's licenses drive less. To separate these effects, Figure 4 shows the number of car driver journeys per year by people with car driver's licenses and the average length of those journeys.

Women with driver's licenses reduce the number of journeys they make as car drivers from age 50, with the number of journeys falling steadily from 800 per year at ages 50 to 54, to 200 a year for ages 85 and over. Men maintain a rate of 800 to 900 journeys a year to age 75, then reduce

their rate to 400 a year at ages 85 and over. The average length of women's car driver journeys varies little with age, ranging between 5 and 7 miles over the entire age range. Younger men make longer journeys—typically 10 or 11 miles—up to age 65, and then reduce their average journey length to about 5 miles for ages 80 and over.

There is no research to establish whether the reduction in the number of car driver trips by older women is a result of having fewer activities to which to travel, of making more journeys as a car passenger after the husband's retirement, or of self-regulation that leads women to stop driving under more stressful conditions, such as at night. Anecdotal evidence suggests that women do avoid driving at night, on motorways (interstates), and for long distances at younger ages than men.

### Driver's Licenses

In Britain, car driver's license holding by men increased rapidly from the 1970s to the 1990s but is now saturated for men up to the age of 75. It is still increasing for older men. About 90% of men ages 40 to 70 hold a driver's license, and about 80% of those in their early 70s hold a driver's license (Figure 5). License holding by women

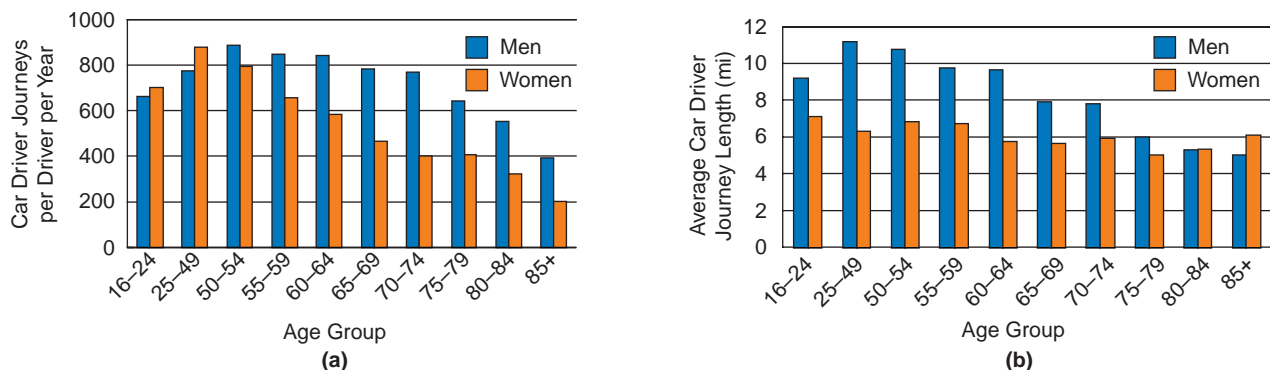


FIGURE 4 Car driver journeys per (a) licensed driver and (b) average journey length: Britain, 2005.

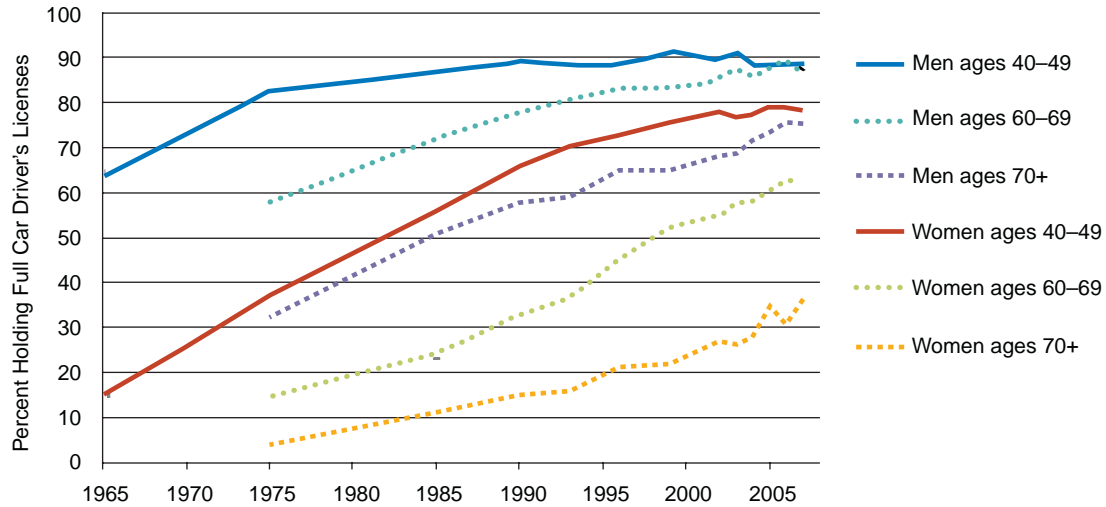


FIGURE 5 Percentage of men and women holding full car driver's licenses: Britain.

was much lower than that of men. For women in their 40s, license holding appears to have just reached saturation at around 80% of the population, but for all older age groups it is still increasing.

The increase in license holding in older age groups occurs because most drivers obtain their license when young or in early middle age and then retain it into older age. The 37% of women ages 40 to 49 who held a driver's license in 1975 are now only in their 70s; of women in their 70s, around 32% held a driver's license in 2005. Men ages 70 and over have had a slightly lower percentage of license holding than women ages 40 to 49 since 1975. Between 1975 and 2007, license holding by both groups increased from about 35% to about 77%.

By following the license holding of cohorts through National Travel Surveys, it is possible to estimate the percentage of drivers who surrender licenses at various ages (Figure 6). For men, there is clear evidence of some surrendering of licenses from age 70 onwards. License holding

for the cohort of men in their late 70s drops about 5%. By ages 85 and over, it drops between 10% and 15%. For women, license holding is always lower, and there is little evidence of licenses being surrendered earlier than by men. For women in their mid-80s in 2005, license holding was about 15%, compared with about 22% a decade earlier for the same cohort. For those in their mid-70s, the reduction was to around 40% in 2005, from about 48% 8 years earlier. For those in their 60s in 2005, of whom about 64% held licenses, there is no systematic evidence of a reduction in license holding over the previous decade. For the cohort of men in their 60s in 2005, license holding was about 88% and had been steady for the previous 20 years. The interpretation of these figures as showing no difference in license surrender rates between men and women assumes that the mortality rates of license holders and nonholders are the same. Because these are survey results, the effect of death removing people from the population but not from the count of licenses does not apply.

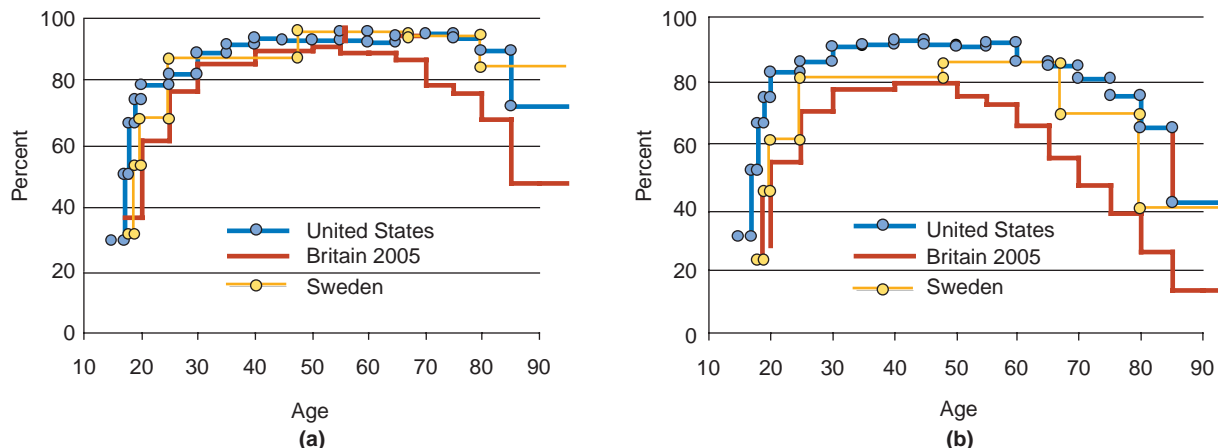


FIGURE 6 Percentage of (a) men and (b) women holding car driver's licenses in the United States, Sweden, and Britain: 2005–2006.



Higher percentages of people in the United States and Sweden hold car driver's licenses than in Britain, and in Britain, the reduction in the percentage holding licenses decreases more with age. For women, this reflects lower license holding in the past by middle-aged women. For men ages 70 and over, and for women ages 50 and over, license holding is increasing. License holding in Sweden and the United States is similar, though a little lower for women in Sweden.

## SAFETY

For Great Britain (that is, England, Wales, and Scotland), detailed road safety statistics are available since 1971, published annually by the Department for Transport and its predecessors in *Road Casualties Great Britain* (7).

For all age groups, fewer females than males are injured in road accidents. In Britain since 1990, male road accident deaths have outnumbered female deaths by two to one, and for casualties of all severities, males outnumber females by about 40%. In the United States, the ratio of male to female deaths is rather more than two to one, but slightly more females than males are injured in traffic accidents (8). In Sweden three times as many men as women were killed in traffic accidents in 2006 (9).

## Casualty Rates for Car Drivers

It is well known that for car drivers, the fatality rate per driver's license increases with age after an age of about 50 or 60. Much of this increase is caused by the greater fragility of people as they age, as reported by Evans (10). Of car occupants injured in traffic accidents in Britain,

0.6% of those ages 30 to 49 die of their injuries, compared with 2.0% of those ages 70 to 79 and 4.5% of those ages 80 and over.

Figure 7 shows how the car driver casualty rates per license varied with age and severity of injury in Britain in 2006. The rates are given on different scales (fatalities per 10 million drivers, killed and seriously injured (KSI) per million drivers, and all severities (including fatal) per 100,000 drivers) because there are approximately a hundred casualties of all severities and 10 KSI casualties for each fatality.

The fatality rate is lowest for drivers ages 50 to 59 and increases by more than a factor of almost four for drivers ages 80 and over. The rate for KSI casualties is lowest for drivers ages 60 to 69 and doubles for those ages 80 and over. The rate for casualties of all severities is lowest for drivers ages 70 to 79 and increases by 22% for those ages 80 and over. This shows that the increase in accident involvement per year is small for even the oldest drivers, and that the increase in fatalities is largely a result of fragility. (Because older drivers drive fewer miles, the casualty rate per mile driven does increase for older drivers.)

Published road safety information for Britain only gives data covering road user type, gender, and age for KSI casualties, not for fatalities or for casualties of all severities. The remainder of this section analyzes KSI casualty rates for car drivers by age and gender.

Figure 8 shows car driver casualty rates per license for male and female KSI casualties in 2006. For all driver ages, the casualty rate for male drivers is higher than for female drivers; however, the difference is much greater for younger drivers. By the age of 60, the rates for men and women are similar, and in some previous years, the rate for older women has been higher than for older men.

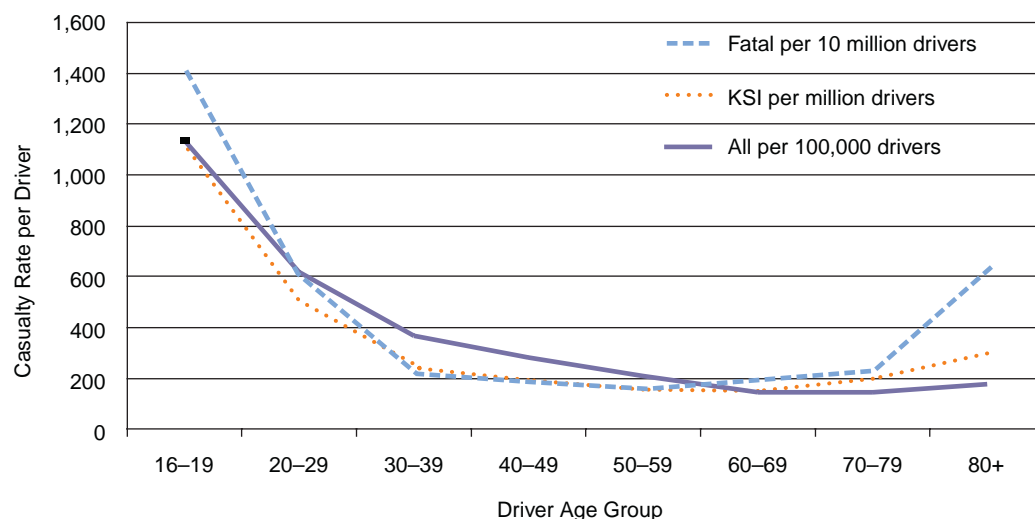


FIGURE 7 Car driver casualty rates per driver's license: Britain, 2006.

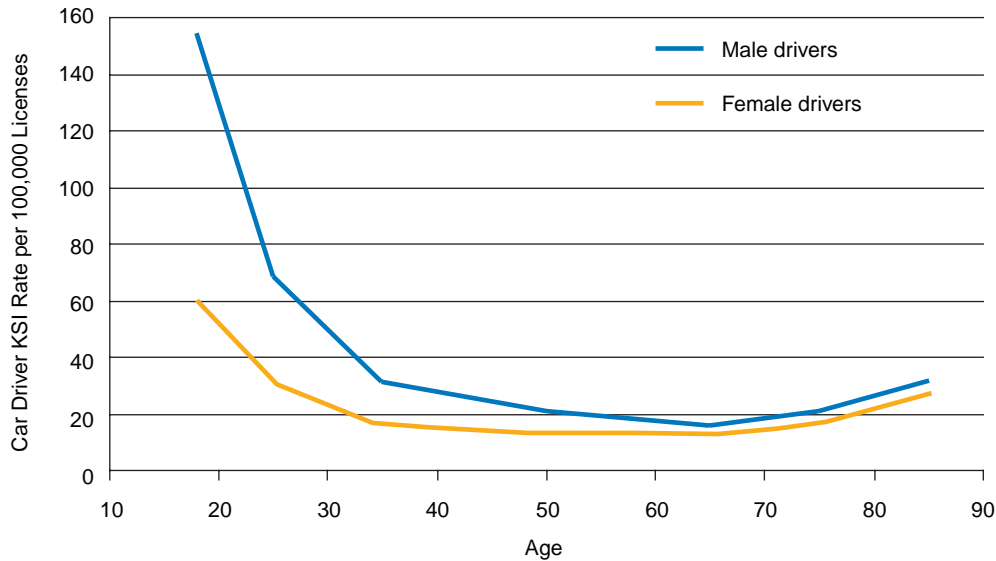


FIGURE 8 Car driver KSI casualty rates per license for male and female drivers: Britain, 2006.

Female car drivers drive fewer miles per year than male drivers. When the casualty rate per mile driven is calculated, women have a higher rate than men for ages over 40, although the difference does not become substantial until the age of 60 (Figure 9). For women, the casualty rate is lowest for the age group 40 to 49, while for men it is lowest for the age group 60 to 69. The casualty rate per mile is calculated for 2004, the latest year for which information is available on miles driven by men and women of various ages, including 80 and over.

### Trends in Car Driver Casualty Rates

Casualty rates per driver license have been decreasing for both male and female car drivers and for all age groups. Figure 10 shows the rates for male and female drivers for a number of age groups. As would be expected from the previous section, the difference in rates between male and female drivers is greatest for the youngest drivers. The casualty rate is lowest for the age group 60 to 69.

In general, the rates for female drivers are lower than those for male drivers. Exceptions are 2003, when female

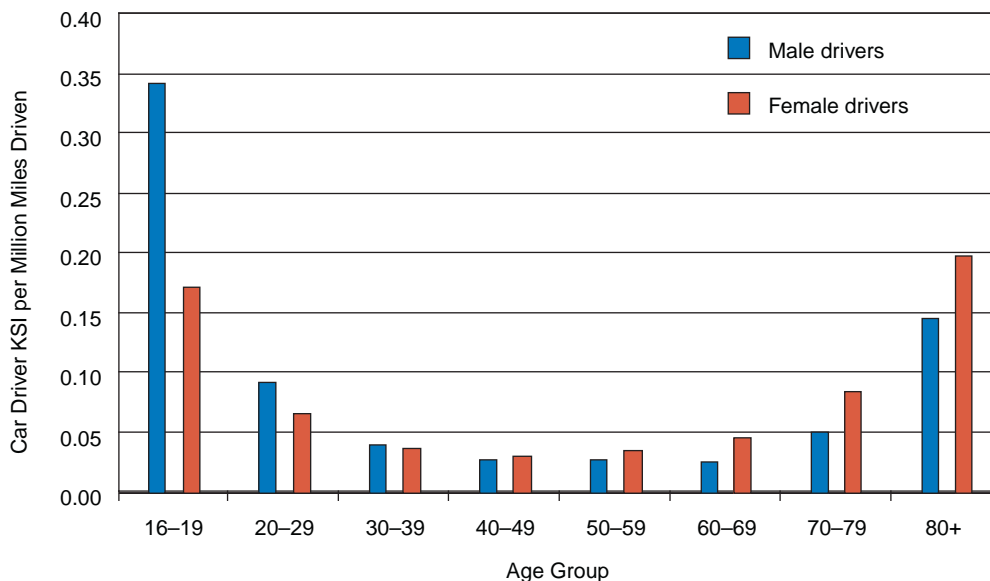


FIGURE 9 Car driver KSI casualty rates per mile driven for male and female drivers: Britain, 2004.

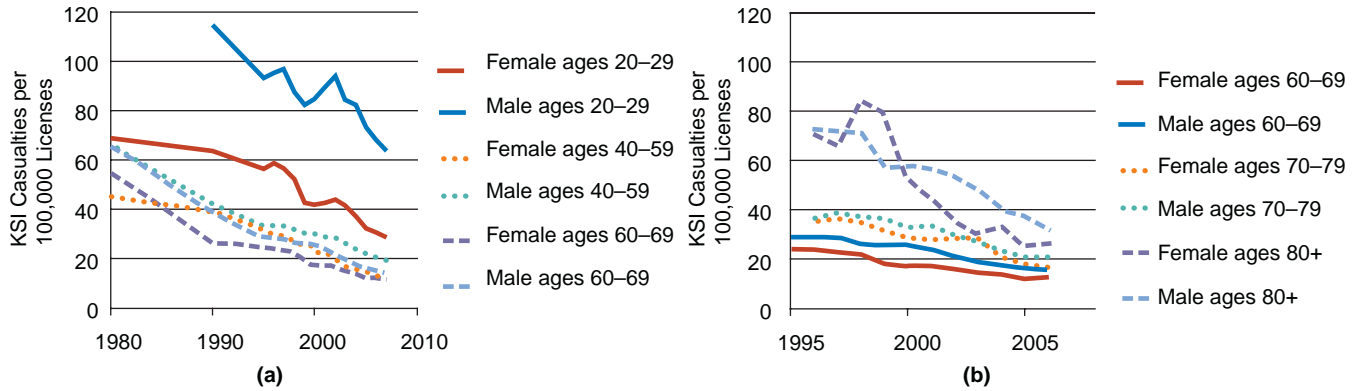


FIGURE 10 Trends in car driver KSI casualty rates per license for male and female car drivers in Britain: (a) 1980–2010, and (b) 1995–2005.

drivers ages 70 to 79 had a higher rate than male drivers, and 1998 and 1999, when female drivers ages 80 and over had a higher rate than male drivers.

For drivers ages 80 and over, the casualty rate decreased by 60% between 1997 and 2007, while for the younger age groups, the decrease was about 50%. The casualty rates per mile driven decreased more for women than men, and more for older drivers than for middle-aged drivers.

### Risks to Other Road Users

A measure of the risk that different groups of drivers pose to other road users is the number of pedestrians killed by

each group of drivers. The number of pedestrians killed by male and female car drivers of different ages has been tabulated for the year 2005 by the Department for Transport.

Figure 11 shows the number of pedestrians killed by drivers in 5-year age groups. At all ages, male drivers killed more pedestrians than female drivers. Below a driver age of 60, the difference is large, a factor of at least three to one.

This measure can be converted into the risk per driver of killing a pedestrian and the risk per mile driven. Figure 12 shows these two risk measures. The risk per driver is greater for male than female drivers up to age 70 but approximately equal for older drivers. The risk per mile driven is greater for male drivers up to age 60 but greater for female drivers above age 60.

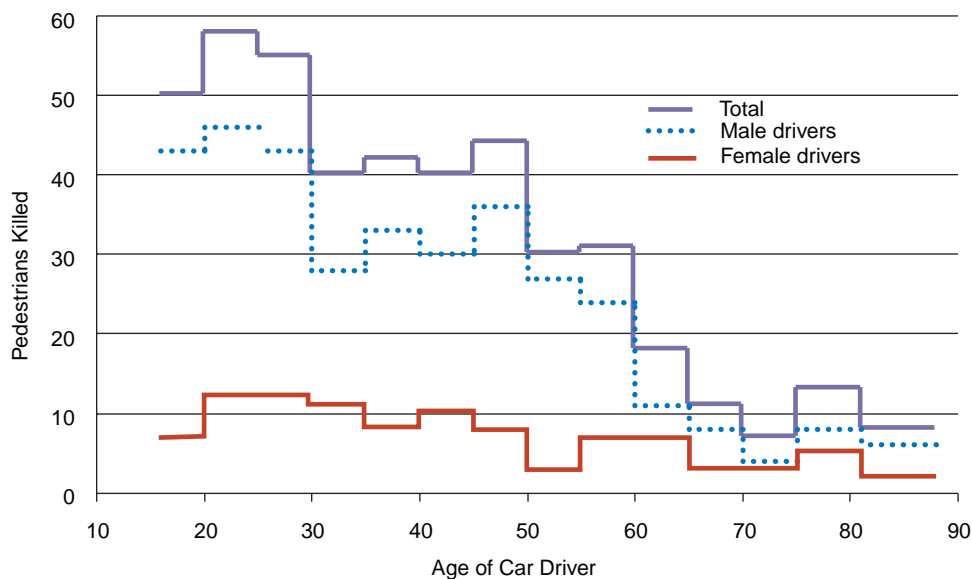


FIGURE 11 Number of pedestrians killed by car drivers of different ages: Britain, 2005 (special tabulation by Department for Transport).

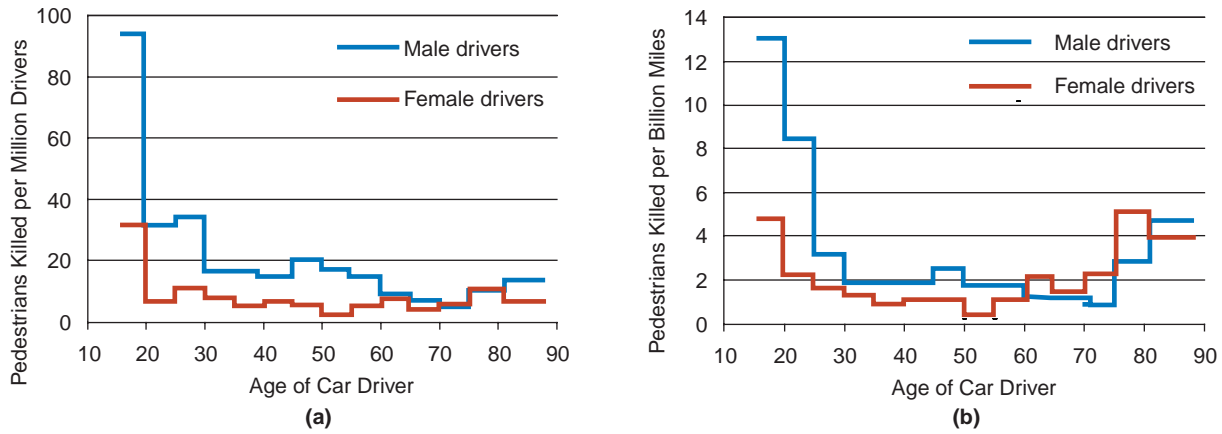


FIGURE 12 Risk of killing a pedestrian (a) per driver and (b) per miles driven: Britain, 2005.

**Pedestrian Casualties**

The fatality rate per population for pedestrians increases greatly at age 70 and above (Figure 13), again reflecting the greater fragility of older people. This statistic has been used to argue that older people are at greater risk of death as pedestrians than as car drivers, because for older people, the fatality rate per population for pedestrians is higher than for car drivers. For people ages 70 and over, the pedestrian rate is marginally lower than the rate for car drivers per license.

Although fatality rates per person and per driver are similar for pedestrians and car drivers, because more journeys are made as car drivers than as pedestrians, the risk per journey is greater for pedestrians than for car

drivers. The fatality rates per journey can be estimated, and these are shown in Figure 14 for the years 2005 and 2006. Both years are given to indicate the variation in the estimates from year to year.

The fatality rate per journey is lower for car drivers than for pedestrians for all ages over 30. The year-to-year variation in the estimates, while significant, is not large enough to cast doubt on this result. Therefore, any policy that causes people to replace car driver journeys with pedestrian journeys will increase the road accident fatalities overall.

KSI casualty rates per journey for female and male pedestrians and car drivers are shown in Figure 15. For both men and women, the rates for pedestrian casualties are higher than for car driver casualties for all ages over

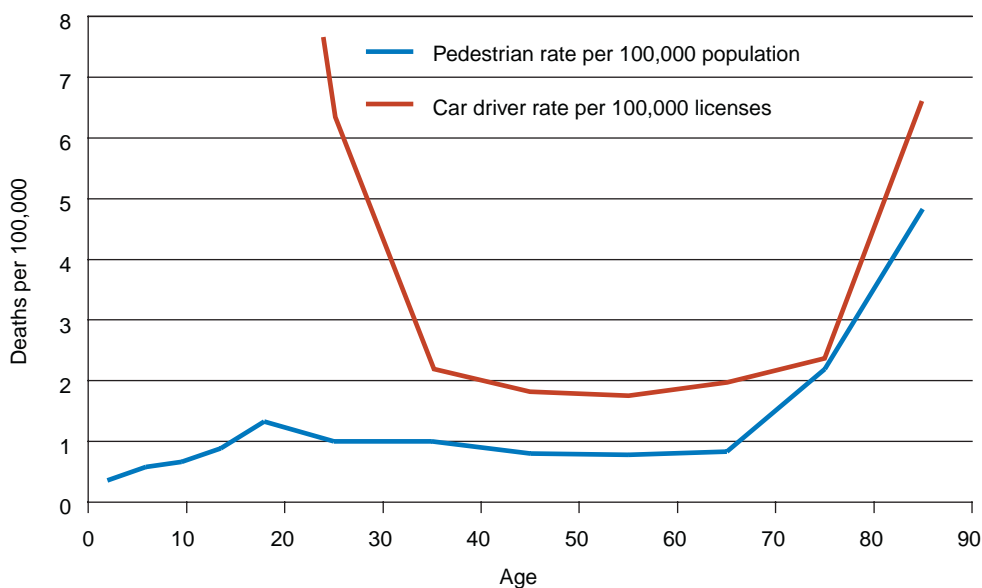


FIGURE 13 Fatality rates for pedestrians per population and car drivers per license: Britain, 2006.

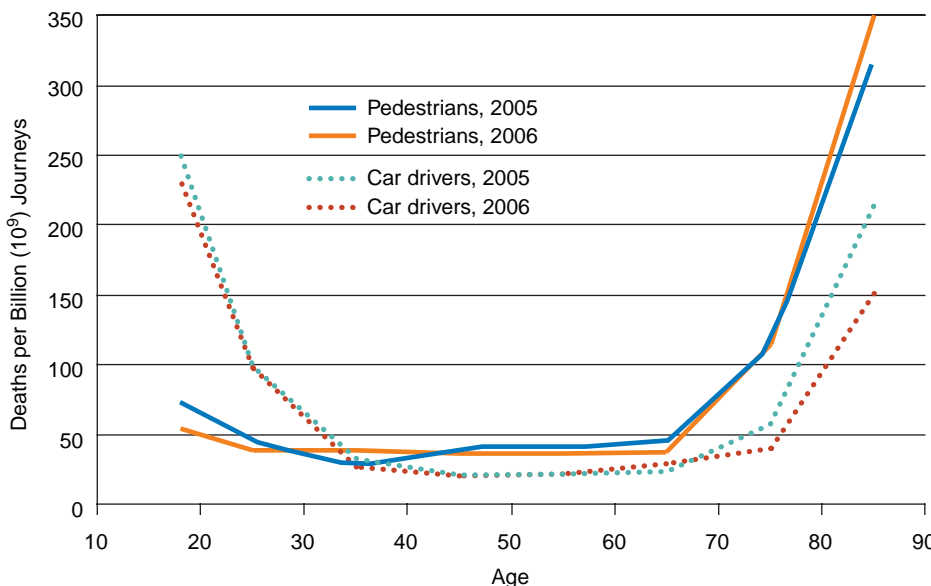


FIGURE 14 Fatality rates for car drivers and pedestrians per journey: Britain, 2005 and 2006.

30. In more detail, male and female pedestrians have similar casualty rates per journey for ages over 60, and the increase in casualties per journey with increasing age is clear. Female car drivers have a lower casualty rate per journey than males for ages up to 60, but for ages over 60 have a higher casualty rate with increasing age, with the gap increasing with age. The smaller increase with age in casualty rates for car drivers as opposed to pedestrians may reflect the greater protection in accidents that car drivers experience.

Any policies that encourage people over the age of about 70 to switch car driver journeys to pedestrian jour-

neys would increase the overall number of KSI casualties. The difference in casualty rates between car drivers and pedestrians is greater for men than women, so the tendency of older male drivers to continue driving may well be contributing to a safer road system.

DISCUSSION AND CONCLUSIONS

There certainly are some older people who experience social exclusion as a result of transport difficulties (4, 5); however, the increase after retirement in nonwork

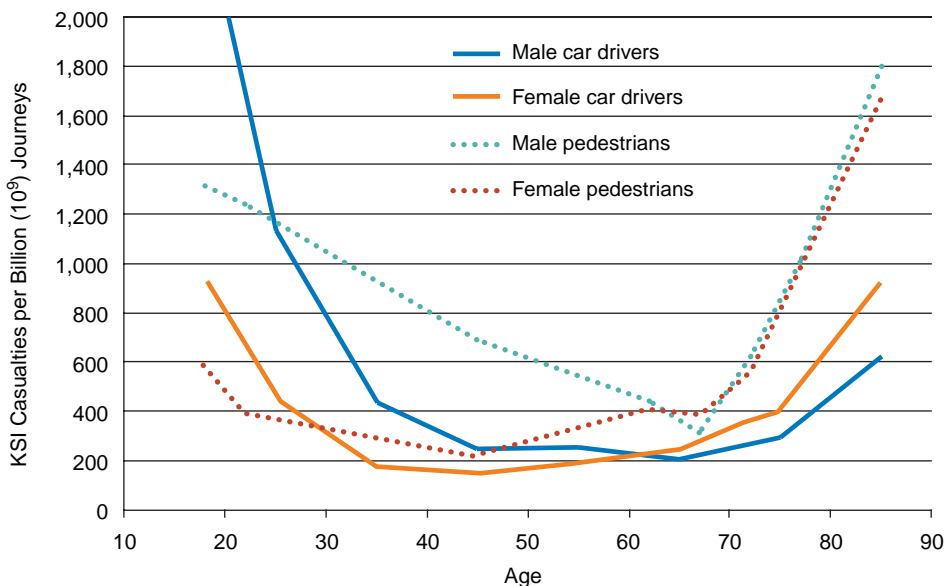


FIGURE 15 Car driver and pedestrian rates per journey for KSI casualties: Britain, 2006.

journeys by both men and women suggests that for many people, transport does not limit the activities in which people participate, at least in their 60s and early 70s.

The pattern of women traveling as car passengers and men as car drivers is found in any country for which data are available. Partly for this reason, women drive fewer miles per year than men. A recent study by Langford et al. shows that in the Netherlands, it is only people who drive less than 3,000 km (approximately 2,000 miles) per year whose accident involvement rate increases for the ages of 75 and over (11). This does suggest that there are safety benefits in encouraging older female drivers to share driving more with male partners, to maintain their practice as drivers under conditions with which they feel comfortable.

Older female drivers reduce the number of car driver journeys they make at about 20 years younger than older male drivers, from age 50 for women and age 75 for men. This reduction may indicate that women self-regulate their driving to avoid stressful conditions at younger ages than male drivers, but there is no research evidence to confirm that this is occurring. Also, following cohorts of drivers provides no evidence that women surrender driver's licenses at younger ages than male drivers.

The rates per license for car driver KSI casualties are higher for male drivers than female drivers at all ages, but the difference is much greater for young drivers than for drivers age 60 and over. The casualty rate per mile driven is high for male drivers up to age 40, but higher for female drivers over age 40. There is research evidence from Britain that

Males at fault were much more likely to commit deliberate risk-taking types of accident than females. . . . For female drivers, a far greater proportion of their speed-related collisions involved ignorance of the correct speed than for males. Where females were involved in deliberate risk-taking, they were more likely to be travelling too fast for the conditions rather than above the speed limit. (12)

The changes in casualty rates with age are consistent with both male and female drivers becoming safer as they become more experienced, with the difference in rates decreasing for older drivers because male drivers become less reckless as they age. If this is what is happening, there could be benefit in providing refresher training for older drivers to address problems of poor judgment of driving conditions.

On the results presented for Britain, older female drivers are no safer than older male drivers. Thus there would be no direct safety benefit in transferring some car mileage from older male drivers to older female driv-

ers. Because older female drivers drive fewer miles than older male drivers, however, they could well benefit from more driving experience, which could well have an indirect safety effect.

It must be emphasized that nothing should be done to encourage older female drivers to drive more in conditions in which they do not feel comfortable. Their apparent willingness to self-regulate probably provides safety benefits by enabling female drivers to avoid stressful and dangerous driving conditions.

For both men and women, casualty rates per journey are higher for pedestrians than car drivers for ages over 30. Any policies that encourage people over the age of about 70 to switch car driver journeys to pedestrian journeys would increase the overall number of KSI casualties.

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# Traffic Violations Versus Driving Errors

## Implications for Older Female Drivers

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Research has shown that rates for motor vehicle-related crashes are twice as high for older men as for older women, but the proportion of fatalities is higher for older women. To better understand driving errors made in crashes and to suggest prevention strategies, this study (a) classified violations underlying crashes into errors made during on-road assessments; (b) quantified age, gender, and types of driving errors as predictors of postcrash injury; and (c) examined whether different violations and driving errors occur in different age cohorts ( $\leq 75$  and  $> 75$  years). The 2005 Florida Traffic Crash Records Database ( $N = 5,345$  older drivers) was used to select violations underlying crashes. The mean age was 76.08 (standard deviation = 7.10), with 2,445 (45.7%) female drivers. Female drivers had statistically significantly more failure to yield (intersection or alley-driveway), failure to obey required traffic controls, and speed-related violations predictive of crash-related injuries. A greater percentage of injured female drivers made statistically significantly more yielding errors ( $p < .001$ ) and more speed regulation and gap acceptance ( $p < .05$ ) errors. These findings generally held true when younger ( $\leq 75$  years) and older ( $> 75$  years) women were compared with their age cohorts. The findings show that compared with older male drivers, older female drivers are at a greater risk for injuries from crash-related violations and driving errors. This finding holds true when younger and older female drivers are compared with their age cohorts. Injury prevention strategies on the person, vehicle, and environmental levels must receive serious consideration and be tested empirically for effectiveness.

In 2006, the United States had approximately 30 million drivers ages 65 and older, (1); by the year 2030, the number of older drivers is expected to more than double, making up 25 percent of the total driving population (2). This future group of older drivers is predicted to have a larger proportion of women driving more often and for longer distances (3–5). While past research findings have been recognized as predominately “gender neutral,” researchers are calling for attention to differences between male and female older drivers in research, practice, and in the development of policies supporting transportation and mobility services (6). Existing studies illustrate significant gender differences in driving patterns (7), crash risk and protective factors (8, 9), crash types and rates (10, 11), crash injury or fatality outcomes (12), and self-regulation of driving and driving cessation (13). Specifically, and compared with older male drivers, older female drivers have limited driving exposure, drive fewer miles on freeways, are less confident about their driving skills (14), and display driving errors such as incorrect vehicle speed for environmental conditions (15). Women drove fewer miles, drove more on local roads versus highways, and reported greater avoidance of difficult driving situations (e.g., in rain or in high traffic) (16, 17).

Trend data predict that older women will drive more often and for more years of their lives (5). Given the current gender characteristics discussed above and the knowledge that older women are more seriously injured in crashes, the purpose of this research was to examine gender differences among injured drivers. The study had three aims: (a) to examine gender differences among injured drivers in committing driving violations, (b) to



examine gender differences among injured drivers when committing driving violations that were classified as driving errors, and (c) to examine whether different violations and errors occur for different age groups ( $\leq 75$  years and  $> 75$  years) within the older driving population.

A driving violation is defined as a behavior that engages in deliberate breaching of safe driving practices (18, 19). Violations were operationalized as those citations administered by law enforcement officers in accordance with Florida state statutes. These included criminal violations (e.g., driving under the influence), nonmoving violations (e.g., improper parking), and noncriminal moving violations (e.g., failure to yield right-of-way or exceeding the speed limit) (20). For the purpose of investigating the second of the study's aims, the study was interested in driving violations that could be classified as driving errors; therefore, it focused on noncriminal moving violations.

Driving errors are indicated by a maneuver executed erroneously, such as a lane maintenance error or a speeding error (21). To classify the violations, the study used visual scanning errors in combination with seven driving errors operationalized in the National Older Driver Research and Training Center's (NODRTC's) on-road assessment (22). These errors included those made during yielding, speed regulation, gap acceptance, lane maintenance, signaling, vehicle position, and adjustment to stimulus or traffic signs and errors made during visual scanning (Table 1).

## RATIONALE AND SIGNIFICANCE

A gap exists in gender differentiation by type of driving violation or type of driving error among older female drivers who sustained a crash-related injury. Bridging this gap will provide information on the female gender differences—as well as on age differences among females—pertaining to type of violation or type of driving error predictive of crash-related injuries. In turn, this information will make it possible to recommend strategies for practice or policy changes and to suggest future research opportunities for gender-specific injury prevention.

## METHODS

This study was approved by the University of Florida's Institutional Review Board.

### Design

A cross-sectional design was used for studying driving violations by analyzing the 2005 Florida Traffic Crash Records Database (FTCRD) ( $N = 526,833$ ). NODRTC

operational definitions were used to study seven driving errors (Table 1) (22).

### Sample

Subjects in the FTCRD were all crash-involved drivers. Subjects were included in the study if they were  $\geq 65$  years of age, had daytime crashes, were driving automobile or automobile derivatives (not scooters, bicycles, golf carts or heavy-duty vehicles), and did not have noncriminal moving violations. Subjects were excluded if they had missing data or criminal moving violations (e.g., drunk driving) or if their age, gender, or injury status was unknown.

### Procedure

When applied to the 2005 FTCRD driver population ( $N = 526,833$ ), the inclusion–exclusion criteria listed above yielded a final sample of 5,345 older drivers.<sup>1</sup> Figure 1 displays the process of participant inclusion and exclusion. Driving violations recorded in the 2005 FTCRD were matched to driving errors by identifying 32 driving violations that were collapsed to 16 non-criminal moving violations. These were then presented electronically to three experts knowledgeable of driving violations and driving errors. These experts were a senior-most commander in the Florida Highway Patrol with 15 years of law enforcement experience and two occupational therapists: one certified driving rehabilitation specialist with 6 years' experience in this field and one occupational therapist trained in driving evaluation with 2 years' experience in this area.

Operational definitions for each driving error are presented in Table 1. The expert raters were asked to choose up to two out of the seven driving errors (vehicle positioning, lane maintenance, speed regulation, yielding, signaling, adjustment to stimuli and traffic signs, and gap acceptance) that match each violation. Examples of violations are given in Table 2. The raters were instructed to select only one driving error for a given traffic violation if they believed with great confidence that only that single error was related to the violation. Based on the raters' responses, points were assigned to each error. When a rater chose two errors, 1 point was assigned to each error. When a rater chose only one error, 2 points were assigned to the error. To calculate the total scores, the points assigned by all three raters were summed for each driving error. For example, for the traffic violation

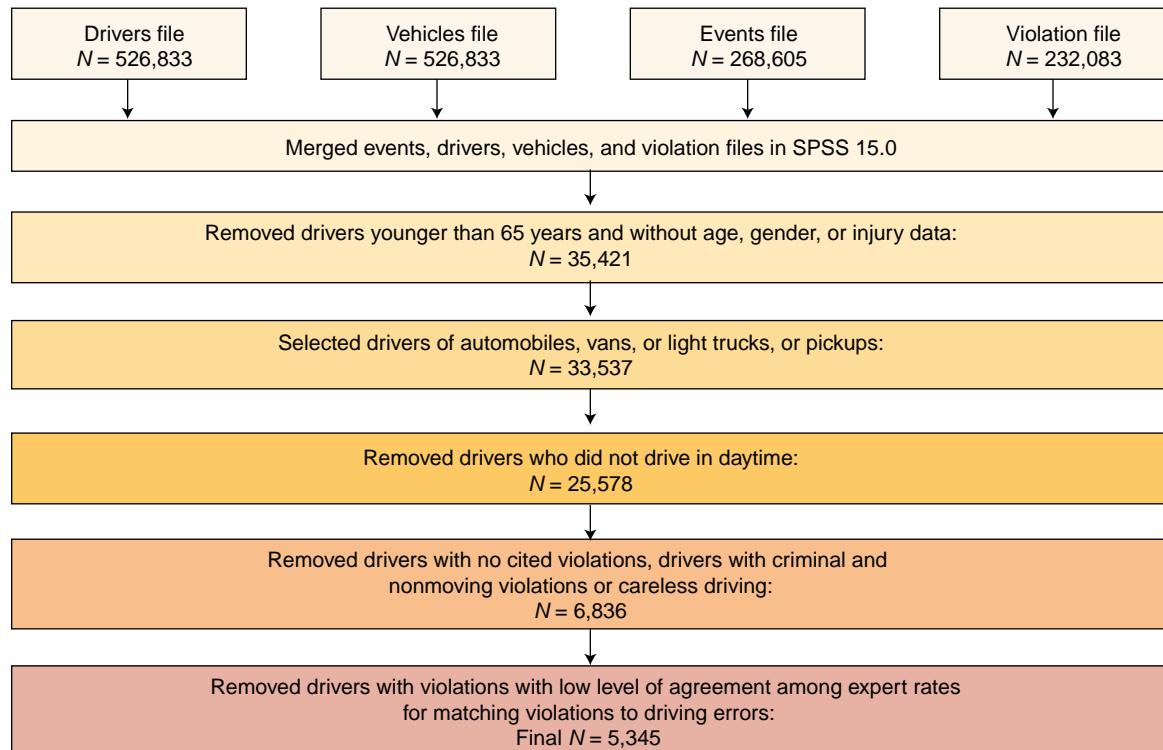
<sup>1</sup> A procedure for database management of the 2005 FTCRD is available from the first author of this study at [sclassen@phhp.ufl.edu](mailto:sclassen@phhp.ufl.edu).

**TABLE 1** Operational Definitions of Driving Errors

Driving Error	Definition
Vehicle position (anterior or posterior)	Refers to the position of the vehicle (anterior or posterior) in relation to other vehicles and to objects and pavement markings. This captures following distance during forward movement and vehicle spacing during lane changes and merges. Examples of errors: traveling too closely, inadequate space cushion during merge or lane change, and stopping across a crosswalk or too far back from either pavement markings or other vehicles.
Lane maintenance	Refers to the lateral (side-to-side) positioning of the vehicle during driving maneuvers (turns, straight driving, lane changes) and while stopped. Reflects ability to maintain steering control. Examples of errors: drifting out of driving lane, encroachments on perpendicular traffic or wide turns, and parking outside designated space markings.
Speed regulation	Reflects ability to follow and maintain speed regulation limits and to have adequate control of acceleration and braking features of the vehicle. Examples of errors: not coming to a complete stop at a stop sign, traveling too slow or too fast, inadequate merging speed regulation, and abrupt or inappropriate braking or acceleration.
Yielding	Giving right-of-way when appropriate. Refers to the ability to recognize common rules of road safety. Yielding is assessed at four-way or two-way stop intersections, right turns on red, and merges.
Signaling	Proper use of turn signals. Examples of errors: leaving the turn signal on, not using the turn signal when turning, and using the turn signal inappropriately (wrong signal for a given turn, signaling too short until maneuver).
Adjustment to stimuli and traffic signs	Ability to respond appropriately to driving situations. This category captures the ability to adjust appropriately to changing road sign information, other vehicle movements, and pedestrian movements and to recognize potential hazards. Examples of errors: not adjusting speed regulation for posted limits, not following proper evaluator instructions, choosing improper lane from posted signage, and improper response to traffic or pedestrian movement.
Gap acceptance	Choosing an appropriately safe time and or spacing distance to cross in front of oncoming traffic (unprotected left turn). Errors in gap acceptance are based on evaluator judgment given the speed regulation of oncoming traffic and number of lanes to be crossed. Errors in gap acceptance consist of driver estimates that are both too short and too long for the given speed regulation and distance to be traveled.

of failure to yield for emergency vehicle, Rater 1 chose the driving errors yielding and adjustment to stimuli and traffic signs, but Rater 2 and Rater 3 chose only adjustment to stimuli and traffic signs as a corresponding driving error. Thus, 5 points were assigned to adjustment

to stimuli and traffic signs, 1 point to yielding, and 0 points to the other errors. Under this system of matching errors and violations, the violation of failure to yield for emergency vehicle had the strongest relation to the driving error adjustment to stimuli and traffic signs, as it



**FIGURE 1** Procedure for including or excluding drivers from the 2005 FTCD.

**TABLE 2** Driver Demographics, Traffic Violations, Driving Errors, and Injury in the 2005 FTCD

Variable	Number (N = 5,354)	Percent
Driver demographics <sup>a</sup>		
Female	2,445	45.7
Traffic violations		
Failure to yield (left turn)	1,569	29.4
Failure to yield (intersection)	1,116	20.9
Failure to yield	1,032	19.3
Failure to yield (alley or driveway)	448	8.4
Failure to obey required traffic control	406	7.6
Speed-related violation	394	7.4
Following too closely	166	3.1
Failure to drive in single lane	96	1.8
Pedestrian violation (e.g., failure to yield to pedestrian)	46	0.9
Failure to yield for emergency driver	18	0.3
Violation of right-of-way	14	0.3
Violation of flashing light	13	0.2
Driving errors		
Vehicle positioning	166	3.1
Lane maintenance	96	1.8
Speed regulation	394	7.4
Yielding	4,179	78.2
Adjustment to stimuli	104	1.9
Gap acceptance	406	7.6
Injury (yes)	2,382	44.6

<sup>a</sup> Mean age = 76.08 years (standard deviation = 7.10).

had the best rater matching and therefore the best score. All the other traffic violations were similarly matched to a driving error.

After the first round of expert ratings and matching, the violation-to-error classifications with a low level of rater endorsement (score < 4) were selected. These violation-to-error classifications included failure to yield, failure to stop, right turn on red light, improper turn or U-turn, and improper backing up. The raters were asked to reclassify the violations in this set of classifications into one driving error type. The raters were in complete agreement on failure to yield but not on any of the other violations; therefore, failure to yield and all of the violation-to-error classifications from the first round of reviews were used in the subsequent analyses, but the other driving error categories were excluded. The final violation-to-error classification yielded six of the eight driving errors (no statistically significant agreement for signaling and visual scanning).

In the FTCD, crash-related injuries are coded as fatal (<1%), incapacitating (6%), noncapacitating (16%), possible (22%), and none (56%). For the purpose of this study, the injury categories were collapsed to a dichotomous yes-no variable.

## Analyses

The data were analyzed to answer the three aims of the study (SAS 9.0) with the univariate procedure for

descriptive statistics. To examine the effects of gender and age within the female group in traffic violations and errors among injured drivers, a contingency table was used and Fisher's exact test was conducted for each traffic violation. (The chi-square test was not used because some traffic violations in the contingency table had fewer than five observations.)

## RESULTS

The mean age was 76.08 (standard deviation = 7.10), with 2,445 drivers (45.7%) being female. Table 2 displays driver demographics, traffic violations, driving errors, and injury. The highest number of violations occurred as yielding violations. Failure to obey required traffic control was the second-largest category, followed by speed-related violations. A subanalysis of drivers cited for speed-related violations indicated that 23 (5.9%) were traveling above the posted speed limit, 87 (22.0%) were moving at the posted speed limit, and 284 (72.1%) were estimated to be driving at speeds lower than the posted speed limit. The highest numbers of errors were made in yielding, gap acceptance, and speed regulation. Forty-five percent of the group had sustained crash-related injuries.

Table 3 displays the numbers and percentages of injured drivers and *p*-values for traffic violations predicting injuries, by gender. For all violations (except violation of a flashing light), the percentage of injured female drivers was greater than the percentage of injured male drivers. For example, 774 drivers (342 males and 432 females) committed a failure to yield violation (left turn). Of these 774, a total of 432 female drivers (58.22%) and 342 male drivers (41.35%) were injured. The results of Fisher's exact test (*p* < .001) showed that the difference between the two percentages was significant. Failure to yield (intersection or alley or driveway), failure to obey required traffic controls, and speed-related violations also showed statistically significant differences between injured male and female drivers, with higher percentages of older female drivers sustaining injuries. More injured male drivers (71.43%) were cited for violation of a flashing light than were injured female drivers, but this difference was not statistically significant.

Table 4 displays the numbers, percentages, and *p*-values for injured drivers by gender and driving error. A greater percentage of injured female drivers made driving errors compared with injured male drivers across all six categories of driving errors, but only three of the categories were statistically significant. These were yielding errors (*p* < .001) and errors for speed regulation and gap acceptance (*p* < .05). No statistically significant gender differences were indicated for vehicle positioning, lane maintenance, and adjustment to stimuli driving errors.

TABLE 3 Traffic Violations Predicting Injuries, by Gender

Traffic Violation	Male Injured		Female Injured		<i>p</i> -Value for Gender Difference
	Number	Percent	Number	Percent	
Failure to yield (left turn)	342	41.35	432	58.22	<.001***
Failure to yield (intersection)	236	39.27	290	56.31	<.001***
Failure to yield	198	36.13	262	54.13	<.001***
Failure to yield (alley or driveway)	89	35.60	100	50.51	.002**
Failure to obey required traffic control	87	40.28	101	53.16	.01*
Speed related violation	70	28.69	59	39.33	.04*
Following too closely	20	20.20	19	28.36	.26
Failure to drive in a single lane	19	39.58	28	58.33	.1
Pedestrian violation	0	0.00	1	6.25	.35
Failure to yield for an emergency driver	3	27.27	3	42.86	.63
Violation of right-of-way	2	40.00	6	66.67	.58
Violation of a flashing light	5	71.43	3	50.00	.59

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$  level (two-tailed test).

Table 5 shows traffic violations predicting injuries by gender for the younger driver group (age  $\leq 75$ ). Statistically significant differences were identified for all failure to yield categories as well as failure to obey required traffic control devices ( $p = .002$ ). Table 6 displays the driving errors predicting injuries by gender for the younger group (age  $\leq 75$ ). Statistically significant differences were identified for yielding ( $p < .001$ ) and gap acceptance ( $p = .002$ ).

Table 7 shows the traffic violations predicting injuries, by gender, for the older group (age  $> 75$ ). Statistically significant differences were identified for all failure to yield categories. Table 8 displays the driving errors predicting injuries, by gender, for the older group (age  $> 75$ ). A statistically significant difference was identified for yielding ( $p < .001$ ) only.

## DISCUSSION OF RESULTS

The purpose of this research was to examine gender differences among older ( $\geq 65$  years) crash-involved drivers. The study had three aims: (a) to examine gender differences among injured drivers who committed driving violations, (b) to examine gender differences among injured drivers when committing driving violations that were classified as driving errors; and (c) to examine whether

different violations and errors occur for different age groups ( $\leq 75$  years and  $> 75$  years) within the older driving population.

The increased risk of crash-related injury as people age is supported by the driving literature (4, 23–25). The findings of this study, however, demonstrate that older women emerge as a high-risk group for sustaining more serious crash-related injuries and that specific violations and driving errors are predictors of those crashes.

Injured female drivers had statistically more failure to yield, failure to obey traffic control devices, and speeding (under the posted speed limits) violations. In terms of driving errors, female drivers made significantly more yielding, speed regulation, and gap acceptance errors as compared with male drivers. Younger women (65 to 75 years of age) are committing more violations that predict crash-related injuries (all failure to yield categories and failure to obey required traffic control devices) as compared with all drivers in that age group. Older women drivers ( $> 75$  years of age) have more failure to yield violations (all categories) as compared with drivers in that age group. Similarly, compared with their age cohort, younger women (65 to 75 years of age) are committing more yielding and gap acceptance driving errors predictive of injuries, whereas older women ( $> 75$  years) are committing more yielding driving errors predictive of injuries when compared with their age cohort.

TABLE 4 Injured Drivers, by Gender and Driving Error

Driving Error	Male Injured		Female Injured		<i>p</i> -Value for Gender Difference
	Number	Percent	Number	Percent	
Vehicle positioning	20	20.20	19	28.36	.26
Lane maintenance	19	39.58	28	58.33	.10
Speed regulation	70	28.69	59	39.33	.04*
Yielding	867	38.86	1,090	55.95	<.001***
Adjustment to stimuli	10	16.13	12	28.57	.15
Gap acceptance	87	40.28	101	53.16	.01*

\* $p < .05$ , \*\* $p < .01$ , \*\*\* $p < .001$  level (two-tailed test).

TABLE 5 Traffic Violations Predicting Injuries in Younger Group (Age ≤ 75), by Gender

Traffic Violation	Male Injured		Female Injured		<i>p</i> -Value for Gender Difference
	Number	Percent	Number	Percent	
Failure to yield (left turn)	131	35.69	205	60.83	<.001***
Failure to yield (intersection)	105	36.33	151	55.93	<.001***
Failure to yield	86	32.21	120	53.81	<.001***
Failure to yield (alley or driveway)	41	33.06	48	48.98	.02*
Failure to obey required traffic control	37	36.63	49	60.49	.002***
Speed related violation	33	25.38	30	37.04	.09
Following too closely	9	17.31	14	34.15	.09
Failure to drive in a single lane	8	38.10	13	54.17	.37
Pedestrian violation	0	0.00	1	11.11	.32
Failure to yield for an emergency driver	1	25.00	2	33.33	1.00
Violation of right-of-way	2	50.00	3	60.00	1.00
Violation of a flashing light	5	83.33	0	0.00	.11

\**p* < .05, \*\**p* < .01, \*\*\**p* < .001 level (two-tailed test).

TABLE 6 Driving Errors Predicting Injuries in Younger Group (Age ≤ 75), by Gender

Driving Error	Male Injured		Female Injured		<i>p</i> -Value for Gender Difference
	Number	Percent	Number	Percent	
Vehicle positioning	9	17.31	14	34.15	.09
Lane maintenance	8	38.10	13	54.17	.37
Speed regulation	33	25.38	30	37.04	.09
Yielding	365	34.73	527	56.48	<.001***
Adjustment to stimuli	8	20.51	7	29.17	.55
Gap acceptance	37	36.63	49	60.49	.002***

\**p* < .05, \*\**p* < .01, \*\*\**p* < .001 level (two-tailed test).

TABLE 7 Traffic Violations Predicting Injuries in Older Group (Age &gt; 75), by Gender

Traffic Violation	Male Injured		Female Injured		<i>p</i> -Value for Gender Difference
	Number	Percent	Number	Percent	
Failure to yield (left turn)	211	45.87	227	56.05	.003*
Failure to yield (intersection)	131	41.99	139	56.73	<.001***
Failure to yield	112	39.86	142	54.41	<.001***
Failure to yield (alley or driveway)	48	38.10	52	52.00	.04*
Failure to obey required traffic control	50	43.48	52	47.71	.59
Speed related violation	37	32.46	29	42.03	.21
Following too closely	11	23.40	5	19.23	.77
Failure to drive in a single lane	11	40.74	15	62.50	.16
Pedestrian violation	NA	NA	NA	NA	NA
Failure to yield for an emergency driver	2	28.57	1	100.00	.38
Violation of right-of-way	0	0.00	3	75.00	.4
Violation of a flashing light	0	0.00	3	75.00	.4

\**p* < .05, \*\**p* < .01, \*\*\**p* < .001 level (two-tailed test).

TABLE 8 Driving Errors Predicting Injuries in Older Group (Age &gt; 75), by Gender

Driving Error	Male Injured		Female Injured		<i>p</i> -Value for Gender Difference
	Number	Percent	Number	Percent	
Vehicle positioning	11	23.40	5	19.23	.77
Lane maintenance	11	40.74	15	62.50	.16
Speed regulation	37	32.46	29	42.03	.21
Yielding	502	42.54	563	55.47	<.001***
Adjustment to stimuli	2	8.70	5	27.78	.21
Gap acceptance	50	43.48	52	47.71	.59

\**p* < .05, \*\**p* < .01, \*\*\**p* < .001 level (two-tailed test).

The implications are that planners of prevention programs must understand and address activity demands embedded in these types of violations and driving errors. The demands related to failure to yield, failure to obey traffic control devices, yielding, speed regulation, and gap acceptance must be identified so as to understand and prevent crashes and related injuries. This study leads to a consideration of additional questions; for example, in considering client factors:

- Do older female drivers have different visual and perceptual processing abilities as compared with older men (26)?
- How can the effects of physical frailty that may have a greater impact on the severity of injuries sustained by older women be curtailed?
- Should interventions primarily involve role competence strategies that provide practice opportunities for behind-the-wheel training and, in so doing, increase the driving skill of older women?
- Compared with older women, why are younger women ( $\leq 75$  years of age) committing more violations and driving errors predictive of crash-related injuries? What are the best strategies to curtail such violations and driving errors?

In considering vehicle factors, it is suggested that older women:

- Consider vehicles with smart features (e.g., head restraints and front and side airbags) that can reduce the impact of crashes and therefore crash severity and risk of injury;
- Be fitted to their vehicles for optimal use and control of the features (e.g., pedal extenders for reaching pedals) or for safe positioning in terms of the features (e.g., tilt and telescoping steering wheels that can be adjusted to maintain a safe distance between the driver's chest and the steering wheel); and
- Use vehicles equipped with systems such as the OnStar in-vehicle system to alert authorities and receive help quickly after the occurrence of an adverse road event.

In considering environmental factors, it is suggested that older women:

- Pay attention to posted speed signs and traffic signs and observe the speed limit and traffic control devices;
- Consider route-trip planning as an option to reduce yielding and gap acceptance maneuvers (e.g., plan a trip to include making protected left turns to reduce judgments on the distance and speed of oncoming traffic); and
- Consider options such as alternative forms of transportation or help from volunteer drivers if a trip requires negotiating complex traffic situations.

These suggested person, vehicle, and environmental recommendations point to future research, specifically, to studying the complexities embedded in the female gender, such as cultural expectations or role competencies related to the driving task. The effects of protective or alternative strategies in preventing crash-related injuries must also be studied among older female drivers.

The types of errors made yield useful information for rehabilitation professionals and driving evaluators when reviewing the performance patterns of older adults, such as driving history or violation records (27). For example a violation of failure to obey a required traffic control device may be interpreted, based on the results of this study, as the potential for having difficulty with gap acceptance. Additional, more focused, testing of client factors (e.g., cognition), performance skills (e.g., visual perception), activity demands (e.g., sequencing and timing), or contextual demands (e.g., roadway dynamics) underlying such a driving error may be necessary. In this way, rehabilitation professionals and driving evaluators may discern the underlying challenges for the older adult and choose adequate intervention strategies to best address such challenges.

The limitations of this study pertain to using retrospective data from which cause and effect or temporality cannot be inferred. Crashes may also be underrepresented. The violation-to-error classification may further over- or underrepresent the findings. The generalizability of the results may be limited by the inclusion of "noncriminal moving violations" only in a subset of older drivers, the examination of violations at one point in time, and the collapsing of injury into a dichotomous variable. Nevertheless, to the authors' knowledge, this is the first study that classifies violations as driving errors and that examines younger and older age groups within the older driver population as a determinant of violations and driving errors that predict crash-related injuries.

## CONCLUSION

The findings from the 2005 FTCRD have shown that, compared with older male drivers, older female drivers are at a greater risk for injuries from crash-related violations and driving errors. This finding holds true when younger and older female drivers are compared with their age cohorts. Injury prevention strategies on the person, vehicle, and environmental levels must receive serious consideration and be tested empirically for effectiveness.

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# Gender Differences in Attitudes to and Mobility Impacts of Driving Cessation

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Safe travel is essential; however, recognition of the benefits of continued mobility and, conversely, the consequences of loss of mobility must also be considered. Driving affords the greatest mobility for many older adults. Unfortunately, at some point, most individuals need to consider retiring from driving. Although there are reported gender differences in the timing of and reasons for driving reduction and cessation, with potential impacts on mobility, health, and quality of life for some, much remains unknown about how older drivers perceive the difficulties in transitioning to being a nondriver and whether there are any gender differences in this process. Even less is known about how people decide to stop driving and the strategies that may improve the outcomes of this transition. This study examined gender differences in the mobility impacts of driving cessation and in life satisfaction. A total of 1,718 drivers (40% female) and 108 former drivers (58% female) completed a self-administered survey designed to examine issues surrounding the adoption of self-regulatory driving practices and the mobility impacts of driving reduction and cessation. The study highlights gender differences in the processes of driving reduction and cessation, particularly driving frequency and experiences and plans for driving cessation. While few gender differences were noted among former drivers, particularly in the number of trips and satisfaction with current mobility, older females were more likely than males to have planned ahead, made the decision themselves, and stopped at appropriate times, and to use alternative transport options, suggesting a good adjustment to nondriving with a more favorable mobility outcome. These findings have implications for

the development of education and training programs to assist male and female drivers to achieve a smooth transition from driving to nondriving.

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Mobility is essential for general independence as well as for ensuring good health and quality of life. One of the most relevant and important activities of daily living for maintaining independence in most western societies is the ability to drive. For most seniors, driving represents not only a means of transportation but a fundamentally important symbol of autonomy, independence, and self-reliance and is a key facilitator of community inclusion. A wide body of research shows that many older adults in motorized countries rely heavily on driving for most of their transportation needs and that seniors are strongly interested in keeping their cars and licenses after retirement (1, 2).

There is also good evidence that older people who are mobile and drive have fewer health problems such as osteoporosis and hip fractures and use fewer prescription drugs compared with those who do not drive (3). In addition, driving one's own vehicle is associated with higher levels of life satisfaction, higher adjustment, less loneliness, and better-perceived control (4–8). While it is likely that a host of other age-related factors also play a role here, the ability to drive seems to contribute significantly to overall health and well-being.

In contrast, forfeiture of driving privileges is considered a major loss by many older adults in terms of social identification, control, and independence. There is

no doubt that many older people report strong feelings about the importance of driving and that the prospect of reduction and, more particularly, cessation of driving evokes a level of fear. For many, particularly those with a decline in health status, driving cessation is thought to contribute to poor psychological outlook, life satisfaction, community engagement, and quality of life and to increase depressive symptoms, feelings of isolation, loss of self-consciousness, and a decline in out-of-home activity levels and community mobility (5, 9, 10). Further, for at least some people, the same health conditions and functional impairments that cause a change in driving patterns will also limit access to other transport options, such as walking, cycling, and public transport, thereby further contributing to restricted community mobility and its consequences. Driving status thus plays a critical role in the complex interactions between aging, physical and psychological health, community mobility, and use of health services.

Given these factors, there is a strong emphasis around the world for older people not only to maintain their mobility for as long as possible, but also to ensure that they remain drivers for as long as it is safe to drive and reduce their driving and make the transition to nondriver status at appropriate times. How and when this decision is made is likely to have an important influence on a driver's experience and adjustment to life without driving. Indeed, evidence suggests that, with good planning and a good psychological outlook, the transition can be smooth and successful in reducing negative mobility consequences (11–13).

An important consideration for those who manage older people's safe mobility is the impact of individual differences and variables (such as gender) on mobility needs and decisions about driving reduction and cessation. Indeed, there are reported gender differences in crash and injury patterns, overall driving patterns, and the timing and processes of driving reduction and cessation. There is general consensus internationally that older female drivers are safer; have a higher likelihood of driving reduction, particularly driving in stressful conditions (14, 15); and have higher likelihood of voluntary cessation at a younger age, for less pressing reasons, and in better health as compared with older men (16, 17). There is also some evidence that some women may give up driving prematurely, even though they may still be capable of driving safely (18, 19).

Some evidence suggests that there is a difference in quality of life between voluntarily giving up a license and having it revoked by the authorities, and that those who make the decision themselves and give up their license voluntarily are less likely to experience depression and loss of self-confidence and status to the same extent as those who have lost their license involuntarily (12). Little is known about these associations, however, and

whether there are gender differences. It is possible that many older female drivers manage and plan the process of reducing and retiring from driving well, making the transition smoothly, with little stress and minimizing the loss of mobility. On the other hand, as suggested by Stutts et al. (18), some older women may experience more severe mobility consequences as a result of premature driving cessation.

This paper examines gender differences in the transition from driver to nondriver status among a sample of Australian older seniors.

## METHOD

This study surveyed seniors ages 60 years and older living in the Australian States of New South Wales (NSW) and Victoria and in the Australian Capital Territory (ACT).

Participants for the survey were recruited through two main sources: the ACT Council on the Ageing National Seniors Office and the NSW Seniors Card Office, using the respective jurisdiction Seniors Card membership databases. In ACT and NSW, more than 90% of eligible seniors hold a Seniors Card, and the databases contain basic personal information on all ACT and NSW residents who have membership to Seniors Card. To be eligible for an ACT or NSW Seniors Card, individuals must be age 60 years or older, be a permanent resident of ACT or NSW, and not be in paid employment for more than 20 hours per week. In addition, a smaller sample of former drivers in the State of Victoria was recruited through advertisements in seniors' newspapers, auto club magazines, seniors' clubs, retirement villages, and local government aged care services.

A questionnaire was designed to elicit information about driving patterns, self-regulatory driving practices, transportation needs, and decisions about driving cessation. The questionnaire included both open-ended and closed-ended questions. Items included questions about demographic variables (e.g., age, gender, and place of residence), current driving patterns, recent crash and infringement history, recent changes in driving (distance, speed, and quality), and confidence in and avoidance of potentially difficult driving situations. To assess health status and functional abilities, seniors were asked to complete a checklist indicating the presence of specific medical conditions and to rate (excellent, good, fair, or poor) their overall health and functional abilities for safe driving, including vision for daytime driving, vision for nighttime driving, speed of decision making, upper and lower body strength, and head-neck movement.

The questionnaire was self-administered by all participants in ACT and NSW; for participants in Victoria, the questionnaire was conducted as a telephone interview by an experienced telephone interviewer. For the

self-administered survey, questionnaire packages including a cover letter, the questionnaire, a consent form for a follow-up interview, and a reply-paid envelope were sent to the respective Seniors Card agents and then mailed to a random selection of 3,000 older ACT residents and 3,000 older NSW residents. To target a representative sample of the population of older drivers and former drivers in ACT and NSW, the selection was stratified according to population-based gender and age groups for these jurisdictions. All participants were informed that their names had been randomly selected from the Seniors Card membership list and that personal details had not been given to any party. They were invited to complete the questionnaire if they were 60 years or older and either currently drove a car or had recently ceased driving (within the past 12 months). If they had never driven a car, they were asked to pass on the questionnaire to another older driver or former driver who met the specified criteria. A total of 1,826 completed responses were returned, including 1,718 current drivers and 108 former drivers; 201 surveys were returned either unopened or incomplete. This represented a valid response rate of 27%. Regarding the sample of former drivers, an additional sample of 29 participants from Victoria who responded to a telephone interview were included in the analyses. In total, the combined sample included 1,718 current drivers and 137 former drivers.

## RESULTS

### Respondent Characteristics

Respondents identified themselves as either a current driver or former driver (having given up driving within

the past 12 months). Table 1 presents some demographic characteristics of both groups by gender.

Overall, current drivers were younger— $\chi^2$  [3 degrees of freedom (df)] = 123.3,  $p < .001$ —and more likely to be married [ $\chi^2$  (4 df) = 70.1,  $p < .001$ ], compared with former drivers. Current drivers were also more likely to have achieved a higher educational level and less likely to be retired as compared with former drivers.

Gender differences were also noted among the group of current drivers in terms of marital status [ $\chi^2$  (4 df) = 202.1,  $p < .001$ ], age [ $\chi^2$  (3 df) = 32.8,  $p < .001$ ], educational level [ $\chi^2$  (3 df) = 24.6,  $p < .001$ ], and employment status [ $\chi^2$  (3 df) = 26.5,  $p < .001$ ]. In general, male drivers were more likely to be married, while females were more likely to be widowed. Female drivers tended to be younger than males, to have achieved a lower educational level, and to be less likely to be working full time, and they engaged in more voluntary work than males.

For former drivers, a gender difference was found for marital status only, where female respondents were more likely to be widowed as compared with males, who were more likely to be married [ $\chi^2$  (3 df) = 17.5,  $p < .01$ ].

### Travel Patterns

Respondents were asked a number of questions relating to their travel patterns and behavior and satisfaction with current mobility. Responses from current drivers regarding questions on driving distance, driving status, and use of other forms of transport are summarized by gender in Table 2.

Female drivers were less likely than male drivers to drive longer distances. Only 53% of female drivers reported driving more than 51 km each week, compared with 73% of

TABLE 1 Characteristics of Current and Former Drivers, by Gender

Characteristic	Percentage of Current Drivers ( <i>n</i> = 1,718)		Percentage of Former Drivers ( <i>n</i> = 137)	
	Female	Male	Female	Male
Marital status				
Married	53.6	83.7	28.2	55.4
Divorced	12.4	6.5	17.9	10.7
Widowed	29.2	6.7	52.6	25.0
Never married	4.8	3.1	1.3	8.9
Age (years)				
<64	33.8	21.8	5.1	5.5
65–74	44.8	52.8	30.8	21.8
≥75	21.4	25.4	64.1	72.7
Education level				
Primary school	6.7	6.8	17.6	14.3
High school	53.2	42.5	62.1	55.4
College	40.1	50.7	20.3	30.3
Employment status				
Retired	79.0	82.3	95.9	94.5
Part time	10.9	9.5	2.7	5.5
Full time	1.4	4.3	0	0
Volunteer	8.7	3.9	1.4	0

**TABLE 2** Travel Patterns and Behavior of Current Drivers, by Gender

Variable	Female Drivers (%)	Male Drivers (%)	Odds Ratio	95% Confidence Interval
Driving distance (km per week)				
<50	46.2	26.2		
>51	53.8	73.8	2.41	1.96–2.97
Driving status				
Main driver in household	70.7	90.2		
Not main driver	29.3	9.8	3.80	2.91–4.97
Use of other forms of transport				
Yes	42.2	49.1		
No	57.8	50.9	1.43	1.17–1.74

male drivers. Female drivers were also less likely than male drivers to consider themselves the main driver in the household (70% versus 90%) and were less likely than male drivers to use other forms of transport (42% versus 49%).

Among former drivers, almost all respondents (97%) indicated that their main form of transport was the private car, as a passenger. Other frequently used forms of transport reported were public transport (70% use), taxi (69% use), and walking (76%). No gender differences were found.

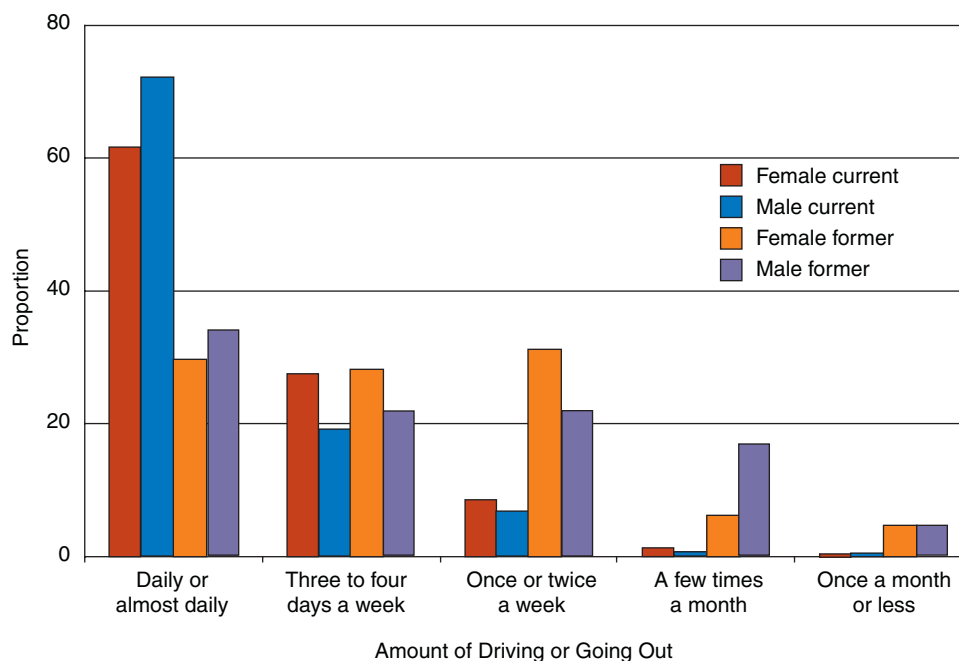
Further, drivers and former drivers reported on their level of mobility. Figure 1 shows frequency of driving or going out by driver status and gender.

Overall, there were significant differences in levels of mobility between the two groups [ $\chi^2$  (5 df) = 178.5,  $p < .001$ ]. Only 30% of former drivers went out daily, compared with 68% of current drivers. Very few current drivers went out less than once or twice a week.

Among the current driver group, there was a significant effect of gender on frequency of driving [ $\chi^2$  (5) = 23.2,  $p < .001$ ]. Female drivers were less likely than male drivers to report driving daily or almost daily (62% versus 72%, respectively), and more likely than male drivers to report driving 3 to 4 days a week (28% versus 19%, respectively). No significant effect of gender was found for level of mobility among former drivers.

Respondents also indicated their satisfaction with their current level of mobility. First, current drivers were asked to describe how not being able to drive might affect them personally. The most frequent response categories cited by drivers were the following:

- Restriction of activities (loss of freedom or convenience, or both),
- Need to use public transport (more time consuming and difficult),

**FIGURE 1** Frequency of driving or going out, by driver status and gender.

- Need to change place of residence (no access to services where they currently live), and
- Need to rely on family members for transportation.

In addition, current drivers reported on level of driving as compared with 5 years earlier (Figure 2), while former drivers rated their satisfaction with current ability to get to places (Figure 3).

Overall, the majority of current drivers (83%) felt that they were driving about an equal amount compared with 5 years earlier, and the majority of former drivers (74%) were either very satisfied or somewhat satisfied with their current level of mobility, with only about a quarter reporting dissatisfaction. Gender effects were found among current drivers [ $\chi^2$  (3 df) = 13.3,  $p < .01$ ], but not among former drivers ( $p = 0.52$ ). A greater proportion of male drivers than female drivers thought that they were driving the same amount as they were 5 years earlier (55% versus 51%, respectively), while a greater proportion of female drivers than male drivers thought they were driving more than previously (13% versus 9%, respectively). While there were no significant gender differences regarding satisfaction with current mobility amongst former drivers, there was some suggestion that men reported higher satisfaction than women.

### Driving Reduction and Cessation

An important factor in successfully reducing and retiring from driving is planning ahead. Drivers were asked whether they had thought about the possibility of not driving one day, and 61% indicated that they had given

some thought to this. Age and gender were associated with this variable. Generally, older drivers (ages 75 years and above) were more likely to have thought about this issue than younger drivers [ $\chi^2$  (2 df) = 44.7,  $p < .001$ ], and women were more likely than men to have thought about stopping driving [ $\chi^2$  (1 df) = 3.9,  $p < .05$ ] (64% versus 59%, respectively). Marital status and location of residence were also associated with this variable. Those who were widowed or never married were more likely to have thought about this issue than those who were married or divorced or separated [ $\chi^2$  (4 df) = 24.4,  $p < .001$ ], and those living in metropolitan areas or in country towns close to the town centre were more likely than those living in rural areas to have thought about the possibility of not driving [ $\chi^2$  (3 df) = 13.4,  $p < .01$ ].

In response to questions regarding planning ahead for not driving one day, the majority of drivers (75% of females and 82% of males) reported that they had not made any plans. Female drivers were, however, more likely to report having made some plans compared with male drivers (20% versus 15%, respectively) [ $\chi^2$  (2 df) = 12.2,  $p < .01$ ]. Table 3 shows specific plans by gender.

Of those who indicated that they had made plans for not driving one day, female drivers were more likely than male drivers to have made specific plans such as moving to another house and exploring alternative transport options, including public transport. A greater proportion of male drivers reported sharing the driving compared with female drivers. Few drivers had talked with their family doctor about planning for their future without the car.

While these specific questions were not asked of former drivers, this group was asked to indicate whether

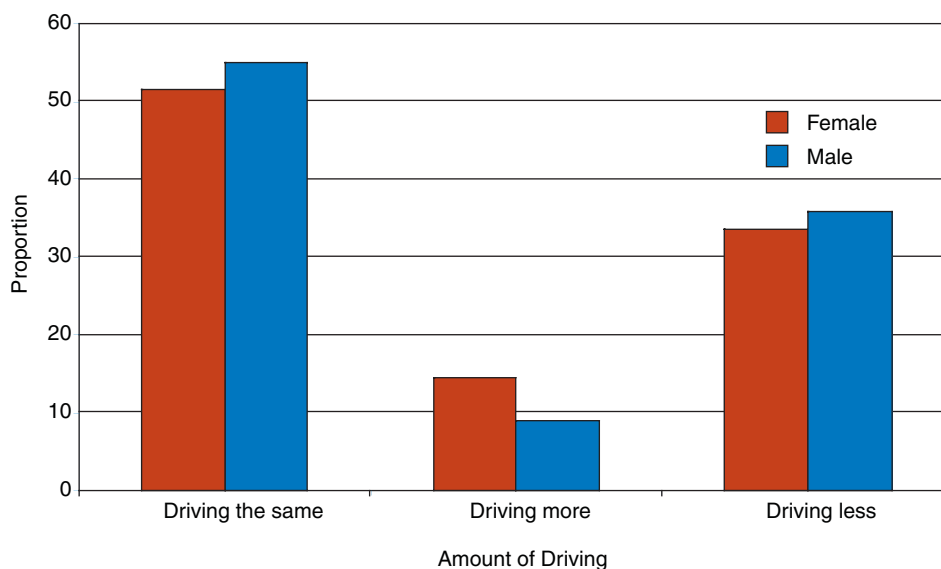


FIGURE 2 Current drivers' level of driving compared with 5 years earlier, by gender.

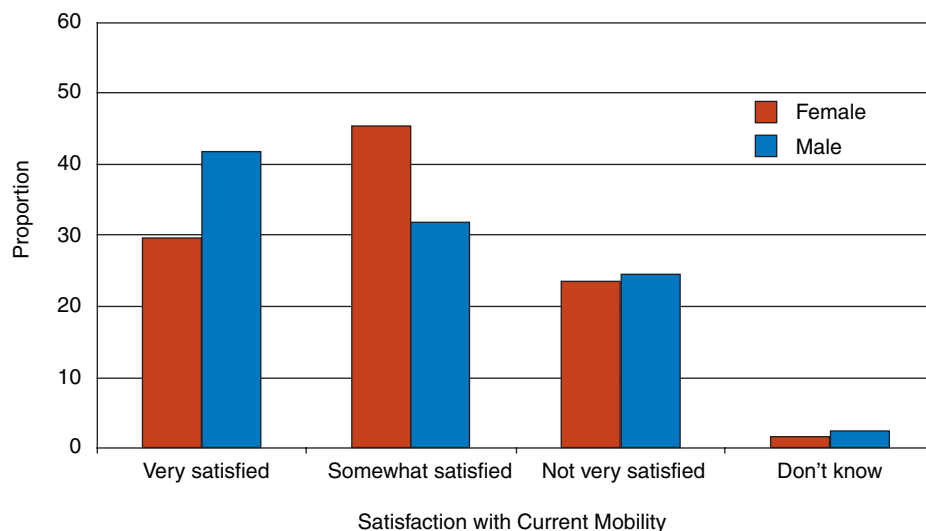


FIGURE 3 Former drivers' satisfaction with ability to get to places, by gender.

they thought they had stopped driving at the right time and whether the process was gradual or sudden. Overall, the majority of former drivers (65%) reported stopping all at once, and there was some suggestion that females were more likely than males to have stopped gradually (39% versus 27%, respectively). This difference, however, did not reach statistical significance. In addition, the majority of former drivers felt that they had stopped at the right time (60%), and there were no gender differences in this response.

A number of reasons for stopping driving were provided by former drivers, including the following: having someone else to drive (41.1%); alternative transport options available (48.4%); no longer enjoyed driving (48.2%); safety reasons (46.7%); health reasons, such as vision problems and poor reaction time (38.6%); encouragement from family and friends to stop driving (28.3%); crash involvement (17.3%); high cost of running a car (36.6%); nonrenewal of license (13.3%); and nonattendance at medical or license renewal (26.7%). No gender differences were found for reasons for stopping driving.

When asked about how and by whom the decision to stop driving was made, 75% of females indicated that they made the decision themselves, compared with 60% of males. Moreover, fewer females than males reported that others made the decision for them (8% versus 25%, respectively) [ $\chi^2$  (3 df) = 9.04,  $p < .05$ ].

Some additional analyses of the data were performed to explore associations between satisfaction with current mobility and the people involved in decisions (Figure 4) and the timing of their decision to stop driving (Figure 5).

Although these associations were not statistically significant, some interesting trends emerged. For those who made the decision themselves, overall satisfaction with current mobility (somewhat to very satisfied) was approximately 80%, compared with approximately 65% satisfaction when the decision was made either by others or jointly with others. Some gender differences are evident here, particularly when the decision was jointly made with others: females tended to report greater satisfaction compared with males (80% versus 50%, respectively).

Similarly, among those who felt that they had stopped at the right time, overall approximately 80% reported

TABLE 3 Current Drivers' Planning for Retiring from Driving

Plan	Percentage of Drivers Responding Yes		<i>p</i> -Value	Odds Ratio	95% Confidence Interval
	Female	Male			
Moved house	38.8	22.9	<.01	0.47	0.27–0.83
Became familiar with public transport	75.7	66.4	NS		
Explored alternative transport	75	61.7	.07	0.59	0.34–1.04
Moved closer to family, friends, social networks	35.3	18.9	<.05	0.43	0.23–0.80
Talked to GP	16.9	9.2	NS		
Shared the driving	31.7	49.3	<.05	2.10	1.17–3.75

NOTE: NS = not significant.

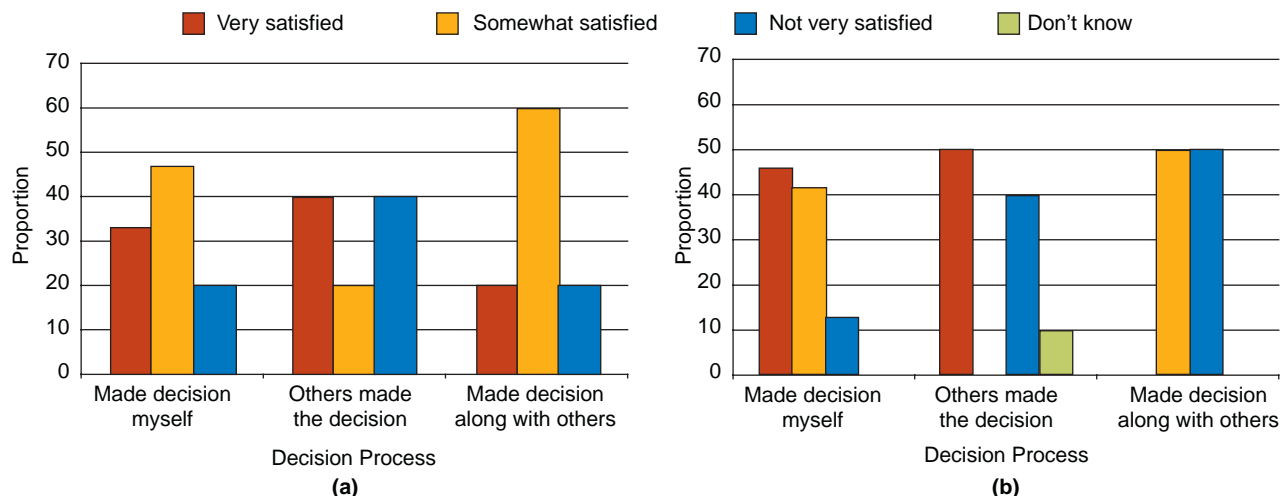


FIGURE 4 Former drivers' satisfaction with current mobility, by decision process: (a) females and (b) males.

being very or somewhat satisfied with their current mobility. In contrast, for those who stopped too early or too late, reported satisfaction with current mobility was lower (for females, this was 64% and 63%, respectively, and for males, 57% and 0%, respectively). Females were generally more likely to report satisfaction as compared with males, regardless of the timing of their decision, especially those who felt that they stopped too late.

DISCUSSION OF FINDINGS

Independent mobility is an important part of well-being for all, and car use (as a driver or passenger) is one of the major determinants of quality of life for seniors in most western countries (1, 3, 5). There has been much emphasis in transportation research over the past few

decades on understanding transportation needs and the factors associated with safe driving, and many programs and initiatives have been developed to help extend safe driving. Unfortunately, much less emphasis has been directed toward assisting those who need to consider retiring from driving, and particularly toward focusing on the specific mobility needs of older female road users. This study sought to understand the processes involved in successfully maintaining mobility options in the transition from driver to nondriver status. In particular, a better understanding of the effect of gender on this process was sought.

The findings of this study suggest that, although many drivers are strongly interested in driving for as long as possible and have negative perceptions of the mobility consequences of this transition, those who have gone through this process generally seem to have a more posi-

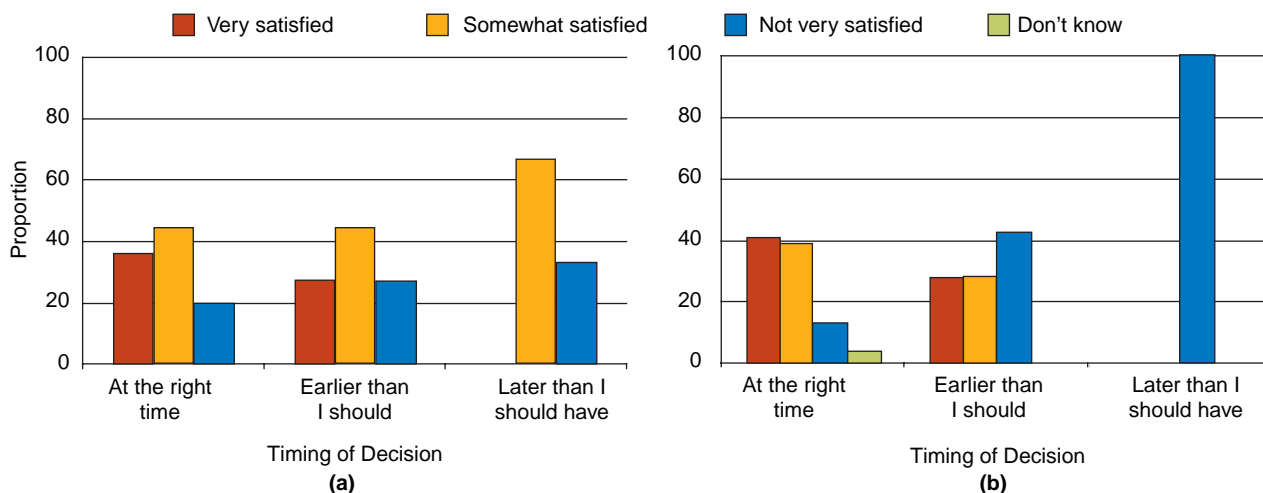


FIGURE 5 Former drivers' satisfaction with current mobility, by timing of decision: (a) females and (b) males.

tive attitude. Moreover, the findings of this study suggest that two factors—making the decision themselves or jointly with friends and family and feeling that they stopped at the right time—result in greater satisfaction and quality of life. This seems to be true especially among female former drivers.

In terms of driving patterns and behaviors among drivers, the current findings confirm those of previous studies. This sample of Australian drivers was fairly mobile, driving frequently and for substantial distances, and, importantly, they reported good satisfaction with their amount of driving. As in previous studies, there were noted gender differences in travel patterns, particularly lower mileage and frequency of travel among females as compared with males, and fewer females reporting being the main driver of the household (16, 17, 20). Only a small proportion of respondents felt that they drove less than they would have liked, and they were most likely older male drivers.

While former drivers' amount of out-of-home travel was lower than that of drivers, there was still substantial mobility among this group, with almost two-thirds reporting that they went out at least 3 to 4 days per week, mainly as passengers. More importantly, there were no gender differences here—females were as likely to engage in out-of-home activities as men.

The reduction and cessation of driving and the processes involved in this transition were the main focus of this paper; the goal was especially to understand more fully what behaviors, attitudes, and processes result in a successful transition. Moreover, a greater understanding of gender differences in this transition was investigated given previous suggestions that older women modify, reduce, and voluntarily stop driving at a younger age and in better health than older men (14–17, 21, 22), and, perhaps for some, with a more negative mobility impact (23).

Giving up driving evokes a level of fear among many older drivers, and there are reports of negative consequences of driving cessation for some, including stress and poor psychological outlook, life satisfaction, community engagement, and quality of life (5, 9, 10); an increase in depression and isolation; loss of self-confidence and status; declines in physical activity and health; and, in extreme cases, even early death (6, 24, 25). It is also possible, however, that, if this transition is managed and planned well, the impact on mobility and life satisfaction may not be so severe (11, 12). The findings of this study suggest that this is the case.

Current drivers generally perceived only negative impacts of driving cessation, including loss of independence, reliance on others for transportation, difficulty in using public transport, and the need to change their lifestyle to accommodate the loss of driving privileges. While a large proportion reported having thought about the possibility of not driving one day, unfortunately,

the great majority indicated that they did not want to make this decision, and few had made any plans for this event. Females were more likely than their male counterparts to have thought about this and to have made specific plans, particularly moving and exploring alternative transport options. Few women reported that they shared the driving, but a substantial proportion of men reported doing so. This supports previous findings that many older women lose confidence in driving and lack up-to-date driving experience as a result of their male partner undertaking most of the driving when driving together (20, 26), and it points to the need for educational programs aimed at promoting increased (safe) driving among women.

Encouragingly, this study's findings also suggest that, although the anticipation of transitioning from driver to nondriver status generates a considerable level of concern among those still driving, this effect appears to be less evident among those who have actually taken the decision to stop driving. Among the former driver group, even though close to half said that driving was very important to them and that frequency of out-of-home activities had decreased since they stopped driving, their reported levels of satisfaction with current mobility were relatively high. Three-quarters of former drivers reported being somewhat to very satisfied with their ability to get to places. Thus, although out-of-home activities were lower among former drivers as compared with current drivers, satisfaction with mobility did not diminish as might be expected. The fears held by many current drivers regarding potentially poor outcomes of the transition to nondriver status may not be warranted.

There were also some noted gender differences in the transition from driver to nondriver status, with associated differences in satisfaction levels. Males were more likely to have reported stopping driving suddenly, while females were likely to stop gradually, confirming previous findings that women are more likely to self-regulate (17, 18, 20), but also suggesting that there was some level of planning involved in this process. It will be interesting to explore this issue among former drivers in the future.

Two decision-making processes were explored further in these analyses: (a) who made the decision to stop driving, and (b) the timing of that decision. Although few statistically significant findings were achieved, due to a small sample size of former drivers, some interesting trends emerged. Those who made the decision to stop driving by themselves and made it in a timely manner (i.e., who felt that they stopped driving at about the "right time") were more likely to report higher levels of satisfaction compared with those who had the decision made for them and stopped earlier or later than they should have.

Furthermore, there was some suggestion of gender differences. Overall, females were more likely to have



made the decision on their own, while males were more likely to have had the decision made for them. Interestingly, the satisfaction of females who made the decision jointly with others was generally high. This was not so for males. Regarding the timing of the decision, stopping too late seems to have had a negative impact for males only. Moreover, stopping too early did not seem to result in dissatisfaction, especially for females. This raises some questions about previous suggestions of the negative impact of premature driving cessation for some women (18). While these are only preliminary findings, and there are no doubt many contributing factors to the timing of the decision to stop driving and resulting life and mobility satisfaction, they suggest that, perhaps with good support and planning ahead, an early transition to nondriver status among women may not result in the negative consequences previously thought. This issue warrants further investigation, and with a larger sample of former drivers.

These findings can play some role in guiding efforts to improve seniors' safe mobility, with and without the car. Education and training to improve the driving experiences of older drivers are central to current international thinking about this group's safe mobility, and there is increasing recognition of the benefits of programs aimed at assisting a smooth transition from driver to nondriver status. This process needs to be managed well; however, understanding attitudes, behaviors, and gender differences is an essential step in developing resources to assist seniors. Resources that provide appropriate gender-specific information and strategies for ways to retire from driving gracefully and information on alternative transport options can play a major role in removing some of the stress and trauma typically associated with this decision.

## CONCLUSIONS

This study examined gender differences in the transition from driver to nondriver status among a sample of Australian drivers and former drivers. The study highlights some factors that may achieve a more acceptable and potentially less stressful transition and alleviate the consequences of poor mobility, particularly among older women.

The findings of this study confirm those of previous studies that note gender differences in driving patterns and the tendency for women to reduce and cease driving earlier than men. A major contribution of this study has been the addition of some new information on gender differences in the decision-making process and the identification of some strategies and attitudes that may play a major role in reducing some of the stress, trauma, and mobility impacts generally associated with driving cessation.

As implied in the findings discussed above, it is unlikely that any single factor can adequately explain the reasons for driving reduction and cessation and the attitudinal and behavioral factors that contribute to a successful transition from driver to nondriver status. While there is still much to be understood about this transition and the strategies and behaviors that can be used to achieve successful retirement from driving, the findings from this study provide some information on which to conduct further research. This study has explored some interesting attitudinal differences between those still driving and those who have already made the transition to nondriver status. It has added to the current understanding of the importance of how and when decisions are made in influencing seniors' experiences and adjustments to life without driving. Further, it has identified associations between planning ahead, a good psychological outlook, and recognizing the right time for stopping driving and good life satisfaction and mobility outcomes, particularly for women.

These findings have practical implications for both the road safety community and health-care specialists. In particular, this study identified the need for promoting strategies through gender-specific resources, information, and training programs to assist a smooth driver to nondriver transition.

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# Abandon All Hope, Ye Who Enter Here

## Understanding the Problem of “Eve Teasing” in Chennai, India

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Fear of victimization and crime are important concerns for women in cities around the world, and this fear is provoked through encounters with men in public space because they are “unpredictable, potentially uncontrollable and hence threatening.” The South Asian literature has focused more on the subordinate role of women in Indian society and the workplace than on gender-based crime (referred to as “Eve teasing”) in the public spaces and transportation systems in South Asia. The objective of this paper is to elicit information on sexual harassment faced by women commuters in Chennai, India. The study found 66% of the surveyed respondents had been sexually harassed while commuting. Many of the respondents first encountered sexual harassment during their adolescent years. Very few (5% or less) found any of the modal choices to be best. The largest number of women (more than 40%) rated their worst harassment experiences to be in buses and trains with no separate sections for women. The paper offers other findings on the nature and frequency of sexual harassment and suggestions to address these incidents.

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Researchers have indicated that women’s security needs are different from men’s (Brooks 1997; Smith 2008). Fear of victimization and crime are important concerns for women around the world (Loukaitou-Sideris 2005; Koskela 1999; Pain 1991, 1995). The fear is provoked through encounters with men in public space because these encounters are “unpredictable, potentially uncontrollable and hence threatening” (Valentine 1989). The sociology, anthropology, and

criminology literature of the West has emphasized that women are fearful of crime and vulnerable to assault (Loukaitou-Sideris 2005; Wesley and Garder 2004; Koskela 1999; Ferraro 1996; Pain 1991, 1997; Valentine 1989; Stanko 1987). The South Asian literature has focused more on the subordinate role of women in Indian society and the workplace (Gangoli 2007; Mohan 2006; Puri 1999; Mandelbaum 1986; Omvedt 1980). However, little is written on the geography of gender-based crime (referred to as “Eve teasing”) in the public spaces and transportation systems in South Asia (Police Academy 1979; Shah 1993; Gender Study 1996; Baxi 2001). The following story, printed in the *India Express* in 1998, describes the tragic outcome of one case of harassment.

On July 18 1998, after a Youth Congress (YC) meeting in Chennai, India some of the young members who left the meeting in an auto encountered Sarika and her friends walking towards a juice bar. The unprovoked attack had deadly consequences. One of the perpetrators, Hari, who was spraying water on the women, lost his balance and fell on Sarika. Under the impact, Sarika lost her balance fell down and sustained head injuries. The auto sped away leaving Hari who hid behind bushes to avoid being beaten up by angry onlookers. Hari however, managed to escape the scene with the assistance of couple of other auto drivers who were sent to rescue him while Sarika lay unconscious on the sidewalk. The incident was reported as a traffic accident and it was only later that the news

about Eve teasing came out. A week later, on her birthday, Sarika passed away in the hospital never regaining consciousness.<sup>1</sup>

Eve teasing is a form of sexual aggression toward women or girls in South Asian countries (India, Pakistan, Bangladesh, and Sri Lanka). In the *Times* (1960, 9, cited by Barrett 2006, 109) the phrase "Eve teasing" was first used to refer to the common pastime of male university students toward the female students in coeducational institutions:

Independent India is discovering social problems undreamed of in Mahatma Gandhi's philosophy. As the caste system and the traditional Hindu family begin to crumble, the barrier between the sexes in India is no longer the formidable fence it used to be. Last week in Agra—where India's two most famous lovers, the Mogul Emperor Shah Jehan and his queen, lie buried under the Taj Mahal—the Indian Youth Association held a solemn seminar about a new kind of problem: the sidewalk dalliance that Indian youth calls "Eve-teasing."

Puri (1999, 86) further elaborated on the various acts that fall under Eve teasing to include being "slapped on the bottoms, being touched on the breasts, being whistled at, being deliberately brushed against, receiving sexually suggestive comments."

Sexual harassment of women is rampant in India; in many ways it is an expression of masculine domination over women who stepped out of the "normative private sphere" (Baxi 2001). As early as 1960, a speaker at the first Indian Youth Symposium held at Agra attributed the sexual harassment to sociological issues: "36.9% of India's people suffer from boredom, 49.7% from blighted hopes, 26.7% from emotional depression, 6.4% from sexual frustration, 49.9% from a polluted and unwholesome atmosphere" (*Time* 1960). After reviewing several books written on gender inequality in India, Hale (1989) summarized that single working women are primary targets for such attacks because they most visibly signal their independence from male control. Women who resist the definition of them as private sexual property by going out to work suffer the risk of being public sexual property (Hale 1989). An exploratory content analysis of sexual violence in nine randomly selected popular Hindi films from 1997 to 1999 found that moderate sexual violence is depicted as fun, enjoyable, and a normal expression of romantic love. Victims were more likely to be women, and sexual violence committed by heroes was a common portrayal, particularly moderate violence such as

harassment of women with whom the heroes ultimately became romantically involved (Ramasubramanian and Oliver 2003).

Harassment of women occurs every day (Kanjilal 2003). Every 51 minutes a woman is sexually harassed. Every 21 minutes a woman is molested. Eve teasing is something that women must contend with every day.<sup>2</sup> Unfortunately, these incidents are not well-documented, and only the most heinous get public attention. Some of these acts of public humiliation and violence are brought to attention in newspaper articles. One such article describes a series of unprovoked attacks on women and the societal indifference toward the women who pursued justice.<sup>3</sup>

Since the early 1970s, an important task for feminists has been to establish gender as an area of research and understanding. In the early 70s, one of the first organized campaigns by female students against Eve teasing took place in Hyderabad. The campaign raised awareness on the hostile and sexually threatening conditions Indian women had to deal with everyday, not only in the universities, but also on the streets and in every kind of workplace (Tharu and Niranjana 1994). Although many organized protests have occurred since then, there has been little research during this period. Debnath (1999) criticized the paucity of research by Indian anthropologists on the endemic nature of this harassment after reading about an incident in a transit bus:

Not a single Indian sociologist or anthropologist has discussed the "Eve-teasing" case of Manisha Verma of Delhi by the Delhi Transport Corporation (DTC) employees in 1990 in a bus which would have led to rape if the woman did not jump out of the bus. . . . In our country, especially in our urban areas, perhaps alienation of the deprived class from the local wealthy contributes to the occurrence of rapes. The frustrated and alienated but adventurous commoner, thus, indulges in rape for a temporary status by subjugating a soft target.

Debnath's assertions have not been backed by research as the literature in this area is still greatly lacking. Furthermore, there have been very few surveys conducted to elicit information from women on the nature and frequency of sexual harassment in public places and their strategies for coping with it. Researchers routinely cite the Gender Group Study (1996) of the faculty and students of Delhi University (DU), which surveyed DU students and faculty. The study shed light on the widespread occurrence

<sup>1</sup> Monday, July 27, 1998. <http://www.expressindia.com/news/ie/daily/19980727/20850084.html>.

<sup>2</sup> Kanjilal, S. Eve Teasing a Growing Menace. Chennai online, February 2003. <http://archives.chennaionline.com/society/eveteasing.asp>.

<sup>3</sup> Hassled, but Helpless, *The Hindu*, Sept. 10, 2002. <http://www.hinduonnet.com/mp/2002/09/10/stories/2002091000070100.htm>.

of harassment on the DU campus (Gender Study Group 1996). The survey results showed that in 1996, 91.7% of all residents of women's hostels and 88.2% of all women day scholars had faced sexual harassment inside the campus. The study also found that most women respondents felt that Eve teasing constituted male behavior that could be overlooked and ignored; it was sexual harassment only when it crossed the threshold of their tolerance. Verbal harassment tended to be classified as Eve teasing and physical harassment or sexually explicit behavior as sexual harassment. They distinguished the two by the harm caused to them by each: Eve teasing as largely harmless and sexual harassment as harmful. Many women respondents spoke of having developed a threshold of indifference, deploying silence or ignoring the harassers, as a strategy to deal with the harassment because they believed that no one would take them seriously or come to assist them (Gender Study Group 1996 cited by Baxi 2001).

## METHODS

The objective of this study is to assess the harassment faced by women commuters in Chennai, India. Chennai ranks 13th among all the cities in India for crimes against women (*Crime in India* 2006, Table 5.1).

There are no survey instruments available to ask sociocultural questions related to sexual harassment in India's public spaces and the public transportation system. The authors developed a survey by using the existing literature on gender and crime. The authors used the word "harassment" instead of "Eve teasing" to avoid the bias attached to that term (women being the temptress). The questions did not differentiate between verbal and sexual harassment. However, the open-ended questions on the types of sexual harassment encountered in different modes of travel were asked to elicit additional information on the nature and types of assaults on women. The first part of the survey asked demographic questions followed by sets of questions to gather information on the nature, type, frequency, location, and societal and personal attitudes toward sexual harassment. The questions were set using a five-point Likert scale (strongly disagree, disagree, somewhat agree, agree, and strongly agree) to assess the level of agreement to questions on sexual harassment. There were also a few open-ended questions that elicited information on types of harassment and suggestions to address the problem.

The survey was administered by students of St. Peter's College, Avadi, to women ages 18 years and older who were randomly chosen in college campuses, dormitories, trains, and buses as well as at the train and bus stops in the northwestern part of Chennai. The women were asked if they would like to participate in a survey related

to Eve teasing. The participants were notified that their participation was optional and they could withdraw anytime. The students handed the survey to those women who agreed to fill them out.

## Participants

For this study, 274 women were surveyed in Chennai. The mean (M) age of the surveyed women was 21.4 years, with a standard deviation (SD) of 12.96. The women traveled an average of 15.4 km (SD = 14.7), with an average commute time of 43 min (SD = 36.26). Most of the participants (92%) were college students and not working. The rest were employed and had undergraduate degrees. Of the college students, 67.8% were attending a college in Avadi. The rest of the students attended colleges scattered throughout Chennai.

Of the respondents, 23.2% walked, 32.2% traveled by bus, 18% used other modes such as personal automobile or a three-wheeler (auto), and around 1% used scooters or bicycles.

## Findings

Almost 66% of the surveyed respondents had been harassed. The mean age of the respondents when they had their first encounter with harassment was 14.95 years (SD = 2.58). A few of the women had encountered harassment at a much younger age (Figure 1).

Harassment in public places occurs in public transport, bus stops, and while walking to and from destinations or traveling in autos. The surveyed respondents were asked to rate their sexual harassment experiences by modes of travel, including waiting at bus stops, as best, tolerable, or worst. Very few (5% or less) found any of the modal choices to be best (Table 1). The largest number of women (over 40%) rated their worst experiences in buses and trains with no separate sections for women. Inside the buses and trains (with no restrictions), women have been exposed to deliberate physical contact ("brushing past") (27%) and verbal harassment (22%).

Generally speaking, 45% to 55% of the women rated most modal categories (except for women-only buses and trains, which were better options) as tolerable. Buses and trains with no separate accommodation for women were deemed worst by 42.8% of the respondents. Bus stops were found worst by 28.3% of the surveyed women. A paired sample test, which compares the means of responses to paired questions, was used to assess how each respondent ranked a pair of modal choices that have some common features. The paired sample *t*-test [ $t(178) = -11.626, p = .001$ ] revealed that women were less afraid of harassment in buses reserved for them ( $M =$

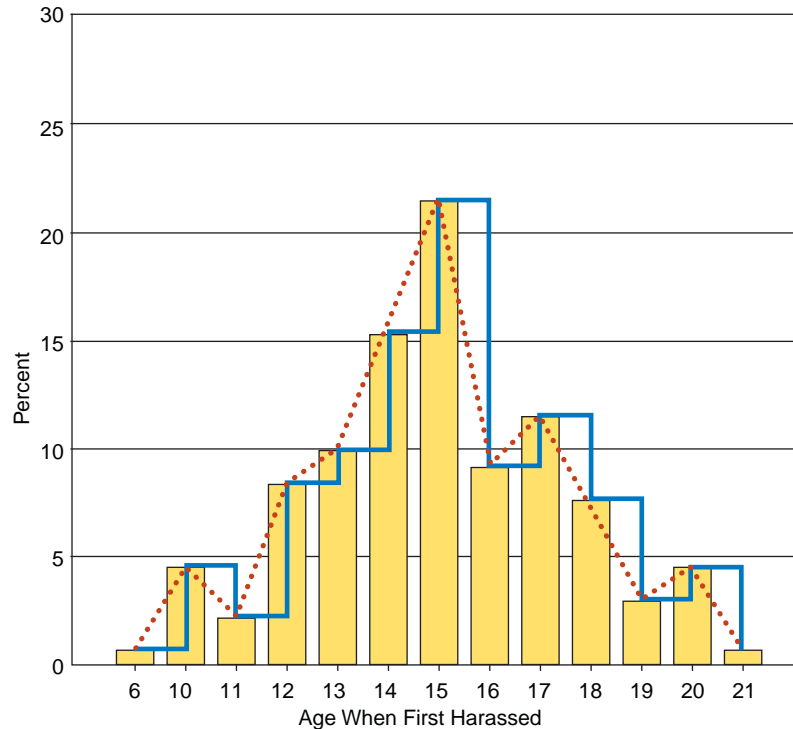


FIGURE 1 Graph showing frequency of age when survey respondents were first harassed.

2.05, SD = .455) than in buses with no restrictions (M = 2.63, SD = .507). The paired sample test found the difference of means for the responses (to level of harassment) to be significant [ $t(182) = -11.190, p = .001$ ] for trains with reserved cars for women (M = 2.02, SD = .432) or for trains with no restrictions (M = 2.54, SD = .541). The paired sample test found the difference of means for the responses (to level of harassment) to be significant [ $t(186) = 3.149, p = .01$ ] for harassment while waiting at the bus stops (M = 2.33, SD = .51) and walking during the daytime (M = 2.19, SD = .47). Exposure to harassment walking in the daytime (M = 2.19, SD = .47) was rated lower than in the evening (M = 2.32, SD = .501). The paired sample test was significant [ $t(186) = -7.462, p = .001$ ]. The means of the paired responses to modes are shown in Figure 2.

Survey responses found 35.9% agreed that they were more harassed at nighttime while waiting at the bus stop;

only 9% and 4.7% of the women were harassed at the bus stops in the afternoons and mornings, respectively. Sexual harassment faced at bus stops is mostly verbal (singing and whistling), followed by comments made about body parts. A few of the respondents have been also stalked. Walking is the preferred mode of travel for 23.2% of the women. For 51%, walking during the daytime is tolerable, while 15.9% of them found it very uncomfortable. The percentage of women very uncomfortable jumped to 25% at night (Table 1). Verbal harassment (singing and whistling) was common, followed by stalking.

### Other Experiences with Harassment

The respondents were asked to share the worst incident they had personally experienced and how the incident affected them. Women wrote about all types of verbal

TABLE 1 Percentages from Survey Question “Rate Modes As Best, Tolerable, or Worst Based on Level of Harassment”

Rating	Train—No Restrictions	Bus—No Restrictions	Bus Stop	Walking		Cab Passengers	Scooter	Auto <sup>a</sup> Passenger	Train—Women Only	Bike
				Day Time	Evening					
Best	1.4	0.7	1.4	1.1	2.2	2.2	4	3.3	5.4	3.6
Tolerable	29.3	29.3	46.4	44.9	51.1	44.9	46.7	49.6	57.6	55.8
Worst	42.8	42.8	28.3	25.7	15.9	15.9	15.9	14.5	6.9	3.3

NOTE: Column percentages do not total 100 because of missing data.  
<sup>a</sup> Harassment from other types of vehicle users.

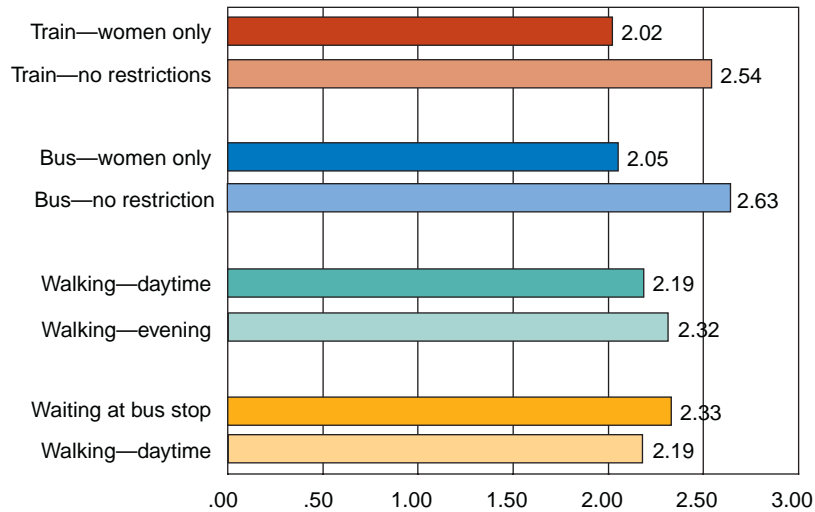


FIGURE 2 Means of paired responses for modes based on where survey respondents most fear harassment. Paired *t*-test significant ( $p = .001$ ) for trains and buses with or without restrictions and walking by time of day.

and physical assaults on women traveling alone. Many women reported nighttime travel as most dangerous and drunken passengers as the most unpredictable and annoying. The responses of some of the women are paraphrased below.

A woman reported how distraught she was when an old man inappropriately touched her one morning on her way to a tutoring class. A middle-aged man groped the same woman in the bus and she confronted him. Another woman described a drunken man's inappropriate behavior toward her while boarding a bus. One of the respondents talked about an incident when she was in ninth grade. She recalled a man in a wheelchair groping her. She shouted at the man and he verbally assaulted her back, leaving her emotionally distraught.

Traveling at night is the worst, as many women become easy targets. Women develop strategies to protect themselves from verbal and physical assaults while traveling. One woman shared that once traveling in a train late in the night she was being verbally harassed by a group of young men. To avoid being singled out as a target she struck up conversations with families traveling in the same car; this strategy worked.

### Strategies to Cope and Confront

Several questions were asked to elicit information about how the respondents confront or cope with harassment in public places. More than 80% of the women surveyed acknowledged that their parents and other family members were concerned about their safety. Of

the respondents, only 18% were willing to pay more to avoid harassment; most of the surveyed women (80%) have not changed their mode of travel, but they prefer to travel in groups (58.5%); dress modestly (60%); and avoid crowded buses where physical assaults (brushing past or groping) routinely occur.

Verbal harassment has been accepted as a daily annoyance by 59% of the respondents who have learned to ignore it; however, many have described these incidents to their families. It is important to note that only 11% sought assistance from the police and only 8% asked a ticket checker in the bus to intervene on their behalf. Only 22% found the police helpful when they sought assistance, although 44% of them found ticket checkers or conductors helpful when they sought assistance. Explanations in the open-ended questions in the survey showed that the women who report to the police (who are mostly men) have not found them sympathetic to their complaints. Very few (12%) agreed or strongly agreed that they confronted the perpetrators or assisted others (16%) being harassed, belong to antiharassment organization (12.9%), or blog their experiences (2.6%).

The surveyed women (55%) prefer to travel in groups to avoid harassment; 70% acknowledge traveling with a male companion, usually a relative, to reduce the threat of physical harassment.

Although more than half the women surveyed have learned to ignore the harassment and have not confronted the perpetrators personally, 28% of them carry weapons of some sort for protection. Those who carried weapons strongly correlated with those who have not changed what they wear ( $r = .244, p = .001$ ); belong to antiharass-

ment organizations ( $r = .385, p = .000$ ); blogged about their harassment ( $r = .228, p = .001$ ); confronted those who had harassed them ( $r = .273, p = .001$ ); helped others being harassed ( $r = .254, p = .001$ ); or sought assistance from police ( $r = .257, p = .001$ ) and ticket checkers ( $r = .324, p = .001$ ).

### Why Do Men Harass?

Survey respondents' opinions were sought on why men harass. A series of statements were provided based on a literature review on factors contributing to male harassment in public places. The surveyed responses either agreed or disagreed (coded 1 or 0, respectively) with these statements. Their responses to the statements were differentiated by their exposure to harassment (affirmative or negative to Eve teasing) in Table 2. There was general agreement among respondents for certain statements

that explained the reasons for male harassment such as influence of peer and movies regardless of their exposure to Eve teasing. Other relevant statements included male-dominated society, sexual perversion, form of enjoyment, lack of self-control, women do not report crime, and women are afraid to speak out (see Table 2 and Table 3 for the percentages). Some differences in responses were based on experiences with harassment, as shown in Table 2. Those who indicated not being exposed to harassment had lower means than those who had experienced it. An independent sample *t*-test was performed comparing the means of responses for the statement about the influence of male-dominated society on harassment between those who were exposed to harassment ( $M = .592, SD = .493$ ) and those who were not ( $M = .435, SD = .500$ ). The test was found to be statistically significant at  $t(202) = .207, p = .05$ . The mean of responses for "women are afraid to speak out" between those who were exposed to harassment ( $M = .641, SD = .481$ ) and those who were not ( $M$

TABLE 2 Comparison of Means from Survey Question "Why Do Men Harass?"

Why Do Men Harass?	Have You Been Eve Teased?	Mean	Std. Dev.	Significant Difference
Influenced by their friends	No	0.613	0.491	
	Yes	0.66	0.476	
More men in public places	No	0.164	0.373	
	Yes	0.225	0.419	
Influenced by movies	No	0.661	0.477	
	Yes	0.711	0.455	
Unemployed men act out frustrations	No	0.258	0.441	
	Yes	0.345	0.477	
Street culture of harassment pervasive	No	0.113	0.319	$t(152) = -2.22, p = .028$
	Yes	0.232	0.424	
Sexual perversion	No	0.532	0.503	
	Yes	0.606	1.085	
Male-dominated society	No	0.435	0.5	$t(202) = -2.07, p = .040$
	Yes	0.592	0.493	
Conservative upbringing	No	0.048	0.216	
	Yes	0.134	0.342	
Able to get away without punishment	No	0.258	0.441	$t(131) = -2.85, p = .005$
	Yes	0.458	0.5	
Mental disorder	No	0.387	0.491	$t(202) = -2.91, p = .004$
	Yes	0.197	0.399	
Unhappy marriage	No	0.323	0.471	
	Yes	0.282	0.451	
Form of enjoyment	No	0.565	0.5	
	Yes	0.754	1.216	
Lack of education	No	0.371	0.487	
	Yes	0.458	0.5	
Lack of self-control	No	0.516	0.504	
	Yes	0.577	0.496	
Men are superior	No	0.355	0.482	
	Yes	0.458	0.5	
Women don't report crime	No	0.403	0.495	
	Yes	0.528	0.501	
Women are afraid to speak out	No	0.452	0.502	$t(202) = -2.549, p = .012$
	Yes	0.641	0.481	
Women like to be center of attention	No	0.161	0.371	$t(202) = -2.511, p = .013$
	Yes	0.331	0.472	
Women encourage by dressing provocatively	No	0.18	0.388	$t(201) = -2.657, p = .009$
	Yes	0.366	0.483	
Only way working-class men can get the attention of educated well-dressed women	No	0.097	0.298	
	Yes	0.136	0.344	

NOTE: Std. Dev. = standard deviation.



**TABLE 3 Percentages of Responses to Statements That Contribute to Male Harassment**

Why Do Men Harass?	Agreed with Statement (%)
Influenced by movies	69.6
Influenced by their friends	64.5
Form of enjoyment	62.7
Women are afraid to speak out	58.3
Lack of self control	55.9
Male-dominated society	54.4
Sexual pervers	52.5
Women don't report crime	49
Lack of education	43.1
Unhappy marriage	43
Men are superior	42.6
Able to get away without punishment	39.7
Unemployed men act out frustrations	31.9
Women encourage by dressing provocatively	31
Women like to be center of attention	27.9
Mental disorder	25.5
More men in the public place	20.7
Street culture of harassment pervasive	19.6
Only way working-class men can get the attention of educated well-dressed women	12.4

= .452, SD = .502) was also significant at  $t(202) = .255$ ,  $p = .05$ . Other statistically significant differences were observed. Women who were harassed had a higher mean for "women like to be center of attention" ( $M = .331$ ,  $SD = .472$ ) and "women like to dress provocatively" ( $M = .366$ ,  $SD = .483$ ) than those who were not exposed to harassment ( $M = .161$ ,  $SD = .371$  and  $M = .180$ ,  $SD = .388$ , respectively). Women who were not Eve teased reported a higher mean ( $M = .387$ ,  $SD = .491$ ) than those who were ( $M = .197$ ,  $SD = .399$ ); this was also statistically significant at  $t(202) = -2.91$ ,  $p = .01$ . Women not exposed to sexual harassment had a lower mean ( $M = .258$ ,  $SD = .441$ ) than those who confirmed they were ( $M = .458$ ,  $SD = .500$ ) for the statement "men are able to get away without punishment" and was statistically significant at  $t(131) = 2.85$ ,  $p = .01$ .

### Opinions About the Effects of Eve Teasing

One of the open-ended questions asked the women to share their thoughts on Eve teasing and how it has affected their life, work, and travel. The women who shared their feelings indicated their sense of despair, anger, and hopelessness with the unequal status of women in public places. While the question about sexual harassment at work was not directly asked, some of the women alluded to that also. Some of their comments are included below.

Eve teasing causes depression because I cannot talk with my parents. It impacts my study because I am depressed thinking about these incidents.

I no longer travel alone. In the nighttime, I travel with my parents or friends.

Sexual harassment has affected many women who work in the evening. They have faced a lot of problems but they cannot share the problems with their parents and husbands.

I have experienced Eve teasing in my college days. After 30 years no improvement at all, and the situation is worse. I try to help young girls who are prey to Eve teasing.

Eve teasing has become a major threat to women. Whatever changes we make in our travel or even in our dressing, Eve teasing will still continue because men cannot change their dirty thoughts. In India, Eve teasing is high compared to other nations. It is because of our culture (male dominance) and lack of proper security for women. Unless this doesn't change Eve teasing will continue to prevail.

Eve teasing is worst part in any woman's life. I don't travel in crowded buses and that makes my travel quite a bit more expensive.

Women face a lot of trouble during travel and work. Women should be equal to men.

Eve teasing is affecting women's mind and discouraging them from traveling late in the night and early in the morning.

### Suggestions by Respondents

The surveyed women offered a variety of suggestions to reduce the incidence of harassment. The most important suggestion was increasing the number and frequency of special buses for women.<sup>4</sup> A few respondents wanted more cars for women in the commuter trains. Women wanted more security at bus stops, and they also wanted a regular police presence inside the buses. The need for female police in the railways and in the transit system was suggested by many of the respondents. There were also suggestions for women drivers and ticket checkers in buses and a help line accessible from different locations in the city, suburbs, and rural areas.

<sup>4</sup> There are women-only sections in the buses, usually on the left side. In trains there are seats assigned for women. Men may use the seats when they are vacant, and while some relinquish them when women board the train, others refuse to yield.

## DISCUSSION OF FINDINGS

In the West, streetcars ushered mobility and freedom to travel longer distances, but the journeys on these public modes of transport were far from enjoyable for women. A *Harper's Illustrated Weekly* from 1871 accurately captured the uncertainties and discomfort faced by women. The cartoon showed two women confronting an unpleasant conductor of a streetcar labeled "Pickpocket's Paradise" while men sitting in the car leer at them. The sign in the front of the car emphasized the conditions inside by using the words Dante saw inscribed over the gates of Hell: "All Hope Abandon, Ye Who Enter Here" (Brooks 1997, 9). The plight of women travelers described by Brooks (1997) is still faced by women commuters in India.

The sexual harassment of Indian women in public places is named and culturally constructed as Eve teasing. The semantic root of the term Eve as a temptress not only trivializes the issue (Gangoli 2007) but also places the blame on women. The conservative rhetoric has led to colleges enforcing dress codes banning western wear. A principal in a June 2009 interview with a *Times of India* journalist supported the dress code, stating

Western dresses, including body-hugging tops and tight-fitting jeans, don't indicate a disciplined atmosphere and attract comments from Eve-teasers. We can't overlook the safety of students. A dress code would check Eve teasing to some extent and also ensure that girls don't waste their time selecting what clothes to wear.

Section 509 of the Indian Penal Code (IPC) criminalizes behavior that insults the modesty of any woman through words or gestures, and Section 354 IPC criminalizes "assault or criminal force to a woman with the intention to outrage her modesty." In addition, Section

209 IPC criminalizes obscene acts and songs. These penal code provisions, which date back to the 19th century, have been found to be inadequate by feminists (Ashby 1992 cited by Gangoli 2007, 63). Baxi (2001) has further asserted that the assault reports are open to interpretation by police, and the inclusion of the term Eve teasing associated with IPC 354 devalues the legal offense. There has been severe criticism from Indian women's movements that women's complaints of sexual harassment are routinely disbelieved. Law enforcement's refusal to file complaints has been documented as a serious problem by victim-survivors. Thus the decline in reported crime, as shown by the statistics for Chennai between 2002 and 2005 (Figure 3), is not necessarily an indication of good policing or a genuine reduction in the incidence of harassment (Baxi 2001). The unwillingness of the surveyed respondents to report harassment to the police also testifies to the same. India now boasts some of the more advanced legislation granting equality rights to women, but the laws are virtually unenforceable in the patriarchal and hierarchal society in India (Hale 1989).

## Planning and Design Issues

Eve teasing acts as a control on most women by impeding their general mobility and accessibility to public spaces. Unlike men, women find their personal spaces frequently invaded by verbal and physical assaults that have a profound effect on their sense of security (Hammer and Saunders, cited by Valentine 1989, 386). Harassment heightens dependency on men for protection in public places. Furthermore, victims are often blamed for being in dangerous places or wearing inappropriate clothes. Many women blame themselves and remain silent or develop coping and avoidance strategies that limit their freedom of movement and ability to seek economic independence. Baxi (2001) found many women internalize

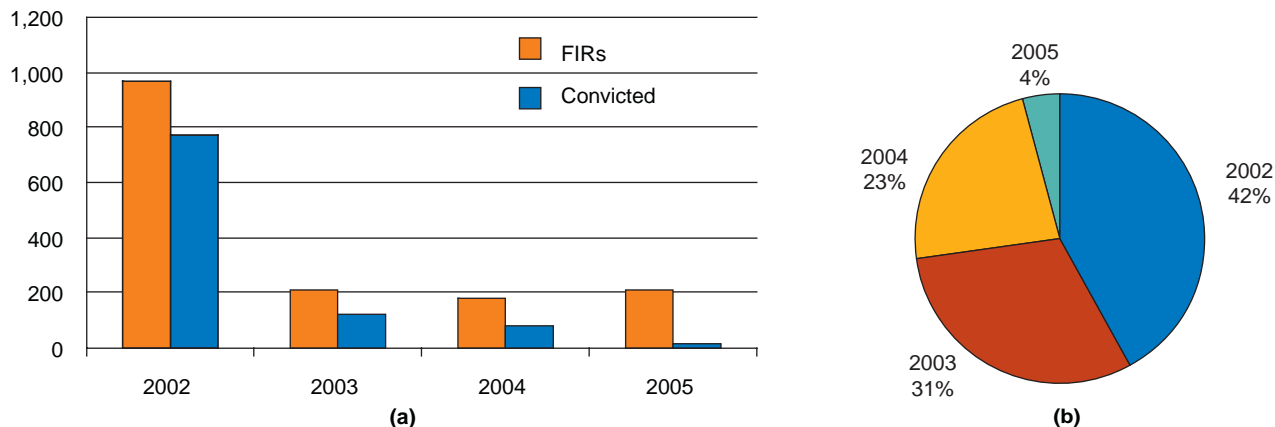


FIGURE 3 Graphs showing (a) FIR (first informational report and conviction rates) and convicted and (b) percentage convicted (Mohan 2006).

the idea that Eve teasing is normal, harmless, and often deserved.

Although crime prevention through environmental design is well-developed for the sociocultural requirements of western countries, it is still in its infancy for South Asian countries. Indian planners have relied on convenient crime-prevention rhetoric (avoid, ignore, travel in groups, and dress modestly) as ways to address crime against women. Such rhetoric has perpetuated male domination of public space and imposed a “virtual curfew” on women (Pain 1991 cited by Koskela 1999, 113). Daytime is found to be safe for women in western countries (Kinsey 1984 cited by Pain 1997, 234; Koskela 1999), but unfortunately the same does not hold true in India. The survey found women commuters face harassment regardless of time of day, although nighttime was particularly dangerous.

### Grassroots Activism

In *A Spatial Exploration of the Accessibility of Low-Income Women: Chengdu, China and Chennai, India*, Srinivasan (2008) is critical about the transportation planning that is most sought after in Chennai (constructing new roads or overpasses as a way of lowering overall travel times) with very little thought to improve local accessibility that would benefit low-income households and women, who have to walk or bike for both work and nonwork activities.

There is a growing discontent with the status quo among women, as mirrored in this statement by Neena, a media professional: “I have got sick of depending on family to pick me up and drop me. I want to be able to be independent. I want to be able to walk the street wearing whatever I want without worrying.”<sup>5</sup> In different cities of India, the younger generation has been creating antiharassment organizations. One such organization that has been embraced by college students and young professionals is the Blank Noise Project. Blank Noise, which was Jasmeen Patheja’s final-year diploma project, was a reaction to her personal experience in public spaces. The outcome of these experiences was channeled through her artistic self-expressions, which have given a voice to women who have been harassed.<sup>6</sup> The messages and her public art form have spread to different cities in India where women routinely organize public events, march together reclaiming their right to public spaces, or display clothes in which they were harassed at publicized

<sup>5</sup> Women Take to Streets to Stake Claim to Their Rights, *The Hindu*, Sept. 17, 2006. <http://www.hindu.com/2006/09/17/stories/2006091711180300.htm>.

<sup>6</sup> Incidents of harassment with photos are shown in <http://www.flickr.com/photos/blanknoisethisplace/3019956499/in/photostream/>.

events. The extent to which the Blank Noise Project’s events and workshops have induced self-confidence and made women feel more confident in public spaces is the most intangible and least documented part of the project (Blank Noise Project). Although the Blank Noise Project has empowered women to speak out against male aggression, it is important to note that among the survey participants, less than 5% blogged or were involved in antiharassment groups.

### CONCLUSION

This preliminary survey was exploratory, and there is a clear need to develop a comprehensive survey to administer to many more women in different Indian cities. There is also a clear need to initiate gender-based planning to integrate crime-prevention design into transportation planning. One area that comes to mind is the design of buses. The doorways of buses are narrow, but passengers routinely alight and board at the same time (Figure 4). Restricting movement—i.e., by passengers first alighting and then boarding—would reduce deliberate “brushing past.”



FIGURE 4 Although bus doors are narrow, riders alight and board simultaneously, allowing deliberate brushing past (photo by P. Partheeban).

As yet transportation planning has been haphazard, with very little concern toward the needs of harassed women commuters. There is clear evidence that sexual harassment is rampant in buses and trains due to overcrowding and inadequate accommodation for women. Yet very little is done to alleviate the commuting hazards faced by women. The authors hope this paper will trigger more studies to assess the nature and extent of harassment faced by women commuters and that this information will shape new policies that lead to effective planning strategies that create safer and more effective transportation systems for Indian women.

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# How Does Fear of Sexual Harassment on Transit Affect Women's Use of Transit?

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The purpose of this study is to understand how women's fear of sexual harassment on transit changes their transit use and travel behavior. The study, which employed a qualitative research approach, found that cultural differences are important to women's perceptions of sexual harassment and women's attitudes about adequate policy responses. Yet cultural differences are not as important as the availability of a car in influencing how women modify their use of transit in response to sexual harassment. Thus, a feasible and effective policy addressing this issue should take the cultural context into consideration.

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**S**exual harassment and fear of sexual harassment on transit can change women's use of transit, and it has become a noticeable issue both in the United States and around the world. For instance, in the United Kingdom in the mid-1990s, one in eight women surveyed said that they felt so unsafe on public transport that they avoided using it (Hough 1995). In Japan in 2005, women-only carriages were introduced in some Tokyo subway lines to crack down on groping (McCurry 2005). In Mexico in 2008, female-only buses were rolled out to respond to complaints from women's groups (Rodriguez 2008). Other countries such as Bangladesh, Brazil, Dubai, India, and Nepal have implemented similar strategies. In New York in 2007, a large-scale online survey was conducted to gather information on sexual harassment and assault on the subway in order to develop strategies to address the problem (Stringer 2007). In Jakarta, Indonesia, a 2008 bus survey showed that 90% of female

respondents support the plan to allocate buses exclusively for women because of safety and comfort (Asrianti 2008). The relationship between sexual harassment and women's use of transit needs additional study.

## RESEARCH QUESTIONS

Although the problem is well-known, the degree to which sexual harassment and fear of sexual harassment on transit change women's use of transit is unknown. Does it change differently across the characteristics of female riders, harassment types, and transit systems? Is there any pattern to these changes? Can the determinants that translate fear of sexual harassment into change of travel behavior be found? All these questions are examined in this research project. The results should provide information about security issues women face when traveling by public transit, how these factors affect travel decisions, and how to remove these transit barriers and enhance women's mobility.

## HYPOTHESIS AND IMPLICATIONS

The literature shows that women's feelings of security are affected by many different factors, such as age, race, knowledge about violence, economic status, frequency of use of transportation mode, activity levels, time of day, lighting, graffiti, and cleanliness (Lynch and Atkins 1988). However, such a complexity of factors makes it even more difficult to say that women with particu-

lar demographic characteristics will modify their use of public transit in a certain way because of their fears of sexual harassment. Also, it is unrealistic to imagine the detailed pattern of change in travel behaviors before any data or evidence is available. To simplify the question and to make the research project feasible, the following hypothesis was made:

Women's perceptions and fear of sexual harassment on transit are culturally specific. However, once they are aware of their vulnerability to sexual harassment on transit, female choice riders will avoid taking transit and female nonchoice riders will modify their use of transit, which will lead to inconvenience and discomfort.

Several terms in the hypothesis need to be defined and explained carefully. First, "choice riders" refers to people who have access to an automobile, so they can choose whether to travel by public transit; "nonchoice riders" refers to people who have no access to automobiles, so they have no choice but to travel by public transit. Nonchoice riders may be physically incapable of driving a car or economically unable to afford one. Second, the definition of sexual harassment adopted for this study comes from the 2007 New York City subway survey, in which sexual harassment was defined as "unwelcome sexual advances, requests for sexual favors, and other verbal or physical conduct of a sexual nature, including flashing, groping, fondling, and public masturbation" (Stringer 2007). Though there are other definitions of sexual harassment, the one from the 2007 New York City subway survey was chosen simply because the survey is transportation related, and, therefore, the definition might be more suitable for the present research purpose. Moreover, because the aim in this research project is to examine the link between women's fear of sexual harassment and their modifications of transit use, what really matters is perceived vulnerability rather than actual vulnerability; that is, the choice of definition of sexual harassment is not so crucial to the research project. Third, "[female choice and nonchoice riders] who are aware of their vulnerability to sexual harassment on transit" means that women understand that sexual harassment might happen on public transit and they might be victimized when riding public transit. The goal is to explore how women's different levels of fear of sexual harassment on transit change their use of transit, so the aim in this research project is women's own perceptions of sexual harassment on transit. Lastly, there are many possible ways for women to modify their use of transit, including use only at specific times, use only with a companion, changing their destination, and reducing their activity levels. It was expected that the research participants would offer different ways of modified use of transit.

If the hypothesis is true, then to retain or increase ridership, local governments and transit agencies need to reduce the inconvenience and discomfort caused by sexual harassment on transit. The results of this research project can provide insights and suggestions for strategy development and further improvement.

## LITERATURE REVIEW

Though the present research only focuses on women's fear of sexual harassment on public transit, this research topic is in fact embedded in three broader elements: women, crime, and space. Much beneficial and useful research has been done to explain the interactions of these three elements: women's fear of crime, crime and the built environment, and the spatial distribution of women's fear of crime.

Fear of crime, especially women's fear of crime, has drawn much attention in contemporary criminology. Researchers have found two paradoxes in women's fear of crime. First, despite the fact that men are at a higher risk for victimization, women are much more afraid of crime. Second, though women feel less secure in public spaces, they are more likely to be victimized in private places (Valentine 1989; Pain 1991; Scott 2003). In the past several decades, many efforts have been made to explain these two paradoxes and to explore how women's fear of crime is formed and developed. Is there any pattern to women's fear of crime across demographic, psychological, and social characteristics? How does fear of crime affect women's daily activities and lifestyles? And what can be done to reduce women's fear of crime and enhance their sense of safety and security? These issues can be divided into three main categories: social psychology, environment and behavior, and feminist geography.

The aim of the social psychology approach is to find the factors that affect women's fear of crime; the research methods adopted are positive and quantitative. Usually data are collected by various crime surveys, and respondents are asked to provide their sociodemographic characteristics and rate their levels of fear in different situations. By applying adequate regression analysis, researchers have found that sociodemographic variables such as age, race, education level, marital status, household income, and area of residence are all strongly related to women's fear of crime (Junger 1987). For example, both younger and older women who are single, minority, of lower socioeconomic class, and living in urban areas report a higher level of fear of crime (Keane 1998). In addition, sociopsychological variables such as activity level, friendship network, family education, media habits, previous experience, and risk management techniques affect women's fear of crime (Farrall et al. 2000).

Though this approach is strong in finding the patterns of women's fear of crime, it is unable to provide a complete explanation of the two paradoxes in women's fear of crime. Some scholars have proposed that, to women, fear of crime is simply fear of sexual crime, because women are physically more vulnerable and more likely to be sexually victimized than men (Scott 2003). Thus sexual crime will shadow other types of crime among women (Ferraro 1996), and that is why women are so afraid of crime. Without taking social context into consideration, however, this explanation can only be partial, since it ignores that as a social phenomenon, women's fear of crime might be socially constructed.

Usually crime surveys also ask women to tell the kind of public spaces they are most afraid of. Not surprisingly the answers include empty parks, dark parking lots, deserted stations, dirty streets with graffiti and vandalism, and so forth, though a higher level of familiarity with these public spaces could reduce the fear (Lynch and Atkins 1988). The results also show that women tend to decrease their use of these public spaces or avoid them altogether because of fear (Stanko 1995). In other words, women's fear of crime becomes an environmental mobility restrictor on their daily activities. Planners and architects are particularly interested in this issue, and they want to find the kind of public space design that can help reduce women's fear and increase their sense of security. The second approach, which focuses on the environment and behavior, is introduced to address women's fear of crime in public spaces. The basic idea of this approach comes from Oscar Newman's defensible space theory (1972), which states that poor design of space can give environmental opportunities for crime and that crime can be prevented through environmental design (Schulz and Gilbert 2000). The research methods of this approach are situational and policy-oriented. By applying before and after attitudinal surveys (Koskela and Pain 2000), researchers found that improved design such as brighter lighting can really reduce women's fear of crime and in turn encourage them to use public spaces more frequently.

Critiques of this approach proposed that though the idea of "designing out fear" can reduce women's fear of crime and improve their quality of life, it fails to capture the complex relationship between women's fear of crime and the social structure (Koskela and Pain 2000). Women's fear of crime can never be eliminated by environmental design if gendered social and power relations do not change. For example, the principles of defensible space have been adopted in the design of many public spaces, but women's feelings of insecurity in these places remain (Schulz and Gilbert 2000). The third approach, feminist geography, provides a more complete explanation.

Feminist geography tries to provide a structural analysis to women's fear of crime. Research has shown

that women's fear of crime largely restricts their use of public space and makes them inactive participants in public life, and feminist geographers think these patterns of inequality in the use of space reflect patterns of inequality in society (Pain 1997). Valentine (1989, 1992) called it a "spatial expression of patriarchy." In other words, women's fear of crime is the outcome of gendered social and power relations (Koskela and Pain 2000). Women were taught about the danger of some public places in their youth, so in part they were educated and shaped to be afraid of some public spaces and to reduce their use of these public places in order to protect themselves and avoid being in trouble (Pain 1997). In consequence, women are more and more reluctant to use some public spaces and participate in the activities that take place in those public spaces, which leads to the exclusion of women not only in public spaces but also in public life. Women's fear of crime, then, can be seen as a means of social control to strengthen the existing gendered power structure in society, which tries to achieve the goal of social exclusion by spatial exclusion (Pain 1991, 2000).

In addition to their analysis of women's fear in public space, feminist geographers pay much attention to women's fear in private space, since the power relations in such space are even more complex. This explains the second paradox of women's fear of crime (Pain 1991). To feminist geographers, it is not who women are but where they live that is more important to an understanding of women's fear of crime. Therefore, by applying a combination of qualitative research methods such as ethnographic study, documentary analysis, observation, participation, interviews, and focus groups to a community, researchers can expect to gain a deeper understanding of women's fear of crime in that local area, attract public awareness of this issue, and attain a better solution of the problem starting from the community level (Pain 2000).

The three approaches mentioned above overlap, but they emphasize different issues. Synthesizing the approaches allows the salient aspects of each to be included in the research design. First, it is important to know how women's fear of sexual harassment on transit is affected by different internal and external factors, so demographic characteristics need to be collected. Second, the space characteristics of public transit and their relations to women's fear of sexual harassment should be examined. Last, women's feelings and perceptions of sexual harassment on transit and their perspectives on effective ways to address this problem should be explored. Including the primary issues of each approach allows the study to assess the extent to which women's fear of sexual harassment and their responding behaviors are influenced or shaped by their own characteristics, built environment, societies, and cultures.



## RESEARCH METHODS

Large-scale, useful statistics on this topic are unavailable. Though some transit agencies have ridership data by gender, and some local governments have already conducted surveys on sexual harassment on transit—for example, in 1988 Women Plan Toronto and Metro Taskforce on Public Violence Against Women and Children distributed a questionnaire asking women to share their experiences on public transit with a focus on sexual assault and harassment (Wekerle 2005)—none of these statistics explain the relationship between fear of sexual harassment and modifications of transit use. So there is still a large gap in the literature concerning fear for personal security and change of travel behaviors.

Although quantitative and large-scale surveys provide important data, their size means that some information is not obtained. Most large-scale surveys are a prepared list of dozens of questions that can be answered with a single word or checked box (Yanow and Schwartz-Shea 2006). For example, the 2007 New York City subway survey shows that 51% of respondents sometimes or frequently feel the threat of sexual assault or harassment or both, and 63% of respondents had been sexually harassed in the NYC subway system, but the subsequent changes in travel behaviors due to the threat and experience of sexual harassment on transit are unknown. Furthermore, as the hypothesis of the present research suggests, female nonchoice riders will still ride transit even if they are aware of their vulnerability to sexual harassment simply because they have no choice. In this case, a survey might reveal that although sexual harassment occurs on transit, ridership is not affected by this kind of incident. If ridership remains stable, the problem of sexual harassment on transit might be ignored by transit agencies.

An adequate treatment of the stated research topic requires a qualitative approach. That is to say, close attention must be paid to the questions to be asked and what data or evidence should be collected to uncover the link between women's fears of sexual harassment and their modifications of transit use. To that end, this research project focused on original data collection and analysis by conducting focus group interviews. Morgan (1988) states that "as a form of qualitative research, focus groups are basically group interviews, although not in the sense of an alternation between the researcher's questions and the research participants' responses. Instead, the reliance is on interaction within the group, based on topics that are supplied by the researcher, who typically takes the role of a moderator. The fundamental data that focus groups produce are transcripts of the group discussions." Focus group interviews are suitable for the research purpose because they can provide a wide variety of qualitative data in a short period of time that can be used as preliminary or exploratory research

and later combined with other qualitative or quantitative methods to prepare a follow-up, large-scale, and in-depth research effort. Employing a focus group method in this research project allowed women with different demographic characteristics to be approached in a short period of time; their experiences, stories, perspectives, and opinions regarding the issue of sexual harassment on transit to be gathered; and their narratives and statements to then be analyzed to construct a more complete and coherent explanation of how fear of sexual harassment on transit affects women's use of transit.

As a form of qualitative research, the focus group method provides in-depth description and deep understanding of an issue rather than establishing a generalization or representativeness of the research results. Thus, one of the common criticisms of quantitative research, such as the sample selection bias, might not be applicable to the present research project. A more appropriate way to assess the research results might be to analyze the transcripts of the focus group interviews to see whether the initial hypothesis can be verified or supported by the focus groups' evidence. If the initial hypothesis is not supported, the next task would be determining how to adjust the initial hypothesis to make it more consistent with the focus groups' evidence and how to provide a reasonable explanation for this modification.

## RESEARCH DESIGN

This research was based on one in-person focus group, two online focus groups, and seven individual interviews. Details are explained in the following subsections.

### In-Person Focus Group

The in-person focus group was held in Irvine, California. Three participants were recruited via flyer and e-mail invitation. The duration of the in-person focus group was about one and a half hours, and participants were asked to provide some sociodemographic information as well as to share their experiences of sexual harassment on transit and their modified use of transit.

### Online Focus Groups

One online focus group was in English, and the other was in traditional Chinese language. Traditional Chinese is the official language in Taiwan, and the participants in the traditional Chinese online focus group were all Taiwanese. The four participants for each online focus group were recruited via online flyer and e-mail invitation. Facebook was the medium chosen because it is a

free-access social networking website and has numerous active users worldwide, so it was easy for the online focus group participants to log in and write their comments on the discussion board. An examination of the results of different focus groups allows a cross-cultural comparison of women's perspectives of sexual harassment on transit. Furthermore, the literature shows that online focus groups allow for a greater depth in response, since the form of participation is in written text (Gaiser 1997). This claim can be verified in this research topic by comparing the results of in-person and online focus groups.

### Individual Interviews

In the process of recruiting in-person and online focus groups, some potential participants told the author that while they were interested in the research topic and had something to say, they could not make it or were not willing to share their stories in public. As a result, seven individual interviews were conducted to get information from these participants. The interviewees include two Americans and five Taiwanese, and the interviews were conducted in person, by phone, and by messenger.

### Interview and Discussion Questions

The interview and discussion questions were basically the same for the in-person focus group, the two online focus groups, and the individual interviews. They are divided into four parts. Part One requests the sociodemographic characteristics of the study participants. Parts Two through Four are discussion questions that aim to understand participants' feelings and perceptions of sexual harassment on transit, their stories and experiences regarding sexual harassment on transit, and their opinions and comments about some existing policies addressing sexual harassment on transit. The questions were as follows:

1. Please provide the following information about yourself: name, age, race/ethnicity, highest grade/degree completed, occupation, marriage status, and number of children.

2. Please describe your feelings about sexual harassment on transit. Do you think it is a disturbing problem in your daily life? How do you compare sexual harassment on transit with sexual harassment in other public spaces such as work and recreation places? Are your perceptions of sexual harassment on transit influenced by acquaintances, news reports, or other information sources?

3. Please describe your experiences of sexual harassment on transit. Include details of the time, place, type of transit, the purpose for your trip, how often you use

that type of transit, and any other relevant information. Did your experiences of being harassed on transit change your future use of transit? Why or why not? If you changed the way you use transit to avoid sexual harassment, describe how your use of transit changed.

4. Sexual harassment has become a noticeable issue both in the United States and around the world. For example, the New York City subway surveyed riders to learn more about sexual harassment on their system. Respondents to that survey suggested increasing police presence, installing brighter lights and emergency phones, and using closed circuit televisions to curb sexual harassment. Some nations such as Japan, Mexico, India, and Brazil introduced women-only subways and buses to reduce sexual harassment. What do you think are efficient and feasible ways to addressing this problem, and why?

### RESULTS ANALYSIS

The following findings reflect the experiences and perspectives of 18 female participants in their twenties and thirties. Six of them are white Americans, six are Taiwanese, and the remaining six are Taiwanese who now live in the United States.

### Cultural Differences in Issues of Sexual Harassment on Transit

The participants in this research are Americans and Taiwanese, and the differences are obvious not only in their answers to discussion questions but also in the ways they respond to discussion questions. These differences show how women's perspectives and behaviors are influenced by the environment and shaped by society, which also partly exemplify the hypotheses of both the environment and behavior approach and the feminist geography approach. Here are some examples:

1. Women's perceptions of sexual harassment on transit: When asked what types of sexual harassment are most likely to occur on transit, Americans said accosting or crazy people and Taiwanese said groping and unwanted touch. When asked what kinds of transit spaces they most fear, Americans said empty bus stops or transit stations and Taiwanese said crowded buses or subways. These two questions are connected since the land-use development in Taiwan is dense and compact, which leads to a heavy use of public transit, consequently crowding and groping become the major problem. On the contrary, a more dispersed land-use development in some American cities, such as Irvine, leads to automobile dependence, and therefore, empty space becomes a security concern to public transit users.

2. Women's comparisons of sexual harassment on transit with other public spaces: When comparing sexual harassment on transit with sexual harassment in other public spaces such as workplaces, participants' opinions become diverse, though they all pointed out that sexual harassment on transit usually happens in a closed space where strangers take environmental opportunities to harass:

Transit is different, because there is no authority to report it to, unless the harassment becomes flagrant or violent. At work, you can report it to a boss or HR. In a public place, you can move away from the situation. On transit, you are sort of encapsulated in the situation. Especially if you have to take that bus or train to get to work every day. (American)

From my experience, sexual harassment on transit makes me feel much more uncomfortable compare to it happened in other place. One reason might be because I cannot clearly recall sexual harassment happen in other place or sometimes it's not clear to define it's a harassment or not. (Taiwanese)

I think sexual harassment in the workplace is much more fearful and bothering, since harassers on transit are usually strangers, however, in the workplace harassers might be your work associates or supervisors, so things become more complex and difficult. For example, you can get off the bus or train when you are harassed, but it is not so easy to change your job. (Taiwanese)

3. How women's perceptions of sexual harassment on transit are affected by others: When participants were asked whether their perceptions of sexual harassment on transit were influenced by acquaintances or news reports, their answers were somewhat diverse. Taiwanese were more likely to be influenced by acquaintances and news reports; participants were impressed by the experiences of acquaintances and could remember them after many years. In contrast, the Americans' perceptions were usually based on their own experiences:

My perception on sexual harassment is influenced by news and friends' experiences. But my perception of sexual harassment on transit is largely based on my own experience. (American)

I think reporting of incidents on buses through the media has deterred many people from taking the bus. Despite isolated incidents in certain high-crime areas, people of all income levels view public transit negatively because of the reporting. (American)

My perceptions of sexual harassment on transit somehow influenced by friends and news reports. I became more watchful on transit after heard some cases. Also become braver and not afraid about letting people around on the transit know what happen if there is a sexual harassment after heard about my friend's experience and her reaction. (Taiwanese)

My perception about sexual harassment on transit is particularly influenced by a high school teacher, since she described very detailed her experience to the class. And it was so impressive to me because she was a tough woman and able to protect herself. I cannot believe such woman can also become a victim. It made me feel very fearful since I need to ride bus to school everyday. (Taiwanese)

I think all my perceptions of sexual harassment come from friends and media. For example, after reading reports about groping addicts on Japan subways, I'm very watchful and try to avoid approaches from untidy middle-age men. (Taiwanese)

4. Women's comments on policies addressing sexual harassment on transit: Participants were asked to evaluate some existing policies aimed at reducing sexual harassment on transit. In general their opinions are similar except that their opinions regarding women-only subway cars and buses are contrary.

Having women-only subways and buses seems somewhat discriminatory for both genders. Are the women-only public transits the same quality as the male-only? Are the drivers female or men? I think that by using greater levels of security measures, there is a significant capacity to deter harassers from bothering women on transit. (American)

Women-only subways and buses are the most effective. It can block groping and unwanted touch. In addition to sexual harassment, women can feel more relaxed and comfortable in such spaces since you don't need to sit or stand by smelly, dirty, or even drunk men. (Taiwanese)

In the process of recruiting for both in-person and online focus groups, Americans who were interested in this topic joined the discussion groups directly. Some Taiwanese, however, mentioned that they were interested and willing to comment, but they did not feel free to share their experiences and feelings in public or post their opinions and comments online without anonymity. That is the main reason for the individual interviews and why the majority of interviewees are Taiwanese.

Some participants who lived in Taiwan before and now work or study in the United States mentioned that in general the ways people deal with sexual harassment issues in the two countries are very different. In the United States sexual harassment is a very sensitive issue; people take it more seriously, and they are more supportive and willing to help those who encounter this problem. Although they feel less worried about sexual harassment on transit in the United States, they are really worried about personal security issues in public places, and therefore, they are even more watchful in the United States than in Taiwan when they ride transit.

### More General Findings in Issues of Sexual Harassment on Transit

In general, participants describe sexual harassment on transit as "unpleasant, uncomfortable, annoying, and disturbing." Some participants think it is a common problem that can happen to everyone; others do not feel it is so common since they have never experienced sexual harassment on transit.

Unlike the importance of cultural differences in women's perceptions of sexual harassment and their attitudes about adequate policy responses, the availability of a car plays a more important role in women's modified use of transit. First, here are a few examples of how participants described their experiences and what they did after these events occurred:

On the bus on the way to work almost on a daily basis. It's the earliest bus of the day (6:30 a.m.), about 5 minutes' ride. The bus was often full of students and elders on the way to their exercise. The seats were always full and at least 10 people had to stand; however, everyone could still manage to have a personal space. After a while, I started to notice a man in his 50s often approaches me when he got onto the bus. I recognized him because I even yielded a seat to him once, but he refused. He often had body contact with me while walking to find a seat. At first I think it was because he couldn't walk steadily on the trembling bus; however, after a few times, I started to feel uncomfortable. Oftentimes, he squeezed into me even though there were plenty of space as if on purpose, and he often ended up standing besides me. I still took that bus everyday, yet I started to stand in places where I could guard myself better (facing front, ample space around.) I even walked away immediately when he approaches and stare at him. I do not change a bus because I didn't want my schedule to be affected, and that's the only bus I could take. In the end, that man showed up less and dared not

to stand by me. If he kept harassing me I'll tell the driver or the other passengers and I think that'll stop him from taking this bus again. (Taiwanese)

It happened several times on my way to (or back from) school. Mostly early in the morning (6:30 a.m.), and very crowded on the bus. That's the bus route I took for more than 10 years. I didn't change the use of the transit since that's almost the only bus I could take. However, I always gladly take a ride from others when I got the chance to avoid this. (Taiwanese)

Worst cases were in San Francisco. It's about subway stalker. I had no choice since it was my only way to get to work. I pretended I was asleep. If I read a book or was awake, he'd try to talk to me. I think much has to do with the woman's reaction. I probably was not assertive enough in telling him to stop. There were also panhandlers in NYC. They were constant and often times very aggressive. And once in France a man harassed my friend, touching her, even during a busy transit time when there were many spectators. (American)

I am a choice public transit rider. I own a car that has insurance and is drivable. However, because there is such a significant amount of traffic, I often tend to take the bus or train to avoid traffic and frustrations over traffic. The convenience and cost often wins. I personally have never experienced sexual harassment on public transit. I have felt unsafe due to either a person who seemed like they were drunk, on drugs, homeless, or sick. I have also felt insecure due to large groups of guys. They never really interacted with me but their presence was a little worrisome. Because I am a choice rider, when I have felt insecure about public transit, I begin to drive my car again. After some time away from public transit, I typically return to taking it when I feel comfortable again. Most women don't have that choice. I also carry mace now. (American)

The types of sexual harassment on transit include groping, accosting, stalking, and panhandling. And the images of harassers are usually drunk, dirty, and smelly middle-aged men. When asked whether they changed the way they use transit after being harassed, nonchoice riders usually answered that nothing can be changed since the transit is their only way to get to work or school; but when participants were asked about minor changes, the responses were surprising. Some participants get off the transit and wait for the next one, some leave the situation and go to safer spaces in the carriage or station, some sit and stand only by women, some use a bag or backpack to avoid unwanted touch, some ride transit with friends, some do

not ride transit after dark, and some avoid bus and transit that pass through areas with high crime rates. Therefore female nonchoice riders do modify their use of transit in minor ways. Even those interviewees who reported never being harassed said they are watchful and make the same minor changes to avoid sexual harassment on transit.

When evaluating some policies aimed at reducing sexual harassment on transit, in general the opinions of participants are much the same about brighter lights, emergency phones, and closed circuit television. Many participants thought that staff training and educating female riders might be helpful, although these possibilities were not mentioned in the discussion questions. Here are some examples:

Police presence. Even just one, visible officer in a station is a deterrent. Maybe also random, undercover cops (like secret shoppers) who travel on lines where there have been the most complaints. Ad campaigns that say sexual harassment will not be tolerated. There needs to be an understanding of what's not allowed and what the consequences will be. Corporations spend lots of time and money training workers on what constitutes sexual harassment. Clearly it is a difficult thing to define. If on a bus, proper driver training to defuse the situation or know when to call transit police. Suggest women traveling during busy times. Since offenders less likely to offend when there are witnesses. (American)

I think that the introduction of more security, brighter lights, emergency phones and such are the answer. While harassment on public transit may be a problem, I think small changes that make harassers aware of security measures will limit the problem. (American)

Encourage women to deal with the problem positively and do not take it as our fault. (Such mentality often exists in plenty of cultures.) Teach women how to deal with such situation. To whom and where should this problem be reported? One of the most important is: Train the staff in the transportation company how to assist women when such thing happens. Do not make women victim again by having an irresponsible or mocking attitude. The staff and drivers on the transit are often the most important authority to stop the harassment immediately. (Taiwanese)

I support the closed circuit television. Everything happened on transit can be video-taped so that harassers dare to do nothing. Even if harassment happened, there will be a record and help victim to identify the offender and take further action. (Taiwanese)

Both American and Taiwanese interviewees mentioned that sometimes they are not sure whether certain behaviors count as sexual harassment, and they suggested a clearer definition of sexual harassment and educating both women and men about what sorts of actions are not allowed. Interestingly, participants from both places pointed out that women should be careful about what they wear in order to avoid sexual harassment on transit. Though it sounds like discrimination, participants thought that is the reality and saw clothing choices as an effective way to prevent sexual harassment.

### Hypothesis Modifications

The hypothesis that "women's perceptions and fear of sexual harassment on transit are culturally specific" can be verified. Even though this study had only Taiwanese and white American participants, many cultural differences in issues of sexual harassment on transit were identified.

The hypothesis about female nonchoice riders is that "female nonchoice riders [who are aware of their vulnerability to sexual harassment on transit] will still take transit but modify their use of transit, which will lead to inconvenience and discomfort." The responses of participants show that they do make some minor changes to avoid being harassed on transit; thus, this part of the hypothesis is consistent with the evidence.

The hypothesis about female choice riders is that "female choice riders [who are aware of their vulnerability to sexual harassment on transit] will avoid taking transit." Though one participant mentioned she drives her car when she felt insecure about public transit, other choice riders said sexual harassment on transit is not a major consideration when they decide whether to drive their cars or ride the transit. Therefore this part of hypothesis does not capture the travel decision-making process of female choice riders.

In general, both choice and nonchoice participants said that sexual harassment is not a major consideration for them in deciding to take transit or drive, and their primary considerations are time, cost, convenience, comfort, and accessibility. Though sexual harassment is an issue for some participants, their responses are being more watchful and alert when riding transit, rather than avoiding taking transit totally. However, participants do mention that safety and security might be a more important consideration when making travel decisions.

### Suggestions for Further Research

The sample size is relatively small. Though important issues of the effects of sexual harassment on transit riders emerged through the discussion and conversation, most American participants responded in a similar way and

most Taiwanese participants responded in another similar way. Merely increasing the numbers of American and Taiwanese participants might not be helpful. However, since issues of sexual harassment on transit are culturally specific, different findings could be expected about women's perceptions, attitudes, and reactions to sexual harassment on transit with a greater ethnic diversity in the participants. For example, if Latina Americans had participated in the study, the findings might be different. Diversifying the participants as well as increasing the sample size will be helpful to expand the findings.

In-person focus groups work better than online focus groups. There are more interactions among interviewees in the in-person focus group discussion, and it is easier for the moderator to ask follow-up questions to get more detailed information from interviewees. In contrast, the interactions among online focus group participants are limited, and some participants thought their opinions might not make sense and therefore they tended to write less.

Small talk and informal interviews are useful in researching this topic. Some interviewees were not willing to discuss sexual harassment-related issues in public, but they were able to talk in a casual and informal way in private. During the interview process, interviewees usually can recall more and more details and elaborate their feelings and perspectives, and in the end, interviewees provide more information than they originally think they can.

Though these findings are preliminary and inconclusive, they can be helpful for preparing a follow-up, large-scale, in-depth survey. With a clearer picture of this issue and more knowledge about what should be asked and what kind of questions make sense, a better survey design can be expected.

## CONCLUSION

As the findings suggest, women's fear of sexual harassment on transit changes their transit use and travel behavior in a negative way. Though these changes are usually minor modifications rather than totally avoiding using transit, in order to retain the ridership, to build a positive image of public transit, and to attract potential female passengers, transit agencies and local government indeed should develop adequate policies to address this problem. Moreover, since women's perceptions of sexual harassment and their attitudes about adequate policy responses are culturally specific, a feasible and effective policy needs to consider relevant cultural contexts as well.

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# Women's Safety and Security Issues with Bicycling and Walking

## Examination of Potential Planning, Design, and Technology Solutions

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In the nonmotorized transportation field, gender differences in bicycling and walking are well documented, and personal safety has been identified as a deterrent to their increased usage. This concern for safety is not limited to the physical environment of the roadways, but includes the individual's perception of safety in the surrounding neighborhoods as well as the environment of multiuse paths and lanes. This paper uses data from the National Crime Victimization Survey and the FBI's National Incident-Based Reporting System to examine gender issues and to identify major safety and security concerns for users. The study incorporates focus group recommendations to offer planning and policy recommendations to increase the number of women who choose nonmotorized transportation.

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**N**onmotorized transportation has been identified as the most affordable and health-conscious alternative to vehicular travel, with benefits not solely predicated in individual health achievements but also in environmental enhancements. Leading medical and health journals have explicitly advocated walking and cycling for daily travel as the most affordable, feasible, and dependable way for Americans to get the additional exercise they need, a critical point given that 64% of Americans were overweight and 31% obese in 2001 (Pucher and Renne 2003). While research publications have advocated additional exercise as a way to combat obesity, and federally assisted roadway project funding benefiting nonmotorized transportation has increased to

more than \$75 billion a year, the share of total trips by nonmotorized transportation in the United States still stands at only about 1%, which is lower than in most European countries (Pucher et al. 1999).

According to the 2001 National Household Travel Survey (NHTS), more than 60% of all personal trips are 5 mi or less in length, with 40% of those trips 2 mi or less. These are considered reasonable bicycling distances. About 14% of all personal trips are a half mile or less, which is considered reasonable walking distance. Based on the defined reasonable nontransportation distances (NHTS 2001), a total of 65.1% of daily personal work trips and 43.7% of daily personal nonwork trips are within walking or bicycling distance, yet these modes are still not achieving the mode share in the United States that they attain in other countries. The percentages of nonmotorized transportation use are more polarized when considering gender. In the United States, bicycling, as a mode share, accounts for only 0.5% of urban trips among women (Pucher and Renne 2003), whereas in Denmark, more women than men use bicycles for transport, with 17% of all trips by women made by bicycles compared with 15% of all trips for men. In the Netherlands, about 31% of all trips by women are by bicycle compared with 26% for men. In Germany, rates of bicycle trips per week among women have increased more than among men (Garrard 2003).

In addition to roadway safety as it pertains to vehicular interactions, the perception of crime, as it pertains to personal safety, has been well-documented as influencing women's travel patterns. Female pedestrians and cyclists may feel particularly vulnerable to crime given their rel-



ative level of exposure compared with persons in cars with doors that may be locked, the potential inability to quickly escape a threatening situation, or a lack of infrastructure (such as street lights or call boxes) that would increase their expectation of safety. According to Lynch and Atkins (1988), it is fear, or apprehension, that influences travel behavior, while Loukaitou-Sideris (2005) has noted that women's perception of risk in public space is influenced by both the social and the physical factors of the environment. The variations in perceptions of risk are derived from both the environment through which the individual is traveling and her relative level of familiarity with this environment. This familiarity is influenced or determined by the preconceived images of an individual regarding a place and its occupants (Valentine 1990). A lack of familiarity with particular surroundings or environments may cause women to avoid these areas altogether or only traverse them during certain times of the day. This concern contributes to inconsistent nonmotorized transportation use and quite possibly lower levels of women bicycling and walking. Several factors are likely to contribute to perceptions of safety and security, and a more in-depth understanding is necessary to determine how enhancements in these areas are likely to improve walking and bicycling conditions and rates of nonmotorized usage among women. Improving the aforementioned issues with nonmotorized usage for women may not, however, be enough to increase their perception of safety and security within the nonmotorized travel mode or even possibly attract new users. Increasing the perception of safety not only involves addressing the built environment issues or the locations of paths, but requires understanding the areas in which these criminal events occur. This paper provides an exploratory analysis of the factors noted by using qualitative methods.

A woman's familiarity with particular areas is one of the main reasons for her utilizing certain paths and roadways, but it is this same familiarity that exposes her to potential offenders because of her formalized routines and patterns of travel. One area of development that has a potential role in improving bicycle and pedestrian usage among women are portable information systems. Although there are currently navigation systems for bicyclists in the market (e.g., the Garmin Edge 705 and Edge 605), these devices are currently restricted to routing information only, with no richness in content regarding conditions of nonmotorized travel, including information on crime and safety. This paper explores the types of content especially related to safety and security that may be useful to female pedestrians and bicyclists by means of such a system.

The research presented here aims to build on the current literature in understanding the gender differences in nonmotorized transportation use and substantiates some of the hypotheses previously proposed by researchers. The paper has two primary objectives: first, to examine

gender issues by using aggregate crime patterns, focusing on those occurring in roadways and in public spaces that may be of concern to women bicyclists and pedestrians, by using data from the Federal Bureau of Investigation's (FBI's) National Incident-Based Reporting System (NIBRS) and the Bureau of Justice Statistics's National Crime Victimization Survey (NCVS); and second, to identify, by means of a focus group, the major safety and security concerns for female users of nonmotorized transportation and the actions they take to increase their perceived level of safety. On the basis of this analysis, recommendations are provided to increase nonmotorized transportation usage by women.

The following sections first provide a brief review of the literature in the area of women's safety concerns. Previous studies have focused primarily on the safety of the built environment (e.g., crash likelihood) in evaluating safety measures. Within this body of literature, the present study evaluates the potential impacts of crime and feelings of personal vulnerability. Results are then presented from the FBI NIBRS and NCVS data on crime patterns in public spaces as they relate to women, and finally the focus group results are presented.

## LITERATURE REVIEW

The present paper is motivated by previous literature that identifies safety as a variable among many potential deterrents to increasing usage of nonmotorized transportation. However, a good portion of the literature focuses on the built environment or safety within the roadway and nonmotorized interactions with vehicular traffic. Such a focus may overlook the issue of personal safety, though crime as a deterrent to nonmotorized transportation is consistently identified in built environment research as one of the main reasons individuals alter their travel patterns or decrease their physical activity levels (Stokols 1992). In addition, one of the limitations to this focus upon the built environment is the inability to reliably measure the individual perception of safety and the other intangibles that it entails.

While the inability to effectively measure the perception of safety and security may negatively affect nonmotorized use in neighborhoods, the presence of opportunities for bicycling and walking are identified as contributing to the livability of the communities (Burden et al. 1999). The benefits of bicycling and walking may be decreased if fear of crime negatively impacts the ability to make use of these opportunities. Livability of communities focuses on the nonmotorized amenities such as mixed-use developments, which provide desirable destinations for residents that are within reasonable nonmotorized distance, continuity of sidewalk and bike path networks and their proximity to vehicular traffic, and

the presence of streetlights to improve the perception of safety. While not exhaustive, this list is indicative of the pedestrian-friendly amenities that may contribute to the livability of communities and the subsequent increase in female nonmotorized users.

Previous researchers, when identifying possibilities for increasing nonmotorized transportation use among women and bicyclists in general, discuss grade separation of bicycle lanes or expanding the roadway infrastructure as a means of improving safety for current bicyclists and possibly alleviating the safety concerns of potential nonmotorized users. Previous research also has shown that women tend to be more concerned with safety factors than males (Krizek et al. 2005) and have a preference for off-road paths. The roadway or built environment does not exhaust the constraints that prevent women from increasing their nonmotorized transportation usage; for example, Garrard et al. (2008) identify personal and socio-environmental constraints that intimidate potential bicyclists, such as unfamiliarity with road rules for bicyclists, bicycling etiquette, and general bicycling knowledge.

Some researchers believe that focus should also be placed upon the utilization of the idea of "designing out fear" in the environment (Newman 1972), which is based on ideas about defensible space. Four factors make a space defensible: territoriality, natural surveillance, image, and milieu. These principles focus on creating or improving the resident's perception of safety and security through a sense of ownership and responsibility. This idea of community involvement allows for potential offenders to possibly reconsider their actions and therefore reduce the levels and frequencies of criminal activity. However, Koskela (2000) believes that a perception of fear is not based solely upon built environment improvements, but is more of an individual social issue and is more complex than the design process that "designing out fear" entails and does not improve women's perception of safety. While the majority of the safety and security focus has been placed on the built environment and the nonmotorized interactions with vehicles, in attempting to understand the discrepancies in nonmotorized use in the United States the social issues that exist within individual interactions and the potential element of crime must also be considered.

## RESEARCH METHODS

This paper has two primary research objectives: to analyze aggregate crime patterns against women in transportation facilities and public spaces by analyzing NIBRS and NCVS data and to understand the types of safety and security concerns among women bicyclists and pedestrians by means of a focus group. In this section, the author expands on the research methods employed to meet these two research objectives.

## Databases Analyzed to Develop Crime Patterns

Two databases relating to crime and victimization were analyzed for the results presented in this paper: first, NCVS, a random sample of nationally representative households; and second, NIBRS, an administrative database on crime incidents reported by local police departments to the FBI. By pooling information from both databases, it is possible to overcome some of the unique limitations of each system and to develop a more complete picture of crimes against women in public places. The purpose of the analysis was to understand gender differences in the location type, distance from home, type of activity at the time of the crime, and the time at which the crime occurred. Additional analysis on the type of crime (coded as per the Uniform Crime Reporting [UCR] system) experienced by women is also presented here.

## National Crime Victimization Survey

NCVS is a primary source of information collected by the Bureau of Justice Statistics (BJS) on criminal victimization. Each year, data are obtained from a nationally representative sample of 76,000 households comprising nearly 135,300 persons on the frequency, characteristics, and consequences of criminal victimization in the United States. The survey enables BJS to estimate the likelihood of victimization by rape, sexual assault, robbery, assault, theft, household burglary, and motor vehicle theft for the population as a whole as well as for segments of the population such as women, the elderly, members of various racial groups, city dwellers, or other groups. NCVS provides the largest national forum to define characteristics of violent offenders and for victims to describe the impact of crime. The greatest benefit of using NCVS is that data on crimes that may be underreported to the police (especially those of a sexual nature, which tend to be far greater in the case of female victims as compared with male victims) are likely to be available from the NCVS. For the purpose of this paper, the national-level NCVS data archives for the years 1992 to 2005 were pooled to yield information on gender differences in the location type, distance from home, type of activity at the time of the crime, and the time at which the crime occurred.

## FBI National Incident-Based Reporting System

NIBRS, a nationwide reporting system for crimes known to the police, is part of the National Archive of Criminal Justice Data. When an incident occurs, data are collected in relation to the offense (such as type of incident and location of incident); the victim (such as age, sex, and gender); general administrative information (such as

incident time of day); property information (such as type of property stolen and recovered); and offender variables. While data are collected on 46 specific types of incidents, crimes for which data are collected that may be of particular concern to women cyclists and pedestrians include the following (BJS 2007):

- Homicide,
- Forcible rape,
- Robbery,
- Aggravated assault,
- Burglary,
- Larceny-theft,
- Motor vehicle theft, and
- Arson

NIBRS is a part of the UCR Program, which provides a view of crime based on the submission of criminal reports from law enforcement agencies across the country. Since 1930, through the UCR, the FBI has compiled and collected data to study fluctuations in levels of crime.

### Focus Group Design

A focus group was held in Chicago, Illinois, to identify factors that were of particular concern to users of nonmotorized transportation. The focus group explored personal safety and security issues while bicycling and walking as well as possible deterrents to increased frequencies of nonmotorized usage. A targeted snowball sampling approach was used, with potential participants contacted via phone call or email by nonmotorized transportation organization listservs, activity calendars, and blogs. Incentives were offered in the form of light refreshments during the focus group, and gift cards were given to the chosen participants upon completion. To participate in the focus group, a short background questionnaire was completed to ensure a more diverse population of nonmotorized transportation users. The design was a dual-moderator focus group, and 15 women from a variety of nonmotorized backgrounds shared their concerns with safety and security and provided information and ideas regarding the issues facing nonmotorized transportation users. The conversation was recorded via a digital voice recorder and notes were taken on flip charts in order to aid transcription.

### DATA ANALYSIS

Analysis of the NCVS data by gender revealed a significant relationship between gender and the place of crime, gender and distance from home, and gender and time of incident occurrence. However, a signifi-

cant relationship did not exist between gender and the activity at time of incident. Understanding these relationships are important to developing strategies to addressing the safety and security concerns of women and to laying the groundwork for potential planning and policy changes to encourage nonmotorized transportation by women.

Table 1 shows that the majority of crimes against both men (38.2%) and women (about 50%) occur within their own home or in the immediate vicinity of their homes. This statistic shows that the perception of safety does not solely depend on unfamiliarity with neighborhoods or bike paths or lane networks, but includes numerous other factors. The occurrence of victimization within or near an area with which an individual is familiar may discourage nonmotorized use due to her needing to avoid potentially dangerous situations as quickly as possible by using the fastest mode of transportation, and the fastest mode of travel available is the vehicle. Table 1 also shows parking lots and garages (10.5%) as more unsafe than open areas, on street, or public transportation (6.61%) for women. This encourages use of the rational choice theory of environmental criminologists, in which the offender may possibly be motivated by the potential rewards outweighing the risks in parking lots or garages rather than in public spaces.

The vast majority of crimes against both men (52.95%) and women (51.95%) occur on their way to and from work and school (Table 1). These routine activities of men and women offer exponential opportunities for offenders to victimize the nonmotorized users. While the chi-squared test of significance shows the relationship between gender and activity at time of incident as not significant, the mere presence of a routine exposes the individuals to the routine activities theory of environmental criminologists, which focuses on criminal opportunities that are created as a result of societal behavior (Cohen and Felson 1979). This unknown risk exposure by the individuals may deter future nonmotorized use if an incident occurs because there may exist a fear of the repercussions of nonmotorized mode use or a decrease in the individual's overall perception of safety.

Table 1 additionally shows that compared to men, women are more likely to be victimized the further they travel from home. This indicates that women may be traveling into unfamiliar areas and exposing themselves to risks that may not be present in areas in which they are familiar. However, the chi-squared test statistic shows a significant relationship between gender and distance from home, and a total of 53.67% of incidents against women occur within reasonable walking or bicycling distance from their home. If the neighborhoods in which women reside are shown to be unsafe for nonmotorized usage, then women are potentially discouraged from using nonmotorized transportation.

TABLE 1 Crime Incident Variables, by Gender

Variable	Men (%)	Women (%)
Place of crime <sup>a</sup>		
In respondent's home or lodging		
In own dwelling, own garage or porch	15.17	23.45
In detached building on own property	2.55	2.42
In vacation home or second home	0.46	0.43
Total	18.18	26.30
Near own home		
Own yard, sidewalk, driveway, carport, unenclosed porch	18.87	21.58
Apartment hall, storage area, laundry room	0.85	1.22
On street immediately adjacent to own home	5.53	4.73
Total	25.25	27.53
At, in, or near the home of a friend, relative, or neighbor		
At or in home or other building on their property	1.93	2.38
Yard, sidewalk, driveway, carport	1.90	1.37
Apartment hall, storage area, laundry room	0.10	0.14
On street immediately adjacent to their home	1.25	0.91
Total	5.18	4.80
Parking lots and garages		
Commercial parking lot or garage	3.13	2.21
Noncommercial parking lot or garage	6.34	5.02
Apartment or townhouse parking lot or garage	3.70	3.29
Total	13.17	10.52
Open areas, on street, or on public transportation		
In apartment yard, park, field, playground	1.75	1.07
On street	8.47	4.67
On public transportation or in station	0.95	0.87
Total	11.17	6.61
Activity at time of incident <sup>b</sup>		
(02) On way to or from work	24.50	22.38
(03) On way to or from school	28.45	29.57
(04) On way to or from other	46.93	47.95
Don't know if (03) or (04)	0.12	0.10
Distance from home <sup>a</sup>		
1 mi or less	22.28	19.81
5 mi or less	32.97	33.86
50 mi or less	33.14	33.50
More than 50 mi	9.05	9.10
Don't know how far	2.55	3.73
Time of incident occurrence <sup>a</sup>		
After 6 a.m. to 12 noon	14.63	15.95
After 12 noon to 6 p.m.	36.23	37.52
After 6 p.m. to 12 midnight	28.25	27.77
After 12 midnight to 6 a.m.	20.89	18.76

<sup>a</sup> Chi-square < .0001 (significant).

<sup>b</sup> Chi-square = .078 (not significant at the .05 level but is significant at .1 level).

SOURCE: National Crime Victimization Survey.

According to the NCVS data, a larger percentage of criminal incidents against women occur between noon and midnight (Table 1). This table is important in understanding why women may hesitate to utilize nonmotorized transportation, and it graphically reinforces the findings from the NCVS data that there is a significant relationship between gender and time of incident occurrence. Simple assault incidents were analyzed from the NIBRS data because NCVS defines simple assault as an attack without a weapon resulting either in no injury, minor injury, or in undetermined injury requiring less than 2 days of hospitalization. These reported incidents have a higher frequency than others, hence they

are assumed to be more common and are the types of incidents that may possibly influence decisions to bicycle and walk.

It is during this time period that, according to the National Survey of Bicyclist and Pedestrian Attitudes and Behavior (2008), 56% of bicycle trips and 50% of walking trips originate. The existence of a significant relationship between gender and time of incident occurrence suggests that time of incident occurrence may have greater implications for female pedestrians than it does for bicyclists. While the levels of risk exposure vary for cyclists and pedestrians, cyclists are more prone to escape potentially dangerous situations involving unfamiliar

individuals due to the higher speeds at which they travel than pedestrians. In addition, while the higher speeds may allow for cyclists to avoid unfamiliar individuals, it exposes them to the other facets of risk exposure, such as vehicles and roadway obstructions.

Crime data analysis implies that nonmotorized transportation modes are subject to the relationships between gender and the variables place of crime, distance from home where the crime occurs, and time at which the crime occurs. These significant relationships provide a glimpse of the reasons why women nonmotorized transportation users are not achieving higher usage levels in the United States compared to other countries and can possibly be addressed via numerous planning and policy changes. These are summarized below.

### Planning

- Introduce nonmotorized infrastructure to areas where it is absent and aids such as alarms, community policing groups, roadside assistance devices and facilities, and social networks of women bicyclists and pedestrians.
- Ensure the continuity of the path and lane network, well-lit facilities, and removal of areas and minimization of conditions that encourage loitering, public nuisance, and crime against women bicyclists and pedestrians.
- Use sketch planning tools to understand whether the urban ecology and environment in which the path or lane is located encourage or discourage criminal activity and develop strategies that can be undertaken at the planning level to improve neighborhood conditions that facilitate crime.
- Design roadway geometry for alternative uses to the vehicle and eliminate nonmotorized user confusion, which can pose hazards by reducing walkers' or bicyclists' focus and alertness against crime.

### Policy

- Aggressively enforce laws that protect cyclists and pedestrians within and in the vicinity of the roadway.
- Increase spending to improve conditions that currently have nonmotorized transportation infrastructure.
- Encourage nonmotorized use via tax incentives to increase the total pool of users so that the increase in numbers itself is a deterrent to crime against women bicyclists and pedestrians.
- Expand driver education programs to include nonmotorized users.
- Expand information technology options to provide real-time information on safety and personal security, connectivity to other women bicyclists and pedestrians seeking to travel in the same direction, information on

weather, construction, special events, and other factors that are likely to create hazards or confusion for women, which in turn can reduce their level of alertness against crime and increase their vulnerability.

While the crime data statistics in Table 1 show significant gender relationships in the location, time, and distance from home with victimization incidents, they don't provide a fully developed view of the environment in which these incidents occur. Understanding the individual perceptions of safety and security are important in knowing which planning and policy activities need to be implemented to improve the experience of the nonmotorized user population. This multilayered issue requires further exploration within a focus group setting to gain insight into the elements of a roadway or path and lane environment that improve individual perceptions of safety and security and whether specific technologies can alleviate any of their concern. Focus group safety and security concerns are shown in Table 2.

### MAJOR RECOMMENDATIONS

Table 3 shows the major recommendations offered, which were categorized as safety, education, marketing, and information (SEMI). These concepts were part of a recurring theme among members of the focus group, whether pedestrian or cyclist, and reinforce the previous research as well as the statistical analysis that shows gender as having a significant relationship with place of incident, distance from home, and time of incident occurrence.

#### Improve Safety

The individual's perception of the safety of the physical environment determines which paths to take for her nonmotorized trips. Individual perceptions of safety center on the known presence of crime or the potential for criminal activity to exist in particular areas. A lack of adequate street or path lighting was a recurring theme in the focus group, as was time of day of travel and presence of "hidden dangers" that may provoke criminal activity. Increasing the number of call boxes or emergency lights throughout the city would increase the perception of safety for women in the absence of a visible police presence. Individual perceptions of safety also involve an ability to escape potentially perilous situations. A participant commented that for safety reasons she "drives to the store or to run her errands as opposed to running or cycling" while another commented that she "feels safer on a bicycle than on foot because she can outrun darn near anyone on foot with her bike, but she can't run as

**TABLE 2 Focus Group Results**

Safety and Security Concerns	Description	Resolution
Path and lane design	Ease of accessibility; continuity of network; awkward location (getting "doored," hidden within trees); lack of lighting; lack of bicycle signage; cyclists aggressive toward pedestrians on paths.	Avoid certain paths and lanes because of location, lack of lighting, continuity, accessibility and path-lane etiquette.
Bicyclist or driver education	Driver's superior feeling to pedestrians and bicycles; aggressiveness of drivers; drivers ignoring stop bars and crosswalks; no roadway etiquette for drivers toward cyclists; cyclists not obeying roadway signage.	Cyclists enrolled in a safety course for cyclists; attend seminars and workshops on fixing bikes and becoming familiar with them.
Criminal activity or intimidation	Pedestrians and bicyclists feel a lack of privacy because they are being gawked at by groups of men; rude comments made by men toward them; concern for possible other "hidden dangers" within the environment (excessive trees, lack of lighting, etc.).	Pedestrians and cyclists change their travel route frequently to confuse potential offenders; utilize a buddy system of walking or cycling with friends and family; change their appearance to appear more athletic, such as wearing a jumpsuit as opposed to clothes that may expose figures; avoid certain paths and lanes; carry personal protection (pepper spray, mace, U-lock); limit travel (commuting or recreation) to daylight hours; seek out community of cyclists and pedestrians; go to gym in their neighborhood or surrounding area to exercise. Pedestrians use car for travel when they normally would walk or run for personal errands.
Roadway safety	Construction roadway closures or catch basin cutouts not visible at night; seasonal factors (ice or rain); presence of curbs that allow no escape from aggressive drivers; lack of bicycle signage.	Cyclists wear reflective clothing for visibility; attended seminars and workshops for cyclist roadway safety; check weather information for trip planning; avoid using certain lanes on roadways with high vehicular traffic.

fast on her feet," so the ability to escape a threatening situation on a bicycle faster than she could on foot is important to her. Pedestrians altered their travel patterns completely if they believed a trip to place them in any danger.

### Increase Education

The overwhelming majority of participants stated that a possible change to the driver's education curriculum would be helpful in decreasing the number of potential conflicts between nonmotorized users and vehicles within the roadway. The program would teach bicyclists how to become more predictable in their actions within the roadway by using hand signals and communicating with the vehicular traffic. One participant admitted that

she didn't know that her actions were "confusing the drivers" until enrolling in a bicyclist education class.

### Introduce Marketing Campaign

The focus group believes that although individuals are aware of the potential health and environmental benefits of bicycling and walking, most choose to ignore them due to current policies and travel environments that favor vehicular travel. It was suggested that an aggressive marketing campaign be undertaken, similar to the anti-smoking campaign, to inform the public of the benefits of bicycling and walking to increase nonmotorized use. A participant further mentioned that she knew individuals who would cycle to work if there were facilities available for showering, clothes changing, and bike stor-

**TABLE 3 SEMI Recommendations**

Recommendation	Description
Increase perception of safety for pedestrians and cyclists	Change the lane or path environment (increase street lighting, remove "intimidation" factors of path or lane location); install emergency call boxes; increase bicycle signage; improve continuity of lane-path network.
Driver and cyclist education	Change the education curriculum for driver education; educate cyclists on becoming more predictable in their movements within the roadway; teach proper path etiquette between cyclists and pedestrians.
Introduce marketing campaign for nonmotorized travel	Speak to health and environmental benefits of cycling and walking, similar to antismoking campaign.
Improve available information to pedestrians and cyclists	Offer real-time weather updates, points of interest along routes or surrounding areas for trip planning, construction updates, location of police or fire stations, news feeds or crime updates, and location of bus or trains.

age at their work location. The possibility of federal tax or employer-offered incentives for cycling and walking were raised as possibilities to increase the population of nonmotorized users.

### Improve Available Information

Various recommendations were offered for technology that pedestrians and bicyclists thought would benefit their travels. While the Weather Channel, WeatherBug, various routing software, bus tracker, and smartphone (RSS feeds) were widely used for information, as well as word of mouth from the community of nonmotorized users, portable devices such as cellular phones or smartphones are used to access information during their trips. Potential areas for technological applications for nonmotorized transportation include

- Real-time weather updates to determine attire to wear or to determine the length or direction of the trip as well as rerouting in case of inclement weather.
- Points of interest, such as festivals, events, restaurants, and shopping for the neighborhoods they are currently in or traveling through.
- Construction updates for advanced notice of road closures for rerouting to other bicycle paths and lanes in the area.
- Location of police and fire stations to increase perceptions of safety for pedestrians and bicyclists and to know where to report possible criminal activity.
- News feeds or crime updates that would be used to determine if a particular neighborhood should be avoided on the nonmotorized trip due to recent increases in criminal activity.
- Vital statistics, such as calories burned and heart rate, as well as on-bicycle computer for speed, average speed, and distance.
- Location of bus or train stations or individual public transportation for use in case of inclement weather or inability to continue by bicycle (e.g., an unrepairable flat tire).

The focus group responses indicate that applicable technologies that inform the user of events or incidents so that they may better plan their nonmotorized trip are needed. These technologies largely centered on the safety and security of the individuals or increasing their perception of safety. The need for real-time weather information, construction updates, location of police or fire stations, location of bus or train stations, all indicate that safety and security are of the utmost importance to the nonmotorized traveler. The knowledge of points of interest suggests that users feel an increase in their perception of safety and security when they are knowledgeable about their sur-

roundings, and this increased knowledge of events breeds familiarity and improves their sense of security.

### CONCLUSION

In the nonmotorized transportation field, gender differences in bicycling and walking are well-documented, and previous studies have indicated that a concern for safety is a relevant factor in explaining possible gender differences in bicycling behavior (Emond et al. 2009). This concern for safety is not limited to the physical environment of the roadways but includes the availability of bicycle facilities and the safety of the surrounding neighborhoods. While the fatality statistics for bicyclists and pedestrians are declining, the exposure risk for women is increasing due to their being equally as mobile as men in overall number of trips (Chicago Metropolitan Agency for Planning 2007).

The offered planning and policy recommendations to address women's safety and security issues are contained within the SEMI approach, which focuses on improving nonmotorized user safety with technology while educating vehicle drivers and nonmotorists and increasing public awareness through marketing campaigns. In order to successfully integrate nonmotorized transportation within a vehicle-dominant environment, major planning and policy changes must take place that will require widespread organizational coordination. This research examined issues that may be of concern to female pedestrians and cyclists by using NCVS and NIBRS data; identified major safety and security concerns for female nonmotorized transportation users and the actions they take to increase their perception of safety; and by means of a focus group, provided recommendations to increase nonmotorized transportation usage by women. Decision makers must understand that addressing women's issues with nonmotorized transportation does not solely involve the roadway environment, but their perception of safety and security and the environment in which the paths and lanes are located. It is through this inclusive methodology that truly understanding female nonmotorized users and increasing the frequency of their trips can be achieved.

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# Youth Transport, Mobility, and Security in Sub-Saharan Africa

## The Gendered Journey to School

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This paper draws on empirical data from a three-country (Ghana, Malawi, and South Africa) study of young people's mobility to explore the gendered nature of children's journeys to school in sub-Saharan Africa. Gender differences in school enrollment and attendance in Africa are well established: education statistics in many countries indicate that girls' participation in formal education is often substantially lower than boys', especially at the secondary school level. Transport and mobility issues commonly form an important component of this story, though the precise patterning of the transportation and mobility constraints experienced by girls and the ways in which transport factors interact with other constraints vary from region to region. In some contexts, the journey to school represents a particularly hazardous enterprise for girls because they face a serious threat of rape. In other cases, girls' journeys to school and school attendance are hampered by Africa's transport gap and by cultural conventions that require females to be responsible for pedestrian head loading (transporting loads such as food crops or fuel on the head) and other work before leaving for, or instead of attending, school. Evidence comes from a diverse range of sources, but the data used here are principally drawn from a survey questionnaire conducted with approximately 1,000 children ages 7 to 18 years across eight sites in each country. The aim of this study is to draw attention to the diversity of gendered travel experiences across geographical locations (paying attention to associated patterns of transport provision); to explore the implications of these findings for access to education; and to suggest areas in which policy intervention could be beneficial.

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This paper examines the gendered journey to school in sub-Saharan Africa. Gender differences in school enrollment and attendance in Africa are well established: education statistics in many countries indicate that girls' participation in formal education is often substantially lower than boys', especially at the secondary school level. Transport and mobility issues commonly form an important component of this story, though the precise patterning of the transportation and mobility constraints experienced by girls, and the ways in which transport factors interact with other constraints, vary from region to region. On the basis of a large set of empirical data gathered by the authors in a research project on children's mobility in Ghana, Malawi, and South Africa, this paper explores the diversity of gendered travel experiences across geographical locations, paying attention to associated patterns of transport provision. The research covers 24 urban and rural sites across Africa. Issues of security form a key theme in some of the locations where data were collected, especially where girls are concerned: they may face a very real threat of rape. In other cases girls' journeys to school and school attendance are hampered by Africa's transport gap and cultural conventions that require females to be responsible for pedestrian head loading (transporting loads such as food crops or fuel on the head) and other work before leaving for (or instead of attending) school. There is insufficient room in this paper to examine in depth the role that girls' household duties associated with Africa's transport gap play in shaping gendered patterns of travel to school, but it is important to note their presence and contextual significance for the daily travel patterns described below.

Following a short review of background literature and methods, the authors present and comment on the comparative survey data for the locations in which they worked. The implications of the findings are examined for gendered patterns of access to education, and areas in which policy intervention could be beneficial are suggested.

## BACKGROUND

Primary education enrollment figures have been boosted substantially across sub-Saharan Africa by the emphasis on “free” universal primary education in the Millennium Development Goals (MDGs), but attendance figures often remain substantially below enrollment. Children’s time spent at school has to be balanced against the opportunity costs of its alternative use in contribution to household production and reproduction. Additionally, although fees have been abolished, parents are still expected to fund other items such as uniforms, books, furniture, parent-teacher associations, and so forth. Other potential constraints include poor school quality and lack of access to credit, though these vary in importance between urban and rural areas (Ersado 2005). The significance of the time, effort, and costs of transport incurred in getting to school has been little considered in the literature.

Once children have completed primary school or junior secondary school (where this latter middle stage occurs), a move to senior secondary education may be contemplated but is often not achieved. The barriers to enrollment are more substantial at this level since fees are imposed. Additionally, secondary schools are fewer in number than primaries and tend to be located in major service centers (Porter 2007). Consequently, in addition to fees and the related school-based costs of uniforms, books, and so forth, there are likely to be substantial travel costs, a very long daily walk, or costs of accommodation at or close to the school. In more remote rural areas even primary school enrollment and attendance may be affected by travel distance, since schools cannot normally be provided in every settlement, but at the secondary level the barriers imposed by distance are usually much increased.

Studies directly concerned with travel to school in Africa are rare, especially outside of South Africa. Early work in Uganda (Gould 1973) showed how poor transport services forced most children to walk to primary school; secondary school children usually had to live away from home due to the distances involved. This situation is still common across Africa. In Ghana, Avotri et al. (1999) found that the closer the secondary school, the more likely it is that children will be sent to primary school, because continuity of the child’s education is feasible. Their work also shows (94–95, 165) how long walks to school due to lack of or high cost of transport

and associated lateness problems encourage late “average” enrollment (especially of girls), truancy, and early drop out. In South Africa, a number of studies indicate the scale of the problem of travel to school. A 1998 survey of rural KwaZulu Natal schools found that 75% of secondary school walkers walked over 3 km to school, while 43% of primary school walkers walked over 3 km: at least 280,000 children in this region walked for over 1 h, one way, to school. An associated survey of school principals found 60% of pupils were often late, 58% sometimes absent, and 70% of pupils were often tired at school, due to long walking distances to reach school each day (Mahapa 2003). The 2003 South Africa National Household Travel Survey adds further support to this picture: 76% of “learners” were reported to walk to their educational destination and almost 3 million out of the 16 million total (especially those located in more rural provinces) spent more than an hour a day walking to and from educational institutions (RSA Department of Transport 2005). Long journeys to school, when coupled with required contributions to household labor, are likely to have a strong impact on attendance. However, Filmer (2007) suggests from his analysis of data for rural areas of 21 poor countries (including some of the poorest in Africa) that simply building schools will not bring large increases in school participation rates: a combination of interventions may often be essential to improved participation.

Children’s school attendance and performance is further impeded by the widespread household transport gap, notably lack of piped water and electricity for cooking. Girls, in particular, are often required to carry water, wood fuel, and other loads, as well as performing other household duties, both before and after school. This delays the time when they leave home, not only increasing the likelihood of late arrival at school (with consequent punishment from their teachers), but also leaving them exhausted during lesson time. Poor roads and unreliable, costly, or nonexistent transport services may add to their problems on the journey to school.

In some countries the school transport situation is further complicated by the substantial expansion of private education. Perceived deficiencies in the quality of education provided in state schools may persuade even relatively poor families to send their children to a more distant private school rather than the local state school. As Lewin and Sayed (2005) observe, the limited availability of places at state secondary schools for the growing numbers of children graduating from the free primary education promoted by the MDG priorities may also encourage this trend.

Since girls’ school enrollment rates are considerably lower than boys’ across much of sub-Saharan Africa, transport impacts on girls’ education are of particular interest. Low enrollment and attendance among girls

are in part related to their particularly heavy household duties, but also associated with cultural perceptions regarding the (limited) value of girls' education, and perceived dangers for girls who have to travel a long distance to school or board away from home. A study in Niger using DHS surveys indicates that there are only 41 girls per 100 boys at school in rural areas, compared with 80:100 in town, and that distance of home from school is a key factor (Department for International Development 2001, 7). Improvements to road access and transport availability can probably make a significant impact on girls' attendance in some contexts, as research in Morocco indicates (Khandker et al. 1994; Levy and Voyadzis 1996 cited by African Union et al. 2005).

## METHODOLOGY

This paper draws on a survey of approximately 1,000 children aged 7 to 18 years in each of the research countries ( $n = 2,967$ ). In the discussion, statistics are compared from the quantitative survey for four locational types in each country:

1. Remote rural (RR) with no school and few, if any, basic services. Poor access along unpaved road with very limited or no transport services.
2. Rural with services (RS), that is, with at least a primary school and some kind of health service, if only as an occasional visiting facility. Poor access along unpaved road with some (fairly limited) transport services.
3. Periurban (PU) or small town within daily reach of an urban center, with some residents traveling daily into the urban center.
4. Poor, high-density urban (U) neighborhoods.

Each category includes two sites per country from different agroecological zones.

A random sample of approximately 125 children per settlement was obtained (see [www.dur.ac.uk/child.mobility](http://www.dur.ac.uk/child.mobility)). The parent or caregiver was asked for basic information about the selected child. The subsequent interview with the child was conducted wherever possible out of hearing (but within sight) of the parent and other family members. The survey was preceded and

accompanied by substantial qualitative research not only by academic researchers but also by 70 child researchers, who interviewed their peers, made photo diaries, and in some cases showed the authors their routes to school. The child and adult qualitative research played a crucial role in shaping the survey design, specific questions, and the interpretation of findings.

## FINDINGS

### Gender and Schooling

The vast majority of the children and young people interviewed in the survey were enrolled in school, which suggests an encouraging trend, probably at least in part a reflection of efforts associated with the MDGs. Gender patterns of enrollment were as one might expect for Ghana (82.4% of girls enrolled compared with 92.6% of boys across the full-country sample of children) and South Africa (90.3% of girls compared to 95.4% of boys), but in Malawi, where overall enrollment figures in rural areas are lower than in Ghana and South Africa, a smaller proportion of boys were enrolled than girls among the total Malawi sample (82.2 % girls compared with 74.2% of boys). However, it is probably more useful to focus on enrollment of children between the ages of 9 and 15 years, rather than the total sample when looking at enrollment statistics, since it is common for younger children to be enrolled fairly late, especially in more remote areas, while children over 15 are beyond the age of compulsory education. A breakdown of this data for 9- to 15-year-olds, by settlement type, provides useful detail (Table 1).

Overall, it would appear that enrollment is directly linked to settlement accessibility only in Malawi, where for both for girls and boys there is a clear pattern of increased enrollment from remote rural to urban settlement types. The significantly higher figures for girls than for boys in Malawi remote rural settlements can be related to the fact that some boys are involved in herding, charcoal burning, and other livelihood activities in the remote rural areas. In rural Ghana and South Africa, enrollment figures are substantially higher than in Malawi. Overall, in both these countries there is less distinction in accessibility terms than in Malawi. In Ghana girls' enrollment

TABLE 1 Percentage of Children Ages 9–15 Years (Inclusive,  $n = 2,180$ ) Enrolled in School

Location	South Africa		Ghana		Malawi	
	Female	Male	Female	Male	Female	Male
RR	96.3	98.7	88.9	90.7	75.8*	58.5
RS	98.9	98.7	90.4	95.8	76.9	87.6
PU	98.8	100	89.5*	97.1	90.8	89.2
U	95.0	98.2	94.9	93.3	96.6	93.3

\* $P$  (chi-square) < .05.

is significantly lower than boys in the periurban locations surveyed, perhaps because in this settlement type girls' household contributions through retail and other employment in a nearby urban economy are highest.

School attendance figures are actually much more important than enrollment figures in terms of children's access to education: very many children who are enrolled spend many days out of school. Unfortunately, attendance data for the last week across all three countries could not be satisfactorily compared because in some locations, particularly in South Africa and Malawi, the survey had to be conducted during the school holidays.

## Travel to and from School

### *Travel Patterns by Gender: Attending the Nearest School*

In the following discussion the focus is on all children in the survey who travel to school (i.e., not only those between 9 and 15 years). The vast majority (95% or over) of both boys and girls interviewed in the survey travel daily to school in all three countries. The majority interviewed also attend the school (relevant to their educational level) closest to home, but there are important distinctions according to location in Ghana and Malawi, where both boys and girls were particularly likely to attend the closest school in rural settlements with services. This is because such settlements all have at least primary and usually also junior secondary school provision, and are sufficiently far from other centers to disincline parents from choosing to send their children to a school elsewhere, since this is likely to involve substantial travel costs. The picture is less clear in South Africa. In all three countries, but especially Ghana, urban children are less likely than others to attend the nearest school: there are opportunities to select other schools which, although not the nearest for their particular level, are clearly within reasonable travel distance, and can usually be reached on foot. They are selected for a variety of reasons, including factors such as family members' having attended the school, religion, proximity to the family business, or government allocation (in the case of secondary school).

Urban figures regarding attendance at the nearest school are highest in Malawi, presumably because this is the poorest, least developed of the three countries, and thus pressures to educate as close to home as possible and at minimum cost are highest, even in urban areas.

Gender distinctions in each country regarding attendance at school closest to home are relatively small in urban areas and rural areas with services (where schools will be close), but in remote rural areas in Ghana and particularly in Malawi, a considerably higher proportion of girls than boys attend the closest school. This presumably reflects poverty levels in remote areas, girls' workloads, and concerns about girls' safety during the journey to school, an issue that is considered later in this discussion. In South Africa, although there are serious safety concerns regarding girls' travel to school, there is relatively more availability of scholar transport in remote rural areas (see below) (Table 2).

### *Daily Travel Times*

Children were asked to estimate the time it took to travel to school on the most recent school day. In Ghana, just over half of all girls who responded to this question ( $n = 1,998$ ) estimated they reached school in 15 min or less (50.6%). Figures for girls in Malawi and South Africa were lower (34.3% and 28.3%, respectively). Corresponding percentages for boys were somewhat lower than for girls in Ghana (44.6%) but very similar in Malawi and South Africa (35.3% and 28.5%, respectively). In all three countries roughly 20% of boys and girls estimated their journey at between 46 and 90 min. Journeys over 90 min were few in Ghana and Malawi (under 3% of girls and boys in Ghana, under 5% in Malawi), but reported by 7.8% girls and 8.4% boys in South Africa.

A review of differences across different settlement types in each country adds significantly to the broad picture. As one would expect, the survey data for estimated daily travel time to school in Malawi shows the longest journeys in remote rural areas, where a majority of children, both boys and girls, estimate that their journey takes over three-quarters of an hour. By contrast, journeys in rural centers with services tend to be the shortest;

TABLE 2 Percentage of Children Attending the School Closest to Home

Location	South Africa ( $n = 879$ )		Ghana ( $n = 865$ )		Malawi ( $n = 784$ )	
	Female	Male	Female	Male	Female	Male
RR ( $n = 569$ )	88.7	90.9	90.7	86.7	92.0*	80.9
RS ( $n = 650$ )	91.1	89.8	97.3	97.4	98.9	98.1
PU ( $n = 629$ )	92.8	87.8	95.2	90.6	95.9	86.9
U ( $n = 680$ )	66.2	67.9	56.6	59.1	72.3	70.7

Note: All children ages 9–18 years currently attending school,  $n = 2,528$ .

\* $P$  (chi-square)  $< .05$ .

not surprising given that this is the settlement type in which the most children are likely to attend the nearest school. Journey time is more varied in both urban and periurban locations, reflecting proximity to schools in urban areas, but also the tendency to attend a school other than the closest, especially in urban locations. Differences in gendered patterns are relatively small, though more boys (especially in remote rural Malawi) travel distances requiring long journeys (over one and a half hours) compared to girls (Table 3).

Daily travel times for South Africa are similar to Malawi in terms of distribution across geographical locational categories, with the majority of the longer journeys in remote rural locations and the majority of short journeys in rural settlements with services. Gender distinctions appear relatively small. The data accord with the 2003 South Africa National Household Travel Survey conclusion that 3 million out of the 16 million total learners (especially those located in more rural provinces) spent more than an hour a day walking to and from educational institutions (RSA Department of Transport 2003) (Table 4).

Daily travel times for Ghana as a whole are relatively short, particularly when compared to South Africa. The preponderance of short journey times in Ghana is in periurban sites, even more than in rural settlements with ser-

vices. This probably reflects the high density of schools in the periurban areas concerned, including private schools. No particular gender pattern is discernable (Table 5).

### *Travel Mode to School*

Walking dominates as the mode of transport to school in all three countries, in all types of settlement, and across both genders. In Ghana and Malawi it is almost the exclusive mode of transport to school in all settlement types. In Ghana 98.6% of girls and 97.4% of boys had walked to school the previous school day, and 99.3% of girls and 99.1% of boys in Malawi. Bicycle use to school (either as cyclist or riding pillion) was reported by only one boy and not even one girl in the Malawi sample, and by three boys and just one girl in Ghana. This may seem surprisingly low, especially in view of the fact that when asked whether they knew how to ride a bicycle, so many children said they could (Ghana: 58% girls, 87% boys; Malawi: 44% girls, 72% boys; South Africa: 48% girls, 82% boys). However, many children learn to ride a cycle through borrowing a family member's bicycle or by hiring a cycle for a few minutes at a time (called *kobokobo* in southern Ghana). If the family has a bicycle, it is unlikely to be available to be parked at school all day

**TABLE 3** Estimated Daily Travel Time to School on Most Recent School Day: Malawi

Location	Under 15 min (%)		16–45 min (%)		46 min to 1 h 30 min (%)		1 h 31 min to 2 h 30 min (%)		Over 2 h 30 min (%)	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
RR	8.8	5.4	17.6	19.6	63.2	57.1	10.3	17.9	0	0
RS	67.7	59.8	29	36.6	1.6	1.2	1.6	1.2	0	1.2
PU	42.2	46.8	37.3	39.2	20.6	11.4	0	2.5	0	0
U	25.2	18.1	57.5	66.7	16.5	13.9	0.8	1.4	0	0

**TABLE 4** Estimated Daily Travel Time to School on Most Recent School Day: South Africa

Location	Under 15 min (%)		16–45 min (%)		46 min to 1 h 30 min (%)		1 h 31 min to 2 h 30 min (%)		Over 2 h 30 min (%)	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
RR	7.7	4.6	21.2	29.6	57.7	50.0	13.5	15.8	0	0
RS	60.4	53.3	28.8	33.7	8.8	9.0	2.1	3.1	3.1	1.7
PU	49.0	47.8	34.6	37.3	15.2	13.8	1.1	1.1	0	0
U	37.2	38.1	48.8	51.4	12.8	10.0	0.5	0	0.3	0

**TABLE 5** Estimated Daily Travel Time to School on Most Recent School Day: Ghana

Location	Under 15 min (%)		16–45 min (%)		46 min to 1 h 30 min (%)		1 h 31 min to 2 h 30 min (%)		Over 2 h 30 min (%)	
	Female	Male	Female	Male	Female	Male	Female	Male	Female	Male
RR	9.5	4.8	26.2	45.2	58.3	45.2	6.0	4.8	0	0
RS	62.8	49.1	17.7	27.2	16.8	18.4	2.7	5.3	0	0
PU	72.5	58.8	22.5	32.4	3.9	8.1	1.0	0.7	0	0
U	49.2	54.3	40.6	35.9	9.4	9.8	0.8	0	0	0

while the child is in lessons. Fears regarding the vulnerability of bicycles to theft at school or on the journey to and from school were also expressed.

Motorized transport use was similarly remarkably low: in Ghana three girls and three boys had travelled to school by motor taxi, while in Malawi only one boy and two girls had taken a bus or minibus to school the previous school day. The Ghana data accord closely with earlier findings in Ghana's coastal region (Porter and Blaufuss 2003). In South Africa the travel to school picture is a little more varied, however, and worth examining in detail since survey data can be compared with data from the national travel survey briefly reported above (Table 6).

Although walking dominates among both genders in South Africa (as in Ghana and Malawi), in remote rural areas of South Africa, the availability of motorized transport services for part of the school journey has clearly proved advantageous for some children, both boys and girls. Cycle use is remarkably low, however. There have been sporadic efforts to expand the use of bicycles among school pupils in poorer areas of South Africa under the Shova Kalula program ((Mashiri et al. 2001; Mahapa 2003), but this has clearly had no influence in the study settlements. According to the 2003 South Africa National Household Travel Survey, 76% of "learners" were reported to walk to their educational destination. This figure is still far exceeded in the (overwhelmingly poor) study areas where the present project focused.

### Dangers Faced on the Journey to and from School

In the survey children were asked about problems faced on the journey to and from school. They were first asked to identify the principal danger (if any) they faced as they travelled to school. In South Africa the three principal dangers identified were (in rank order) risk of attack from thieves or thugs (8.4%); rivers and streams to cross (8.2%); and rough terrain travelling to school (5.1%). In Ghana snakes were ranked first by children as the biggest danger (14.3%), followed by rough terrain (5.1%) and dangerous taxis (4.9 %). In Malawi, rough terrain ranked first (5.2%), followed by crossing rivers and streams (4.4%) and harassment or verbal abuse by

drunkards (4.3%). In each country, a significant proportion of children said they did not experience any major dangers on the journey to and from school: 56.3% in Ghana, 57.9% in Malawi, and 46.1% in South Africa. These figures accord with the qualitative data in that they also suggest that children in South Africa report facing greater dangers on their journey to school in comparison with children in Malawi and Ghana, though as shown below, the degree to which children perceive themselves to face overall danger varies between rural and urban environments in all three countries, and to a smaller extent by gender.

The figures above indicate that the children who feel safest as they travel to and from school in South Africa reside in rural locations with services, where girls feel almost as safe as boys. These are the settlements in South Africa where children's travel time to school is shortest. In urban areas slightly more boys than girls feel safe, perhaps related to girls' perceived (and actual) risk of rape in urban locations (see below). In Ghana the children who appear to feel safest as they travel to and from school are those resident in urban and periurban locations. A greater proportion of Ghanaian girls than boys feel safe in urban locations but a greater proportion of boys feel safe than girls in rural locations. In Malawi the urban children reported the least dangers on the way to school, while those in remote rural communities experienced the most hazards; in all Malawi locations, a greater proportion of boys than girls feel safe (Table 7).

The types of danger experienced also vary considerably between locational types and in some cases by gender. The respondents were asked whether they were exposed to particular specific risks: rough terrain, streams that are difficult to cross, risk of attack from people, risk of harassment (verbal abuse), risk of rape, fear of animals, dangerous vehicles, and supernatural risks. As might be anticipated, there is substantially less difference in gender perceptions of danger for some of these risks than for others.

### *Dangers Associated with Topography and Rivers*

Rough terrain, unsurprisingly, is considered a more frequent hazard in remote rural areas than other locations across all three countries, with the highest perception

TABLE 6 Major Modes of Transport to School on Most Recent School Day: South Africa

Location	Walked Only (%)		Bus, Minibus, or Combi (%)		Bicycle (%)	
	Female	Male	Female	Male	Female	Male
RR	84.7	82.8	15.3	15.5	0	0
RS	80.3	88.5	16.6	11.5	0	0
PU	93.2	88.5	1.7	3.8	1.7	0
U	87.4	85.7	7.4	10.2	0	0

**TABLE 7 Percentage of Children Who Experience No Dangers on the Journey to and from School**

Location	South Africa		Ghana		Malawi	
	Female	Male	Female	Male	Female	Male
RR	20.6	24.4	31.2	43.8	41.9	44.9
RS	72.6	75.4	59.5	49.5	57.0	66.0
PU	39.5	38.1	62.0	58.0	52.6	56.1
U	44.3	47.8	70.3	64.2	67.9	69.7

of danger reported in remote rural South Africa (Table 8). In one of the two remote rural South African settlements, in Eastern Cape, children must cross a mountain even to reach primary school. Gender patterns for the high-risk areas relating to rough terrain—remote rural sites—suggest that a slightly greater proportion of boys perceive topography as an issue than girls in all three countries. This may be because for girls other dangers seem much more important and by contrast rough terrain is considered a less significant impediment to travel, or possibly because girls are used to rough terrain as they are exposed to it when undertaking tasks such as firewood collection. It is also likely to be related to the statistics (see above) indicating that in remote rural areas of Malawi and Ghana, a higher proportion of girls than boys attend the closest school. Boys from remote rural areas who are sent to more distant schools rather than the school closest to home are very likely to encounter additional hazards of rough terrain along their longer route. The significant difference between girls' and boys' perceptions of terrain hazards in Malawi rural with services settlements will need further investigation, but may be related to boys' play or work diversions on the way to school.

Stream- or river-crossing dangers present a similar pattern to rough terrain. In South African remote rural sites they present a major danger to many children. In Malawi remote rural sites they are also a considerable problem for some children, but in the Ghana sites, stream crossings mostly present a relatively insignificant issue for children on their way to and from school. However, the difference between girls and boys in Ghanaian rural with service settlements is significant and may reflect some deviation from the most direct route to school by boys associated with play (as suggested also in the case above concerning terrain and Malawi boys in rural areas with services). The otherwise relatively low reportage of dangers associated with rough terrain and rivers in Ghana is not surprising given that the two Ghana project study regions, Cape Coast and Sunyani (and indeed, the country as a whole) have much less rugged topography than Malawi's Shire Highlands or South Africa's Eastern Cape study regions (Table 9).

### *Traffic Hazards*

Traffic on the journey to and from school mentioned by children as a danger included tipper trucks, taxis, mini-

**TABLE 8 Percentage of Children Reporting Rough Terrain as a Danger in Journeys to and from School**

Location	South Africa		Ghana		Malawi	
	Female	Male	Female	Male	Female	Male
RR	22.7	26.4	13.1	16.7	20.9	21.7
RS	6.6	13.0	10.6	15.5	5.1*	18.2
PU	11.7	13.0	13.7	13.2	7.9	11.0
U	3.6	4.2	5.4	3.3	1.4	5.3

\**P* (chi-square) < .05.

**TABLE 9 Percentage of Children Reporting Crossing Rivers or Streams as a Danger in Journeys to and from School**

Location	South Africa		Ghana		Malawi	
	Female	Male	Female	Male	Female	Male
RR	24.8	22.1	0	1.2	18.6	15.9
RS	3.5	6.5	3.5*	10.3	2.6	3.0
PU	1.5	1.9	1.0	0	1.8	6.1
U	0.5	1.9	0.8	2.2	0.7	1.3

\**P* (chi-square) < .05.



**TABLE 10** Percentage of Children Reporting Dangerous Vehicles as a Hazard on Journeys to and from School

Location	South Africa		Ghana		Malawi	
	Female	Male	Female	Male	Female	Male
RR	6.2	2.4	13.1*	2.4	0	0
RS	5.4	4.7	3.5	1.7	0	0
PU	20.9	21.6	16.7	22.8	20.2	13.4
U	20.9	23.6	22.5	32.6	11.3	18.4

\* $P$  (chi-square) < .05.

buses and combis, even bicycles (the latter especially in Malawi). Children refer to traffic dangers more frequently in urban and periurban areas than in rural areas across all three countries, as might be expected, given associated traffic density patterns (Table 10). In South Africa and Ghana, even children living in remote rural areas are likely to encounter traffic dangers on the journey to school because their schools are located in centers where some vehicular traffic exists. Malawian rural children do not record motorized traffic as a danger, even in the two rural centers with services, because these centers are located off-road in a country where poverty is such that rural vehicular traffic is limited. Malawian figures for urban areas are also relatively low compared to Ghana and South Africa. So far as gender patterns are concerned, girls are significantly more aware of traffic dangers than boys in rural areas in Ghana, which accords with the fact that boys tend to have more traffic-related accidents than girls (see Porter and Blaufuss 2003 on Ghana). In urban areas, however, across all three countries, the data suggest that boys are slightly (South Africa) or considerably (Ghana and Malawi) more aware of traffic danger than girls. However, this does not appear to have translated into reduced traffic accident statistics for boys.

### *Animal Hazards*

The child researchers first alerted the authors to the significance of animals and reptiles (e.g., biting dogs and snakes) as a serious potential hazard for some children, and consequently questions about animals were incorporated in the survey questionnaire. In the survey children included dogs, snakes, cattle, wild pigs, worms, lions,

rats, and donkeys among the animal dangers they might encounter on the journey to and from school. While no child is likely in reality to meet a lion, the imagined prospect of such a meeting can be a very significant issue (Porter et al. in press). The data below show that animal-related dangers were reported in remote rural areas in Ghana and South Africa; in Ghana, in particular, snakes were a major concern. Snakes were reported to be a particular problem for children passing through less habited areas, notably fields or uncleared bush areas on the way to school. The lower percentages for remote rural Malawi are more difficult to explain. There is no clear gender pattern in the data (Table 11).

### *Attacks from People, Including Rape, Other Forms of Attack, and Verbal Harassment*

Hazards presented by people were recorded by many children on their journey to school. Among these "people," children sometimes specified bandits, older boys, murderers, kidnappers, thieves, fighting with friends, men who chase, thugs, unruly pupils, and children who throw stones.

The highest proportion of children observing general danger of attack from people was in rural areas. In urban areas perceived risk of attack is highest in South Africa and lowest in Ghana. In Ghana and Malawi relatively few children, particularly in urban and periurban areas, perceived danger from people. However, gender patterns show a significant difference in perception of dangers in Ghana periurban areas, where boys are more concerned than girls, and in Malawi rural with service settlements, where girls are more concerned than boys (Table 12).

**TABLE 11** Percentage of Children Reporting Dangerous Animals as a Hazard on Journeys to and from School

Location	South Africa		Ghana		Malawi	
	Female	Male	Female	Male	Female	Male
RR	36.8	40.9	53.6	56.0	15.1	17.4
RS	22.7	26.3	27.7	37.9	22.8	22.0
PU	15.4	13.8	5.9	11.8	13.3	8.5
U	3.3	4.7	6.2	7.6	0.7	1.3

**TABLE 12 Percentage of Children Reporting Risk of Attack from People on Journeys to and from School**

Location	South Africa		Ghana		Malawi	
	Female	Male	Female	Male	Female	Male
RR	22.3	21.2	25.0	17.9	17.4	21.7
RS	13.2	11.9	13.3	20.7	19.0*	7.0
PU	10.3	14.1	2.0*	8.8	7.0	6.1
U	11.6	13.0	2.3	5.4	6.4	6.6

\**P* (chi-square) < .05.

However, the data are perhaps more usefully examined below in terms of specific dangers from rape. Figures for Ghana in the generalized category of risk from attack by people were substantially higher than for rape or for verbal harassment (below): children in Ghana often appear to have included risks like fights with friends and bullying from older boys in this general category.

The specific danger of rape on the journey to school was indicated by a much higher proportion of South African children (12.9% of the total sample) than either Ghanaians (0.4%) or Malawians (0.2%). However, the sentiments expressed by a fathers' group in Kanyola, Malawi, were common in qualitative interviews across the southern Africa sites: "We fear girls will be cheated on or get raped on way to school." The figures for Ghana are particularly low and are supported by qualitative evidence, which suggests parental perceptions of children's travel dangers are associated more with getting lost than with "stranger danger" (see Porter and Blaufuss 2003). In southern Africa, rape presents a particularly great danger given the high incidence of HIV and AIDS in the region. In South Africa, boys are possibly more exposed

to dangers of rape than elsewhere in Africa, due to long-standing cultural patterns of male co-residence in male mine-labor communities. Nonetheless, significant gender differences regarding perceived danger of rape are found in South African remote rural, periurban, and urban sites (and in Malawi urban sites) (Table 13).

Risk of harassment and verbal abuse on the journey to school were reported to come from diverse people in various contexts: drunkards, strangers, cannabis users, and minibus conductors were all singled out as potential sources of verbal abuse. Such harassment is reported particularly widely as a hazard by boys and girls in Malawi. Like fear of rape, it is rarely reported in Ghana, and particularly rarely by Ghanaian boys. In both Malawi and South Africa, a higher proportion of girls in urban and periurban areas report harassment or verbal abuse than boys: in Malawi's periurban areas this gender pattern is statistically significant (Table 14).

Despite all the dangers and difficulties the children reported, remarkably few children, girls or boys, are accompanied by adults on the journey to school, whatever their age. Most children travel to and from school in

**TABLE 13 Percentage of Children Reporting Rape as a Danger Experienced on Journeys to and from School**

Location	South Africa		Ghana		Malawi	
	Female	Male	Female	Male	Female	Male
RR	10.3*	1.4	0	0	2.3	0
RS	1.2	0	0.9	0	1.3	0
PU	8.1*	1.1	0	0	2.6	0
U	7.2*	0.5	0.8	1.1	6.4*	0

\**P* (chi-square) < .05.

**TABLE 14 Percentage of Children Reporting Harassment or Verbal Abuse as a Danger or Difficulty on Journeys to and from School**

Location	South Africa		Ghana		Malawi	
	Female	Male	Female	Male	Female	Male
RR	7.0	6.8	2.4	1.2	12.8	15.9
RS	6.2	6.8	1.8	0.9	13.9	18.0
PU	13.6	4.5	2.0	0	22.8*	11.0
U	11.6	4.2	3.1	0	17.1	9.2

\**P* (chi-square) < .05.

**TABLE 15 Percentage of Children Accompanied by a Parent or Other Adult on the Journey to School**

Location	South Africa		Ghana		Malawi	
	Female	Male	Female	Male	Female	Male
RR	0	0	0	0	0	0
RS	1.6	0.4	3.5	0.9	0	0
PU	1.1	0.7	0	0.7	1.8	1.2
U	1.4	1.4	0.8	1.1	0.7	1.3

groups with their siblings and friends—their parents are at work, on the farm, or otherwise occupied (Table 15).

### CONCLUSION: SIGNIFICANCE OF FINDINGS FOR THEORY AND PUBLIC POLICY

Analysis of the empirical data presented in this paper provides a comparative cross-country and locational perspective on boys' and girls' travel to and from school hitherto unavailable. The three countries present rather different contexts, which are reflected in the findings. Some of the selected study areas of Malawi (Blantyre region's Shire Highlands) and South Africa (Eastern Cape region) exhibit considerably more rugged topography than the sites in Ghana, for instance, which are all relatively flat: consequently the journey to school for children in remote rural areas in South Africa and Malawi tends to be more hazardous than for children in Ghana in terms of terrain and flooded rivers. This confirms the rather predictable conclusion that topography presents variable challenges for children on their school journeys, but it is important to take account of the varied terrain of African landscapes in making public policy. With reference to diverse levels of economic development, only South Africa has the resources to provide some degree of motorized transport provision in rural areas, including dedicated school buses. Malawi and South Africa are both experiencing a high prevalence of HIV and AIDS, which not surprisingly translates into concern about exposure to attack from people and, in particular, fear of rape.

Some basic characteristics of the journey to and from school are remarkably similar across the three countries. Walking is the dominant mode of travel throughout all regions and in the remote rural areas of all three countries children walk particularly long distances to and from school each day. The authors have accompanied children on their journeys from school and can attest not only to the very real physical difficulties and dangers they face but also to the less concrete fears they express on these journeys (Porter et al. in press). Passing by a lonely graveyard or sacred grove where witches, lions, and robbers are reputed to lie in wait is a fearsome task if the child is delayed and has to walk home alone. As one pupil in her early teens observed, as she accompanied the

authors on her long walk home from school in a remote area of the Shire Highlands region in Malawi during one of the pilot studies, "There are so many problems [here]. You meet a very long person and I suspect it's a witch, and there are dogs that chase us and fierce animals—lions and hyenas—and they bite us. Three children were once bitten—one by a lion and she died, and two boys were bitten by hyenas, but they are still alive."

Children in rural centers with services appear to be best served in terms of short length of school journey, but this may also reflect a lack of available alternative schools in the vicinity. In urban and periurban areas, although the number of schools is much higher and journeys to school might be expected to be short, more parents choose to send their children further than the closest school appropriate to their level, or are required to do so by school allocation systems. Such urban journeys may impose additional stresses, especially on girls in South Africa and Malawi, who report high levels of harassment and, to a lesser extent, fear of rape. Again, the findings are supported by qualitative research with children and their parents and teachers, including the child research collaborators' own findings. Cecilia observes: "We have to walk in groups because there are boys who are not schooling who take our money and mobile phones" (Cecilia, 18 years, Umtata, South Africa). For Susan, a 17-year-old secondary school pupil in Winterveld in North West province, South Africa, the dangers are even greater. She walks daily about 5 km across an uninhabited bushland area to school: "I fear people who hide in the bush [waiting] for us. They wait for us in the bush and as we walk, especially when you are alone, they grab your school bag and all the belongings that you have with you . . . . The bush is bad, you cannot see people hiding or seeking you . . . . It is even worse to cross the bush at night. There are so many rapists there at night and a lot of drunk people." The authors accompanied Susan on one of her journeys; the next day a girl from the same school was raped along this route. Some boys also fear attack, as the data have illustrated, but for girls the perceived risk appears considerably higher, with likely impacts on broader patterns of mobility.

Several possibilities exist to improve safe school access, especially for girls. These include

1. Expansion of girls' boarding house provision and general boarding provision, especially at primary schools. Boarding is more often available at secondary schools, but provision is inadequate (especially in Malawi). Boarding is also needed at the primary level, particularly for girls who live in remote rural areas. The threat of rape is such that parents delay sending their daughters to school and curtail their attendance. Boarding may reduce children's domestic work burdens during the school week, and the more likely availability of electricity (commonly absent in remote rural settlements) would enable them to complete their homework. The loss of child contributions to domestic production and reproduction would inevitably affect families, particularly in rural areas. A holistic approach will be needed that incorporates not only expansion of girls' school boarding provision, but also pays attention to labor-saving interventions, especially improved water provision, which will reduce domestic work demands in home villages.

2. The walking bus is used in Western contexts to help children to walk safely to school in regions where traffic levels are high and child obesity is a problem (e.g., Kingham and Ussher 2007). However, the walking bus may also offer a route to reducing the dangers of rape and harassment. This suggestion was received with interest in the periurban site at Winterveld, after an author-accompanied school walk with Susan (described above) and other children emphasized the very real fear of rape among children schooling in that community. Funding is now in place to support a walking bus pilot in collaboration with a local NGO.

3. Cycle hire centers based at schools might help to overcome the shortage of cycles available to girls, in particular, for traveling between home and school. This could be particularly effective if accompanied with security measures for guarding cycles at schools and training the girls in cycle riding, maintenance, and repairs. Though many girls say they know how to cycle, being able to cycle over a long distance on poor roads requires associated knowledge in maintenance and repair.

4. Various nontransport interventions aimed at reducing girls' time poverty, including improved availability of water supplies, community woodlots, and grinding mills. These interventions would reduce girls' time poverty by freeing them from some of the tiring and time-consuming duties that interfere with their ability to attend school.

5. Sensitization of teachers and education authorities to transport- and distance-related lateness. Many teachers impose extremely harsh punishment on children who arrive late for school, such as corporal punishment, cleaning the lavatories, sweeping the yard, grass-cutting, or carrying sand for school building. In some cases children reported being sent directly home by teachers because they had arrived at school late, requiring them to retrace their long walk to school, possibly alone: this is the type

of punishment that encourages truancy. Teachers whose pupils collaborated in this research admitted that they had not adequately appreciated the problems that children face in getting to school on time, and there was a common response that they would be more sympathetic to lateness among pupils living at a distance from school in future.

Above all, however, a stronger focus on gendered transport, mobility, and access issues in the development policy and practitioner community is essential. The failure to recognize the specific importance of mobility and transport and the ramifications of immobility in the MDGs is clear testament to this omission. In the context of the MDGs regarding universal primary education (MDG 2) and the promotion of gender equality and women's empowerment through the elimination of gender disparity in all levels of education (MDG 3), a firmer and more specific recognition of the roles which distance, perceived and real travel hazards, transport availability, and other mobility factors play in allowing or barring access to school is urgently required.

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# Privacy and Gender

## Reviewing Women's Attitudes Toward Privacy in the Context of Intelligent Transportation Systems and Location-Based Services

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Limited previous research has shown that women value online privacy more than men, potentially influencing their online behavior or willingness to reveal personal data online. New generations of intelligent transportation systems (ITS) and location-based services (LBS) technologies depend on the input of personalized and localized information to give, potentially, information that may uniquely address women's complex travel patterns, but which may raise locational privacy concerns for women and cause them to hesitate to share the needed information. This paper examines gender differences in the propensity to reveal the potentially sensitive information necessary to make ITS and LBS highly personalized to individual travelers. The authors develop privacy indicators based on refusals to answer sociodemographic and location questions in a household travel survey to evaluate whether women have a significantly different attitude toward willingness to share data related to position and personal identifiers compared with men. The results show that gender differences regarding privacy preferences are not statistically significant. However, this result is inconclusive because the survey overall achieved low response rates and participating households may already be self-selected into being open about divulging sensitive travel and locational information.

panies collect data on usage patterns to determine risk and maximize profits. Electronic toll collection systems use personal data to enhance the ease of travel by allowing vehicles to move seamlessly through toll collection points, paying the fare from an electronically debited account. While arguments can be made for the benefits that accrue from each of these data collection systems (personalization, convenience, and efficiency), the amount of data being shared may have overwhelming ramifications for the privacy of the population. While awareness of some data collection technologies is reasonably high, the level of understanding of the potential implications of use and sharing of data may be substantially lower, leading some to share data that they might prefer to keep private if all implications were known, and some to refrain from sharing any data.

With an increasing turn toward intelligent transportation systems (ITS) and location-based services (LBS) and their reliance on user data for effectiveness, questions of privacy grow increasingly relevant. If users are reluctant to lessen their privacy by allowing collection of their personal data for such uses as electronic toll collection, route navigation systems, or vehicle-to-vehicle safety applications, it is possible that they will elect not to participate in the system, which may hamper the overall effectiveness of "crowdsourcing" as a method of collecting real-time traffic information. Over time, such technologies will have the potential to provide information that addresses women's complex and unique travel patterns (such as real-time itinerary planning or dynamic ridesharing with members of a woman's social network); however, such technologies will depend on the input of information

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**P**ersonal data are increasingly accessed and used in today's technologies. Websites deposit cookies on user's computers, and the resulting data are used to enhance the user's experience. Credit card compa-

that is even more personalized and localized, potentially making individuals hesitant to share such information and raising greater locational privacy concerns.

One subset of the general question of the relationship between privacy and willingness to share data in ITS and LBS technologies is that of gender influences. Prior research in online behavior has indicated that women tend to have stronger privacy preferences than men, and this may influence their online behavior or willingness to reveal personal data online (Sheehan 1999; Garbarino and Strahilevitz 2004). The similarities between methods of data collection and types of data collected online and in the context of ITS and LBS are strong enough that it is possible that such preferences will also translate to the realms of transportation; however, differences in the complexities of women's travel behaviors compared to those of men will necessitate ensuring that appropriate (and detailed, personalized, and localized) data are collected in order to accurately reflect the travel needs and desires of the female traveler. Little research is available that examines the gendered relationship between locational privacy preferences, willingness to share data, and potential impacts on adoption and use of ITS and LBS. Such a study is difficult, in part because the persons whose privacy preferences are highest are unlikely to participate in surveys that would provide an indication of their trade-off preferences between data provision and benefit accrual. As a result, this study is limited to analysis of the responses of those persons who have already consented to survey participation—in this case, the Household Travel Tracker Survey of the Chicago Metropolitan Agency for Planning (CMAP). Unwillingness to participate in surveys is an early indication of weaker privacy concerns (Singer et al. 1993; Couper et al. 1998; DeMaio 1980). Proxy measures of privacy based on refusals to answer potentially invasive sociodemographic and locational information were developed that were asked in the CMAP survey, partly motivated by prior research that suggests that item nonresponse in surveys may also be linked to privacy concerns (Mayer 2002; Zmud and Arce 2000; Riphahan and Serfling 2005; Dixon 2005). This paper explores whether there may be cause for concern related to the potential for not gathering accurate or useful data on women's travel behavior due to gender-influenced privacy preferences and then evaluates the context of privacy–utility trade-offs within ITS and LBS to determine why differences may not be found.

## BACKGROUND

The issue of privacy has gained increasing interest as more and more of our lives are recorded, placed online, or take place in the public or semi-public sphere. The ubiquity of such technologies as surveillance cameras,

online cookies, and data (“reality”) mining software has significantly impacted the expectations there may be for privacy, and current research indicates that the issue may be of particular concern for women. Women consistently indicate a higher level of concern for privacy than men (Kate 1998; O'Neil 2001), which may be a result of such concerns as safety and security, discomfort with loss of control over personal information, and uncertainties regarding use of data, and may impact willingness to share personal data.

Privacy is of particular interest for ITS and LBS, for which user-generated or crowdsourced information will play an increasingly important role in generating collaborative travel opportunities, traffic management, and multimodal transportation use. Many emerging ITS and LBS technologies depend upon the ability to collect and share large amounts of data from locational sensors in handheld devices such as cell phone, personal digital assistants, and vehicles with a variety of infrastructure-based sensors. While many technologies will be embedded in vehicles or the roadway, thus requiring no conscious participation choices from the traveler, other forms of ITS and LBS will require the traveler to consciously opt in to services, which will require ensuring that potential users are aware of and comfortable with the associated consequences of the sharing and use of this data. The novelty of many proposed ITS and LBS technologies has made willingness to adopt a concern for developers, particularly for those applications that will require fairly extensive deployment for maximum effectiveness (e.g., the greater the number of cell phones or mobile devices generating information on congestion or safety concerns, the better the quality of information). Given the amount of data needed for many applications, one critical aspect of this willingness to adopt will likely be the willingness to share, or privacy preference, of travelers, a factor that may have gendered attributes.

If it is true that women will more carefully guard their private information, the combined concerns of willingness to share information and potential willingness to adopt and use ITS technologies may create an imbalance between the amount of information available on travel patterns and habits of men and women. This may, in turn, affect planning and implementation of applications that have the potential to address women's travel needs, such as personalized route planning and trip itinerary development for trip chains; dynamic ridesharing with friends; real-time walking-group formation from transit stations and stops to overcome personal security concerns; integrated weather, construction, and travel information; and other applications that would allow specific travel preferences of women to be addressed by information technology.

The paper first reviews the general findings in the literature related to the influence of gender on privacy

and technology use. Next, an analysis of the willingness of persons to share identification and position information in the CMAP household travel survey is undertaken in order to determine if there are gender influences in willingness to share the types of information that may affect the level and usefulness of ITS and LBS. While the empirical evidence explored in this paper indicates that little, if any, difference exists, questions are raised that should be explored future, including those related to basic privacy–utility trade-offs. Finally, gendered recommendations pertaining to potential privacy protections for ITS and LBS are discussed.

## RESEARCH OBJECTIVES

The aim of this research is to study gender in the context of willingness to share information supporting personalization and localization of information available from ITS and LBS. Pertinent research related to privacy preferences and willingness to adopt is first reviewed. The authors then empirically evaluate the revealed privacy preferences of women in relation to a CMAP travel survey by using question response refusals (those cases in which respondents refuse to answer questions in contrast to choosing “don’t know” as a response) as a proxy indicator. The validity of using question refusals in this study of privacy stems from previous survey research that has linked refusals to question sensitivity, in contrast to “don’t know,” which has been found to more closely reflect cognitive difficulties in answering the questions. For example, Shoemaker et al. (2002) note that questions regarding income generally produce refusal rates of 20% or higher, presumably due to question sensitivity, and observe that refusals in this context may be used to avoid embarrassment, reduce the risk of giving responses that violate social norms, or to protect privacy. The authors argue that a “don’t know” response may be linked more to a lack of motivation to interpret the question and determine the answer than to a lack of opinion or knowledge. Under this interpretation, the use of question refusals may be regarded as a valid proxy for general privacy preferences.

Question refusals are separated into demographic questions (associated with personal identification) and questions related to travel behavior (associated with revealing position or location information). Statistical models of propensity to refuse to answer will allow the determination of the role, if any, that privacy preferences may potentially play in women’s willingness to share the types of personalized and localized information that may be necessary to develop travel assistance from information systems. The study is intended to identify general trends in women’s willingness to share data in the transportation context in order to determine if this is an area that requires additional study.

## GENDER INFLUENCES ON WILLINGNESS TO ADOPT AND USE

Fairly limited research has been conducted on women’s willingness to adopt new transportation technologies in relationship to their privacy concerns. Friedman et al. (2006) reported that in a systematic search of journal articles and conference papers released from 2000 to 2004 related to human–computer interaction, 32 papers recorded empirical findings on privacy, but none included an analysis of gender impacts and effects. This gap in the literature, combined with the complexity and number of trips reported by women (Hu and Reuscher 2004), indicates that this is an area that requires additional study. For example, McGuckin and Murakami (1999) found that women tend to take more responsibility for trips related to household sustainability (such as shopping, errands, and children-oriented trips) and are more likely than men to chain these trips with work trips. The potential for personalized ITS and LBS information would be particularly beneficial for women in this context; however, it will first be necessary for women to adopt these technologies and be willing to share the data that will make them effective.

Consumer adoption of technology has been noted to occur in five stages—innovators, early adopters, early majority, late majority and laggards—which are generally differentiated on the basis of innovativeness, or “the degree to which an individual or other unit of adoption is relatively earlier in adopting new ideas than other members of a social system” (Rogers 1995). Influencing factors on this innovativeness may also include demographic characteristics (including age and education) and prior experience with technology (Munnukka 2007). While males have traditionally dominated the categories of innovators and early adopters (Caruso and Salaway 2007), there is evidence that women are becoming more willing to participate earlier in technological innovations. For example, in a study of online social networking sites, a majority of users of such sites as Facebook (63%), MySpace (63%), and Friendster (58%) were found to be female (Rapleaf 2008). According to the *Business Week* analysis of the study, males tend to gravitate toward more transactional-based sites such as those targeted toward news, sports, and financial information, while women’s online behavior is more geared toward relationship-driven sites (Hoffman 2008). The nature of shared information on these sites is interesting given findings in an earlier study of Internet users that indicated that males believe “censorship” to be the greatest threat to the Internet, while females cited their greatest concern as “privacy” (Herring 2001). Internet privacy has been noted to be more of concern to women than men by Westin (1998), Ackerman et al. (1999), Kate (1998), and O’Neil (2001). These characteristics of



behavior online may have implications for understanding how women, compared to men, will respond to new technologies in the mobile environment.

Privacy concerns become even more critical in the public and mobile environment—called locational privacy—in which considerations of direct personal safety and security may arise. For example, Marchau et al. (2008), evaluating the potential for users to adopt a personal intelligent travel assistant (PITA), state that “Another certain vulnerability would be that travelers resist the willingness to buy PITA because it affects their privacy—i.e., it seems like ‘Big Brother’ watching their travel behavior.” In “The Watcher and the Watched,” Friedman et al. (2006) examined whether gender influences people’s judgments about privacy in public. After an extensive literature review, the authors found that men and women view privacy similarly on some dimensions, but that on others women tend to be more concerned with privacy. In order to test these findings, the authors conducted an empirical study that asked males and females to respond to a series of questions regarding feelings of intrusiveness from being videotaped in a public place with the images shown in a variety of settings and to a variety of people, and whether their feelings changed based on whether they were the watcher or the watched. The authors found that women were more likely to express concerns about the display of images sent from a camera in a public place, and that these concerns did not change on the basis of the condition of watcher or watched. Friedman et al. (2006) concluded that “compared to men, women feel more vulnerable, especially in terms of physical safety and psychological well-being.” While the study was limited to physical surveillance via cameras, some of these findings may be translated to general reactions in locational privacy.

### PRIVACY CONCERNS IN THE MOBILE ENVIRONMENT

Because it is concerned primarily with privacy in the public sphere, and due to the variety of commercial and governmental interests in tracking travel patterns and habits, issues of control and context are particularly relevant to the understanding of privacy in the mobile environment. From a general standpoint, traditional concepts of privacy occur at a static point of reference, while locational privacy exists in the context of a rapidly changing route in the transportation network. Elements of change over time and space heighten the degree of awareness and information needed by the individual to make informed decisions regarding the collection and use of her data and increase the potential that aspects of control may be lost. For example, when an individual uses the Internet she is bound by the privacy policy of the associated Internet

service provider (ISP). If the individual wishes to switch ISPs, she is able to review and accept or decline that ISP’s policy. In a dynamic environment, the rapidity of change related to context and authority may make such considerations impossible in terms of efficiency. For example, if when using a cellular phone one enters a roaming environment, this indicates that the cellular provider does not have coverage at that location but has entered into a contract with another provider in order to ensure service coverage. In this case, the consumer is subject to the policies and terms of the secondary cellular provider, and may not be aware of potential changes in the guiding privacy policy. This situation demonstrates the importance of where and when decision making takes place. Additionally, collected data that include both spatial and temporal identifiers may increase the likelihood that personally identifying information may be gleaned, as it is possible to determine not only where a traveler has been, but also at what times, thus introducing the potential to identify activities that may have taken place.

The ability of data from the mobile environment to be used as both spatial and temporal identifiers may also heighten the privacy concerns specific to women. As noted by Friedman et al. (2006), a sense of vulnerability may be more evident in women than men, and the potential for ITS and LBS to pinpoint both location and identification information for individual travelers may be regarded as a benefit or a detriment. The beneficial aspects of Global Positioning System (GPS) tracking have been revealed in several recent cases in which GPS-enabled cell phones were used to track and recover missing or abducted persons (Barnes and Williamson 2009; Bolduan 2008). Additionally, such services as GM’s OnStar, a subscription-based service offering emergency communications, in-vehicle security, and turn-by-turn navigation, have been increasingly targeted toward women. “‘We’ve tailored the media so it impacts more of the women’s market,’ (Young 2003). ‘We’re not trying to walk away from the men. Men look at it as a way to protect their wife and family. Women look at it as something that could protect them’” (Fahey 2003). While the feeling of security engendered by these services is critical for their increased deployment, issues of privacy and insecurity are also increasing in visibility.

In addition to the traditional concerns relating to secondary uses of data, issues of unauthorized marketing, surreptitious monitoring, and malicious use by unauthorized agents have also been raised. One particular concern for women is that, without well-integrated security measures, it may be possible for GPS stalking to occur, as happened in December 2002 when a Wisconsin man was arrested and charged with stalking a former girlfriend after placing a locating device under the hood of her car (Mayer 2003). While this case involved an outside actor placing a device on a person’s vehicle, the potential

for vehicle- or device-based ITS and LBS to be used for malicious purposes, particularly if personally identifying information is not adequately protected, is great.

The level of trust that an individual has about an information-sharing situation is also an important consideration. A trusted entity is one with which an individual may feel a greater degree of comfort in revealing otherwise private information. There are two aspects to the concept of trust in the current context. First, trust can be built or enhanced with different strategies; for example, Title 13, U.S. Code Protection of Confidential Information of the U.S. Bureau of Census, guarantees the confidentiality of census information and establishes penalties for disclosing this information. In the case of Internet transactions, secure sockets layer (SSL) technology enables encryption of sensitive information during online transactions and communications to the customer and guarantees the vendor's need to comply with her privacy and security requirements. Second, as noted by Sheehan and Hoy (2000), a person's familiarity with the information-seeking entity (Gronroos 1994; Pitkow and Kehoe 1996; Rogers 1996; Wang and Petrisson 1993) can affect the degree of privacy concern. It may be the case that public agencies carry a degree of familiarity and awareness of lack of trust violations in the minds of individuals when they are faced with situations in which personal or locational information are to be revealed. Therefore, the organization that manages and operates the ITS or LBS technology may have a bearing on the level of trust that an individual has about the technology.

## OVERALL RESEARCH DESIGN

Constructing an empirical model for determining privacy preferences of women is difficult due to data and response limitations; however, defining a basis from which to conduct future research will depend on establishing a baseline for evaluating women's privacy preferences by using existing data. This study uses an existing household travel survey (the 2007 CMAP Travel Tracker Survey) to study the relative willingness of women to respond to demographic and travel-related questions when compared to men. Item nonresponse is used as a proxy for privacy preferences in the absence of specific questions related to privacy. Question nonresponse is modeled against the gender of the respondent and other demographic variables to determine if significant relationships exist between gender and willingness to provide data. Results of the model are used to draw general conclusions regarding the relative privacy preferences of women, and suggestions are made for future studies on how these preferences may impact privacy-utility trade-offs and the related willingness to adopt ITS and LBS technologies.

## EMPIRICAL MODEL USING CMAP TRAVEL TRACKER DATA

According to information from the analysis presented above, two primary considerations in determining the willingness of persons to participate in ITS and LBS applications relate to information concerning position and identifiers. Identifying information can include names, vehicle license plates, demographic information, and other data that allow one to be personally identified. Position information is the spatiotemporal information that allows a person's whereabouts to be known at a given location at a given time.

The following analysis of CMAP Travel Tracker Survey data is intended to provide an exploratory analysis of the willingness of women to share such information. While perhaps the most obvious method of determining willingness to share would be to conduct an analysis of the sociodemographics of households that refused to participate in the survey, available data do not lend themselves to such interpretation. Therefore, item nonresponse is used as a proxy for determining the general trend of women's privacy preferences regarding the sharing of data. A number of researchers (Zmud and Arce 2000; Riphahan and Serfling 2005; Dixon 2005; Shoemaker et al. 2002; Biemer and Lyberg 2003) have indicated that item nonresponse is related, in part, to privacy concerns.

Two types of factors may be analyzed in order to study privacy preferences: those relating to personal identification and sociodemographics and those relating to the individual's use of transportation and location information. While many empirical situations give the opportunity to examine refusals and sensitivity or privacy regarding personal identification and sociodemographics, a household travel survey provides a unique opportunity to analyze the types of privacy concerns that may arise in the context of ITS or LBS.

A total of 14,315 households consisting of 23,808 persons in the greater Chicago metropolitan area (consisting of Cook, DuPage, Grundy, Kane, Kendall, Lake, McHenry, and Will counties in Illinois, and Lake, Porter, and LaPorte counties in Indiana) took part in the Travel Tracker Survey (NuStats 2008). A subsample of the respondents were queried as to whether they would be willing to participate in further survey activities, including using vehicle-based or portable GPS devices. The purpose of the dual computer-assisted telephone interviews (CATIs) on trip making and GPS recording of trips is to reduce trips that are unreported, which is a problem with recall in survey-based efforts. In an earlier paper, the authors modeled the propensities of households to refuse to participate in the GPS portion of the survey (Cottrill and Thakuria 2008). Refusal to use the GPS devices potentially represents individuals and

households who perceive ubiquitous locational tracking to be problematic, and thus is partly indicative of locational privacy preferences and concerns about security, although the refusal to use the GPS may also be indicative of difficulties with technology in general, concerns about potential damage to the vehicle, distractions, and so on. The results indicated that while households that made a greater number of trips and with more working members were more likely to agree to participate in the GPS survey, English-speaking, higher-income households with children less than 16 years of age tended to have a weaker propensity to take part in the GPS survey.

Of the participants, 12,625 (or roughly 53%) were female. According to the NuStats (2008) documentation from the survey, the following list comprises question nonresponses and the magnitude of those nonresponses:

- Recruitment instrument:
  - Number of persons depending on you for transportation (0.7%),
  - Number of bicycles (0.6%),
  - Residence type (0.3%),
  - Home ownership status (1.3%),
  - Tenure at current residence (0.1%),
  - Number of cell phone lines (1.3%),
  - Number of landlines (0.7%),
  - Household income (10.4%),
  - Vehicle year (2.1%),
  - Vehicle make (0.5%),
  - Vehicle body type (1.1%),
  - Where vehicle is parked at home (3.7%),
  - Gender (<0.01%),
  - Age (1.8%),
  - Hispanic origin (0.7%),
  - Race (1.6%),
  - Disability status (0.8%),
  - Licensed driver status (0.2%),
  - Employment status (0.1%),
  - Volunteer status (0.1%),
  - Work status if not employed (0.7%),
  - Typical mode to work (0.3%),
  - Type of work schedule (1.2%), and
  - Educational attainment (0.7%).
- Retrieval instrument:
  - Parking details (if auto trip) (10.7%),
  - Whether the trip was made on expressway or tollway (if auto trip) (18.8%), and
  - Car available (if transit trip) (<0.01%).

These item nonresponses were coded to allow for analysis of patterns related to women's willingness to reveal identification and position identifiers.

The following identification and sociodemographic variables and position variables relating to individuals

in the CMAP Travel Tracker CATI Survey were used to construct the six composite variables shown in Table 1:

- Identification and sociodemographic (ID) variables:
  - Residence type,
  - Home ownership status,
  - Tenure at current residence,
  - Household income,
  - Gender,
  - Age,
  - Hispanic origin,
  - Race,
  - Disability status,
  - Licensed driver status,
  - Employment status,
  - Volunteer status,
  - Work status if not employed,
  - Typical mode to work, and
  - Educational attainment.
- Position and travel behavior (TB) variables:
  - Parking details (if auto trip),
  - Whether the trip was made on expressway or tollway (if auto trip), and
  - Where vehicle is parked at home.

The composite variables are either indicator or count variables. The objective of these composite variables is to identify respondents who refused to answer at least one question in the CATI survey or otherwise generated an item nonresponse by not answering a question.

Table 1 also provides gender-based statistics on the six composite variables. The first and second columns of the data set give the composite variable names and descriptions. The third column gives the percentage of all respondents with the attribute for the three composite dummy variables (D\_IDRefs, D\_TBRefs, and D\_AllRefs) and the mean value of the three composite count variables (C\_IDRefs, C\_TBRefs, and C\_AllRefs) for respondents with a positive number of refusals.

Overall, only a small percentage of respondents had refusals of any kind. For example, only 3.83% of all respondents had at least one identification or sociodemographic information variable refusal, 13.9% had at least one position and travel behavior variable refusal, and 16.31% of all respondents had at least one refusal of either type. The percentage of females with at least one refusal in each category is only slightly higher than the percentage of males, and a *t*-test of significance indicated that the male–female differences in refusal percentages for each composite variable was not significant at any reasonable level of significance. Further, the statistics on the count variables also indicate virtually no difference in the mean number of refusals between males and females for all three types of composite indicators. The objective then becomes to examine if these lack of differences

TABLE 1 Composite Variables and Explanation and Summary Statistics

Composite Variable	Description	Respondents (%)		
		All	Male	Female
		D_IDRefs = 1		
D_IDRefs <sup>a</sup>	Dummy (D_IDRefs = 1) indicating at least 1 ID refusal	3.83	3.65	3.98
		D_TBRefs = 1		
D_TBRefs <sup>b</sup>	Dummy (D_TBRefs = 1) indicating at least 1 TB refusal	13.90	13.92	13.96
		D_AllRefs = 1		
D_AllRefs <sup>c</sup>	Dummy (D_AllRefs = 1) indicating at least 1 ID or TB refusal	16.31	16.00	16.58
		Mean of C_IDRefs for (C_IDRefs > 0)		
C_IDRefs	Count of ID refusals	1.20	1.20	1.22
		Mean of C_TBRefs for (C_TBRefs > 0)		
C_TBRefs	Count of TB refusals	0.27	0.28	0.27
		Mean of C_AllRefs for (C_AllRefs > 0)		
C_AllRefs	Count of all (ID plus TB) refusals	1.47	1.47	1.48

<sup>a</sup> IDRefs refer to those question refusals associated with identification or sociodemographic information.

<sup>b</sup> TBRefs refer to those question refusals associated with position or travel behavior.

<sup>c</sup> AllRefs is the total of IDRefs plus TBRefs.

between males and females persist after controlling for factors other than gender that might potentially affect the composite variables giving refusal propensity.

## MODEL RESULTS

In order to analyze differences in propensity to give information, three logit regressions (for D\_IDRefs, D\_TBRefs, and D\_AllRefs) are estimated. The control variables and results obtained from each of the three models are shown in Table 2. The public use data set from the CMAP Travel Tracker Survey was joined to data sets containing a number of environmental factors based on the Census tract of the home location of the persons surveyed. Environmental factors developed for the Chicago area spatial decision support system (SDSS) (Thakuria et al. 2003) were used to hold elements that might impact feelings of security versus privacy (such as crime levels and traffic crashes) constant and to reflect the urban ecological context of the surveyed population (such as transit availability). A number of models, including ordinary least squares regression, zero-inflated Poisson, and negative binomial, were tested by using various combinations of gender, age, and presence or absence of children at the person and household levels. None of the variables associated with gender were found to be significant, including a dummy variable indicating gender, gender by age, or gender by presence of children in the household. The general logistic model results shown in Table 2 indicate the influence of those factors that may affect identification refusals, position refusals, or total refusals. While the degree of response refusal or uncertainty was modeled, it was not significantly different from simply modeling the presence or absence of a refusal to one or more

relevant questions. As shown in Table 2, the general gender attribute of FemDum had no significant influence on the propensity of a person to refuse to answer questions related to specific factors. Those factors that are shown to have a significant degree of influence, such as living in a Census tract with a high minority or high low-income population (EJ\_tract), age (Age), and income (Incom), among others, tend to be relevant to person-based, as opposed to group-based, characteristics.

Various factors may be considered in understanding the result of lack of significant differences among men and women. The first is that the agency for which the survey was conducted, CMAP, is a generally trusted agency, and well-known in the Chicago region. The issue of trust, as noted above, is one of the most influential in the determination of whether a person will respond to a survey or respond to all questions asked. The lack of major trust violations of information collected by government agencies in recent history may have contributed partially to the low rates of participant refusals. The fact that this survey was conducted by a trusted agency may have influenced the willingness of the respondents to answer all questions.

A second issue to address is that of nonresponse. For the pilot test, an overall response rate of 9% was achieved (NuStats 2006), while a 10% response rate for the full study was obtained (NuStats 2008). The authors did not have access to information on nonresponders, making it difficult to evaluate fully the influence of gender on this set. While various factors influence nonresponse, including time and availability, it is likely that privacy concerns will impact the willingness of some persons to participate. Considering Westin's privacy index, it is possible that many of those persons who fall within the privacy fundamentalist or privacy pragmatist groups chose not to participate in the survey at all, and consequently, their information

TABLE 2 Model Variables and Results

Parameter	Description	Estimate		
		Model I: Position Refusals: p(D_TBRef=1)	Model II: Identification Refusals: p(D_IDRef=1)	Model III: All Refusals: p(D_AllRef=1)
Intercept		-8.1922	-3.8629	-4.1687
FemDum	Person is female	-0.0791	-0.00111	0.0102
Crime_low	Crime rate of the home Census tract is in the lower quartile	-0.00744	0.0618	0.0531
Crime_med	Crime rate of the home Census tract is in the second or third quartile	-0.0003	0.1018	0.0865
Crime_high	Crime rate of the home Census tract is in the upper quartile	0.0123	0.0963	0.1164
EJ_tract	Home Census tract is characterized by a minority or low-income population above the region median	0.2449	0.1978	0.2358
Age	Age of respondent	0.0624	0.0143	0.0243
HHSize	Household size	0.3563	-0.0817	-0.0218
Educa	Highest level of educational attainment	0.0595	-0.0386	-0.0203
Incom	Income variable	0.1598	0.3234	0.3046
CookCo	Household resides in Cook County	-8.94E-06	0.0617	0.0658
PTrips1	Number of person-trips reported during interview	0.0372	-0.0112	-0.00618
TAI	Transit Availability Index (see SDSS website at <a href="http://www.utc.uic.edu">http://www.utc.uic.edu</a> )	0.0249	-0.1085	-0.0372
TEAI	Origin Employment Accessibility Index (see SDSS website)	0.2019	-0.1504	-0.1013
LicDum	Survey respondent holds a valid driver's license	-1.2046	-0.2536	-0.4961
Homemkr	Survey respondent is a homemaker	-0.0953	0.3063	0.2501
Tot_crash	Total number of automobile crashes reported in the home Census tract	0.00738	0.00455	0.00464

was not included in the analysis. Additional information on the nonrespondents would allow for a more nuanced determination on the influence of gender. On the basis of the obtained results, particularly those associated with age, it is possible that the persons who elected to participate in the study have a lower degree of privacy sensitivity. If this is the case, it would be useful to conduct a different study that would stratify persons according to Westin's index to determine if the lack of gender influence holds true across all categories. In general, far greater variation is needed in the preferences of subjects studied for these insights to be gleaned from empirical studies.

Finally, the finding of no significance is, of itself, a finding. Little research has been conducted on gender influences on privacy preferences, beyond basic analyses such as those conducted by Westin (1998) and Ackerman (1999) as part of larger studies. While this study has a number of limitations, outlined more fully below, the general findings in relationship to privacy preferences of women related to identification and position variables may provide a basis upon which to base future studies, particularly if more work is conducted to tease out relationships regarding the balance between privacy, security, and utility that the respondent believes will accrue by providing information (including better traffic management and congestion alleviation, time savings, and so on). One potential would be to conduct specific research on gendered privacy preferences

by looking at both stated and revealed preferences based on participation and response.

## CONCLUSIONS

The above review identifies a number of issues for concern in the relationship between transportation, data needs, and gender-based privacy preferences. Transportation agencies and actors are increasingly reliant on data to effectively plan and implement transportation improvements. Differences in travel patterns between genders (Turner and Niemeier 1997; McGuckin and Murakami 1999; Matthies et al. 2002) highlight the need to make certain that representative data have been collected from both men and women. Two primary concerns related to privacy and data, that of general willingness to share data and the potential for that willingness to affect willingness to adopt ITS and LBS, are emergent in the transportation realm. While the research reported above has indicated that men and women may have divergent privacy preferences, it is possible that the presence of a trusted entity in data collection efforts may have encouraged those respondents who have already agreed to participate to provide the data requested, thus minimizing item nonresponse in general and question refusals in particular. The relatively low response rate of 10% achieved by CMAP, however, may indicate that the

presence of a trusted entity is a necessary, but not sufficient, condition for encouraging participation. However, far greater variation is needed in the preferences of subjects studied for these insights to be gleaned from empirical studies, an idea also noted by Hann et al. (2002). Without additional information regarding refusal to participate it is difficult to draw larger conclusions on the revealed privacy preferences of women as a whole.

On the basis of the results of the empirical study, it may tentatively be concluded that once the initial hurdle of participation is overcome, women do not differ significantly from men in their willingness to provide responses to questions of demographics and travel behavior—that is, women who choose to participate will quite possibly be no different in terms of privacy preferences compared to men. This finding indicates that the survey data that are currently used are likely adequate in this regard for representing both men's and women's travel behaviors. This finding, combined with other studies revealing attitudes toward privacy expressed by women in general, may indicate that while privacy concerns may present a barrier toward women's adoption of ITS and LBS, for those persons who are likely to adopt, data will be fully reported. Such a conclusion, though somewhat speculative, would support the use of data collected from ITS and LBS applications for transportation purposes, as it is likely that gendered differences would be accurately reflected.

One potential method of overcoming the propensity toward nonresponse would be to more fully determine the privacy–utility trade-offs, such as those seen in the OnStar experience. For users of OnStar, the safety and security benefits attained outweigh the privacy cost of surrendering certain private data. Hann et al. (2002) argue that privacy concerns are not absolute, but rather that they are subject to trade for economic benefits. In the context of ITS and LBS adoption, such benefits may be accrued through savings of time or safety, and these might balance out concerns of improper access or other privacy-related issues. While the study found no significant gender-based preferences, it is possible that further evaluation of such trade-offs might identify specific issues or concerns that would better encourage women to participate in ITS and LBS adoption despite privacy concerns.

A few research limitations should be noted. First, information on survey nonrespondents is not available, which limits the degree to which the conclusions may be claimed to represent the population as a whole. Second, the use of proxy variables to reflect privacy preferences is not ideal. Item nonresponse has been linked to privacy preferences vis-à-vis reluctance to share information; however, it should not be concluded that privacy preferences are the sole reason for item nonresponse. Discomfort over income or age, an inability to recall information, or other facts may influence the ability or willingness of a person to respond to a given question. The use of item nonre-

sponse as a privacy proxy in this study has been done in order to utilize existing relevant data to determine if a systematic relationship may exist in patterns of nonresponse and gender and environmental factors.

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# Gender Differences in Self-Reported Evacuation Experiences

## Analysis of the City Assisted Evacuation Program During Hurricane Gustav

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The landfall of Hurricane Gustav in 2008 set in motion the New Orleans, Louisiana, City Assisted Evacuation Plan (CAEP), one of the largest publicly assisted evacuations in American history. The gendered response to the Hurricane Gustav evacuation is placed in the aftermath of the evacuations of Hurricanes Katrina and Rita. Findings from two sets of data, including interviews with Katrina evacuees, suggest that significant gender-based differences exist in evacuation experiences. Women have significantly less access to a reliable vehicle for self-evacuation, making them more dependent on a viable CAEP. Women are also significantly more likely to depend on nonfamily entities such as social service agencies for enrollment in CAEP. Overrepresentation of female heads of households in vulnerable communities makes lack of adequate finances a significant barrier to evacuation. While almost three-quarters of the CAEP participants for Gustav were satisfied with CAEP, women were significantly more likely to report dissatisfaction.

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**H**urricane Katrina and its aftermath have become the touchstone for failure—at every level, the system failed to respond in a way that could have prevented the deaths of many more Gulf coast residents. Subsequently, the measure of hurricane preparedness and response is now compared to the experience of Hurricanes Katrina and Rita. Within response to disaster are differences by identity including race, class, gender, and age. Hurricanes are complex social events, from the warnings to the evacuation, response, and recovery. At every phase

of a disaster, research has shown that women and men react differently to the events (Enarson and Phillips 2008; Enarson and Meyreles 2004). This study attempts to isolate the gendered response to the evacuation of Hurricane Gustav, which struck Southeast Louisiana in 2008 and put into motion one of the largest publicly assisted evacuations in American history, known as the New Orleans City Assisted Evacuation Plan (CAEP).<sup>1</sup> The gendered response to evacuation is placed in the aftermath of the evacuation and response of Hurricanes Katrina and Rita.

### GENDER AND TRANSPORTATION

The evacuation experience begins and ends with travel, mostly by car, but occasionally by other means. Travel, like most other experiences, is gendered, meaning men and women demonstrate different behavior patterns. The brief section below outlines how travel by gender emerged for women and men in normal circumstances.

Since the Second World War, significant changes have occurred in the social and economic role of women in society that have resulted in large percentages of women entering the workforce and obtaining driver's licenses (McGuckin and Murakami 1999). Correspondingly, these changes have yielded shifts in how women travel. From 1969 to 1995, women have outpaced men with a growth of 11% in the average annual person-trips taken

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<sup>1</sup> For a more detailed description of CAEP, see *The National Study on Carless and Special Needs Evacuation Planning: Case Studies* (2009) by John Renne, Thomas Sanchez, and Robert Peterson. <http://planning.uno.edu/docs/CASE%20STUDY%20March%2018th.pdf>.



(Hu and Young 1999; Schintler et al. 2000). A significant difference between genders is that women have more complexity and purpose of trip making (Schintler et al. 2000), which stems from balancing traditional roles as caregivers to modern roles as breadwinners.

Studies that examine aggregate gender differences in travel behavior report that women have shorter average trip lengths (Giuliano 1979; Gordon et al. 1989; Hanson and Johnston 1985; Hu and Young 1993; Madden 1981; Mauch and Taylor 1997; Michelson 1983; Pickup 1985, 1989; Rosenbloom 1987; Rutherford and Gerda 1989; Schintler et al. 2000). Mauch and Taylor (1997) reported that the average trip length for women was 21.8 min as compared to 24.8 min for men. However, women make more trips (Koppelman et al. 1978; Michelson 1983; Rosenbloom 1987; Rosenbloom and Burns 1993); for example, women make 75% more grocery trips than men (Mauch and Taylor 1997). McGuckin and Murakami (1999) reported that 61.2% of women make at least one stop after work, and 28.3% make at least two stops or more. In comparison, only 46.4% of men make one stop on the way home from work, and 17.7% make two or more stops.

A study of the 2001 National Household Travel Survey found that women were more likely to carpool than men (51.5% versus 44.7%, respectively) and less like to ride a bicycle (0.5% versus 1.2%, respectively) (Pucher and Renne 2003). Lower percentages of women biking could result from perceived danger, as women tend to be more risk averse as compared to men with respect to transportation choice (Schintler et al. 2000). This could have implications for evacuation planning, which will be discussed later.

Aggregate studies mask important variations in travel behavior among gender, race or ethnicity, and household structure. For example, while women conduct more child chauffeuring and make more household-serving trips than men, single men and women without children demonstrate similar travel patterns (McGuckin and Murakami 1999). "In households with children, women create complex trip chains substantially more than women without children, or than men" (McGuckin and Murakami 1999, 79). Interestingly, single women with children exhibit significantly different patterns of trip chaining as compared to single men with children. Among single mothers, 65% with children under 5 years of age stop on their way to work as compared to only a third of single fathers with children under 5 years of age (McGuckin and Murakami 1999).

One study found that both gender and race or ethnicity were associated with higher commute times and higher levels of transit use among nonwhite women (Wilson and Johnston-Anumonwo 1995 cited in Mauch and Taylor 1997). Another found that gender variation in commuting behavior was greater among whites than nonwhites

and that "workplace factors such as income, occupation, and job accessibility are important in explaining the influence of race/ethnicity and gender on travel" (McLafferty and Preston 1991 cited in Mauch and Taylor 1997, 147). Employment for women is more concentrated in the retail and service sectors, which tend to be lower paid and closer to home (McGuckin and Murakami 1999). Mauch and Taylor (1997) found that gender differences in commuting travel time were greatest among whites and lowest among Hispanics; however, the gender variation in child-serving trips during commuting was highest among Hispanics (215% difference), followed by whites (152% difference), blacks (60% difference), and lowest among Asians and Pacific Islanders (5% difference). As with travel, the evacuation experience is just beginning to be examined from a gendered lens.

## GENDER IMPLICATIONS FOR EVACUATION

Research on "gender has not been central in the field of disaster studies, and how (if at all) such factors differentially affect women and men is not clearly identifiable" (Gladwin and Peacock 1997 cited in Bateman and Edwards 2002, 108). Evacuation planning has been overlooked in the area of women's studies as related to transportation. A keyword search for "evacuation" and "disaster" yielded no results throughout the proceedings of the 2004 Transportation Research Board's Research on Women's Issues in Transportation conference. Moreover, a keyword search for "women" and "woman" yielded no research results in two recent Transportation Research Board publications: *Special Report 294: The Role of Transit in Emergency Evacuation* (2008) and *NCHRP Synthesis 392: Transportation's Role in Emergency Evacuation and Reentry* (2009).

The little research that has been conducted on this topic reports that women are more likely to evacuate for hurricanes as compared with men (Bolin et al. 1996; Fothergill 1996). Bateman and Edwards (2002) summarize studies that attributed differences related to women being more likely to interpret warning signals as valid and accept them as well as to personalize such warnings and have a heightened perception of risk (e.g. Drabek 1969; Flynn 1979; Hodge et al. 1981; Mack and Baker 1961). Bateman and Edwards (2002) conclude that women are more likely to evacuate "because of socially constructed gender differences in caregiving roles, access to evacuation incentives, exposure to risk and . . . a heightened perception of risk" (107).

## STUDY METHODOLOGY

Two sets of data are used for this study: one descriptive and qualitative, the other more quantitative. The

descriptive section illustrates the experiences of the evacuation and aftermath of Hurricane Katrina in 2005, which set the context for the evacuation of Hurricane Gustav in 2008. The findings from the qualitative interviews are taken from four sets of interviews, two from neighborhoods in New Orleans and two from communities of the displaced (one in Houston, Texas, and the other Baton Rouge, Louisiana). The interview schedules in all four settings included a section on evacuation. From all the settings, there are a total of 110 interviews. All the interviews were with African-American respondents, 60% women and 40% men. The only section of the qualitative interviews used for this paper was the part that discussed evacuation. These findings were arranged thematically as they emerged from the data.

In October 2008 the Office of Homeland Security and Emergency Preparedness of the City of New Orleans provided an electronic database to the research team at the University of New Orleans. The database contained contact information for over 18,000 registrants from 7,000 families who had signed up for the city-assisted evacuation. From that database, the research team generated a random sample of more than 700 names for the survey. A survey was designed by the research team and reviewed by the Office of Homeland Security and Emergency Preparedness. Twenty volunteer graduate students trained in survey administration systematically contacted the registrants included in the sample during October and November of 2008. A total of 156 registrants reported either that they did not evacuate or declined to participate in the study; another 340 were registered for CAEP, but used other means to evacuate. Only those who evacuated were interviewed. Those who were registered for CAEP but evacuated by other means were asked only how they evacuated and to what location. As a result, 364 surveys were successfully completed of people who evacuated by using CAEP. The results were analyzed by the research team beginning in January 2009. This yielded results with a 95% confidence level and a margin of error of 5%. SPSS was used to analyze the data. Cross-tabulation revealed several interesting differences in how males and females reported their evacuation experience.

### HURRICANE KATRINA, EVACUATION, AND GENDER

On the surface, the mandatory evacuation (not those that sheltered in place) of Katrina was deemed successful, with nearly 80% of the city leaving. But underneath that success are a myriad of stories that reveal the trauma of the evacuation and the long-term recovery. Several points of

the Katrina experience are salient to understand how the responses to Gustav were shaped. First, while most of the population evacuated, New Orleans did not have an operating plan for evacuating the city. Most residents were left on their own to figure out how to leave, where to go, and what to do when they got there.

This travel experience as reported in the qualitative interviews showed the complexity of the evacuation during Katrina. All the people interviewed had some version of a story about the trauma of the trip out of the city, including one woman describing barely beating the storm as the winds swirled around her car. While the state's highway contraflow for the interstate system worked fairly well, nearly everything else was left to chance. A 2002 *Institute of Transportation Engineers Journal* article estimated that 200,000 to 300,000 New Orleans residents lacked access to private transportation for evacuation (Wolshon 2002). Litman (2006) demonstrates the lack of pre-Katrina effort made by New Orleans officials who knew of the problem, but did little to address it; this situation is common across the United States.

Nearly everyone interviewed caravanned in some fashion out of the city; in other words, they left with other family members. Many of these family members were elderly or were seriously in need of health care. The tasks for caring for these people on the way out of the city primarily fell to the women in the car, as reflected in the literature. One woman describes caring for her 80-year-old father with Alzheimer's on the 16-h trip to Baton Rouge (a trip that normally takes an hour). The care for her father along with her husband, son, and other relatives on this trip, without any support, proved almost impossible for this woman. She would refer to this trip as a "nightmare" and as "something she would not want to go through again."

In the same vein, many of these women and men had to find new ways to get their loved ones out of the city. One woman described finding the help that she needed to transport her invalid, and in her words, "very large" mother out of her house. She finally found some young men with a pickup truck who put her mother and her bed into the truck's flatbed and drove to Baton Rouge.

Throughout the evacuation, the response, and the recovery, normal travel was suspended. During evacuation and for an indeterminate amount of time after the event, the type of travel that became part of the evacuees' everyday lives stretched their capacities both physically and emotionally. For example, many of the evacuees became part of the "long commute"—Baton Rouge to New Orleans, Houston to New Orleans, Atlanta to New Orleans. They would come back for their jobs, their congregations, their homes, and their family members. Women who might not have driven long distances before began spending more and more time on the highways. Also, many of these women and men had to learn to

drive in new cities and new locations. Over and over again, the interviewees reported that driving in Houston, Atlanta, and Baton Rouge was so much more difficult than in New Orleans.

Travel was certainly a gendered experience after Katrina, although both women and men found themselves in unexpected and undefined situations. While the planning for Gustav ameliorated some of the conditions, the following data show how the experience was still not without its problems.

### HURRICANE GUSTAV

After Hurricanes Katrina and Rita, the City of New Orleans implemented a plan that would, in fact, attempt to evacuate the most vulnerable. When Hurricane Gustav threatened New Orleans in August 2008, the city implemented CAEP to help citizens who wanted to evacuate during an emergency but were unable to evacuate on their own. CAEP was not intended to replace individuals' and families' capacity to prepare and implement their own evacuation. Rather, it is meant to be an evacuation strategy of last resort and only for those citizens who have no other means or have physical limitations that prohibit self-evacuation. Those who believed they needed assistance were asked to call the city's 311 hotline and answer the phone survey. Citizens were then notified via postcard with further information about pick-up procedures and bus stop locations. Their information is kept in a database for assistance during an evacuation.

The city's evacuation plan had been carefully developed since Hurricane Katrina in August 2005. The revised CAEP was based on improvements and recommendations by a post-Katrina collaborative regional network of nongovernmental organizations and private and government agencies meeting periodically under the guidance of the Office of Homeland Security and Emergency Preparedness in the years between Katrina and Gustav.

In the days just before Gustav's landfall, CAEP was implemented. In the spring of 2009, the Mayor requested the director of the city's Office of Homeland Security and Emergency Preparedness to evaluate the program. While the city was not concerned with gendered experiences, the data allow the examination of gender differences. These differences are important, as addressing them through careful subsequent disaster planning will decrease the effects of a disaster on the most vulnerable members of the community. In this survey of the most vulnerable in the city, women, from these measures, reported the greatest difficulty. These responses are by women and men who could not leave on their own, and thus give a glimpse of the most vulnerable and their response to the aid provided by the city.

### FINDINGS

Overall, there were significant differences by gender for those who reported they were "very dissatisfied" with CAEP as a whole. While almost three-quarters of the participants were satisfied with the CAEP, women were significantly more likely to report they were very dissatisfied than men.

#### Women Less Likely to Own a Vehicle and Use It to Self-Evacuate

When asked the question about how they evacuated from the city, significant differences by gender emerged for those who had registered for but did not use CAEP. While almost half the CAEP participants surveyed reported they did not own a vehicle, more than one-quarter of the males who registered for but did not use CAEP during Hurricane Gustav reported they owned their own vehicle and were able to use it to self-evacuate. Only 16.5% of women owned a vehicle and were able to self-evacuate. This indicates that men had access to substantially more transportation resources than did women.

For the most part, when CAEP-registered respondents did not use the city evacuation, they used their networks of family and friends. They left with their daughters, brothers, grandsons, or neighbors. Primarily, residents left in vehicles, but a small number reported flying out of New Orleans. Most of the women who registered but did not use CAEP reported that they evacuated by bus or got a ride with a friend or relative. This suggests that women were far less likely to have the means to self-evacuate, and hence were significantly more vulnerable in an evacuation due to their lack of reliable transportation.

#### Finances More Likely to Be a Barrier to Evacuation for Women

A wide variety of barriers to evacuation were reported by those who registered for CAEP. Barriers seemed to affect all participants regardless of gender, yet women were significantly overrepresented in reporting that a lack of finances served as a barrier to evacuation. While on its surface this may seem to point to a need to better educate evacuees that there are no costs for CAEP evacuation—that is, transportation, meals, and shelter are provided by the government—in reality, some of those surveyed reported that this was not the case. Most notably, several reported that there was no food at one shelter, and they had to "go to McDonalds." Although household-head status was not specifically asked of respondents in this survey, lack of adequate finances may have emerged as a significant barrier for women due to the much higher

number of female heads of households in vulnerable communities.

### **Sheltering Issues More Likely to Be Reported by Women**

Shelter experiences were mostly negative and were reported at significantly higher numbers by women. Participant comments indicated that many felt they were negatively stereotyped by shelter personnel. Many residents, particularly the elderly (significantly higher representation by women) and mothers with small children, felt unsafe. While some shelters made special provisions for segregating older evacuees, most did not. Women's roles as caregivers may certainly have influenced their experience in the shelter; they were not only responsible for their own safety, but the safety of others. Also, shelters often take over the traditional roles of women, so women may be concerned about how these tasks are carried out.

### **Men Needing Evacuation Assistance More Likely to Be Enrolled in CAEP by a Family Member**

There were significant differences by gender for those who were enrolled in CAEP by a family member. While three-quarters of the participants enrolled in CAEP by calling 311 themselves, men were 2.5 times more likely to be enrolled by a family member than women. Women were far more likely to have either enrolled themselves, or enrolled through a variety of organizations that included Volunteers of America, dialysis centers, senior citizen groups, Housing and Urban Development, Veterans Administration Hospital ARC, and home health assistance. Referral by outside groups seems to be an important avenue, especially for women. The findings suggest that men are more likely to have a local support system than women, making the latter more vulnerable during disasters.

Press reports indicated that there were long delays in registering for CAEP in the days and hours before Hurricane Gustav made landfall. Telephone lines were overwhelmed. Yet the program had been in effect for several years before Gustav. Data showed that only 7% registered for CAEP through external organizations. In a community made up of largely female-headed households, these women were often faced with CAEP enrollment challenges that may have been overwhelming. The competing duties of managing and caring for a household while facing the potential dangers of an impending disaster certainly made opportunities for enrollment in CAEP difficult. As the data indicated, women were more likely to have self-enrolled or to have enrolled through a civic

organization. This suggests an opportunity for the city to work with organizations such as Volunteers of America, dialysis centers, senior citizens groups, AARP, hospitals, pharmacies, and others well in advance of hurricane season to identify and register vulnerable citizens.

### **Women Almost Twice As Likely to Report "No Problems" with CAEP Transportation Out of the City**

Overall, the transport from the city was met with stoicism and gratitude. Individuals ranked the system as "good" even if the buses were crowded or the train ride was too long. Several comments show the variety:

- "They picked us up from our home and brought us to the train station. From there we went by ambulance to the airport and were taken by helicopter to LSU. All our needs were met so I was happy."
- "Wonderful ambulance took me to airport."

When specifically asked to describe their transportation experiences out of the city using CAEP, women reported "no problems" at almost twice the rate as men, perhaps because women without their own transportation may be more accustomed to the vagaries of public transportation.

### **Women Reported More Problems with Reentry Than Men**

Many CAEP participants reported that significant hardships were experienced during reentry, and females registered the most concerns. Again, this may be due to the overrepresentation of female heads of households. Yet although there were problems with reentry in some neighborhoods, almost 70% of evacuees rated their reentry experience as good or better. For those who gave negative comments, most included being brought back "too soon" or "too late." For those reporting "too soon," the major complaint was lack of electricity and availability of food in their neighborhoods. Some reported a lack of medical services in their neighborhood. For women, especially without their own transportation, returning to a city with lack of services was difficult.

### **Women Reported They Were Almost Twice As Likely to Evacuate for the Next Storm**

Women and men were just as likely to report they would evacuate for the next storm (almost three-quarters of those who registered for CAEP reported they would evacuate

again). Yet their reasons differed. Women were almost twice as likely to report that they would evacuate for future storms due to safety concerns as men. Most of the criticisms related to safety were about the organization, especially the pick-up stops. The concerns of safety are woven throughout the Gustav experience and in other disasters—women feel less safe in these new environments.

## CONCLUSIONS AND RECOMMENDATIONS

No plan and implementation for evacuating New Orleans or any urban area will be perfect. In the four years after Hurricane Katrina, the city adopted a process of continued improvement in evacuation planning. However, the survey indicated that there are still needs that must be addressed to ensure a more complete evacuation of the city's most vulnerable citizens. The findings suggest that there are some significant differences in evacuation experiences based on gender. Women have significantly less access to a reliable vehicle for self-evacuation, making them far more dependent on a viable city-assisted evacuation program. Women are also significantly more likely to be dependent upon nonfamily entities for their enrollment in CAEP, relying on various public service agencies. The overrepresentation of female heads of households in vulnerable communities makes lack of adequate finances a significant barrier to evacuation.

It also must be recognized that lack of trust remains a barrier to evacuation. New Orleans is not unique among American cities in this distrust. Yet an overrepresentation of female heads of households suggests that women from the most vulnerable communities may be those most likely to consistently engage with city bureaucrats. Trust in government requires the involvement of all the city's agencies, not just the Office of Homeland Security and Emergency Preparedness. Street-level bureaucrats within the police department, social services, and other agencies often set the tone for the climate in the community. The authors suggest immediate implementation of proactive, two-way communication between citizens and government agencies to achieve a safe environment with regard to disasters.

One particularly effective model is Project SAFE (Safety and Future Empowerment). In Oakland, California, a local partnership of government, businesses, and private citizens forged a partnership to reduce the costs and consequences of disasters. The purpose of Project SAFE is to ensure that public safety continues to be a top priority and that businesses and the community will be safer and less prone to damage or losses from major emergencies. As a pilot community for Project SAFE, Oakland received seed monies and support and resources from the *Federal Emergency Management Agency* to encourage loss-reduction community activities. These

activities involve initiatives in which agencies could demonstrate their responsiveness to citizen concerns and needs through appropriate and timely action taken by the city in response to those concerns and needs. Certainly, this survey was a step in that direction. (See <http://www.oaklandnet.com/oakweb/fire/safe/project.html> for information on Project SAFE in Oakland.)

From this sample of the most vulnerable, the authors recommend that planners use information from a variety of sources (Jenkins and Phillips 2008) about providing resources for women. At the same time, it is recommended that planning for the elderly be specifically addressed and commensurate familiarity with their special needs by shelter personnel become common practice. On a neighborhood level, better planning for and assessment of the condition of a neighborhood should be done before returning evacuees. Participants may be given an opportunity to decide when to return home. Therefore, as was done in Gustav, it is likely that temporary shelters will need to be established in the city for the returning CAEP participants.

Travel out of harm's way reflects the social complexities of individuals' lives and the composition of their neighborhoods. Understanding the strengths and the challenges of the population will aid in future evacuation planning.

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# Driving Miss Daisy

## Older Women as Passengers

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Nondrivers are a growing segment of the older population, creating a fundamental mobility challenge for larger and larger numbers of older Americans in the United States and a looming policy and planning challenge. Women are twice as likely to be nondrivers as are men of the same age. Although women are 60% of the population 65 years of age and older, they are 75% of the nondrivers. This study focuses on older nondriving women and examines their living arrangements and their travel as passengers in vehicles. The study found that although older women drive about 60% of men's miles, they travel 85% as many miles in vehicles as do men—more often as passengers. Because of longevity, driving confidence, and medical problems, the number of women who cease driving is far larger than the number of men. Many households with nondriving women are located in suburban and rural areas, far from transit and other options. Finally, the study found that nondriving women are heavily dependent on family and friends for rides, especially women who live alone or with another nondriver. This research shows that when an older woman nondriver is a passenger on a vehicle trip, three out of 10 times she is traveling with nonhousehold members. A combination of factors, including suburbanization, extended longevity, and the increase in older women who live alone, will challenge communities to provide safe mobility for people who can no longer drive. Policy and planning suggestions are discussed.

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In the movie *Driving Miss Daisy* (1989), set in the 1950s, Jessica Tandy plays the role of an aging woman who lives alone in her old family home in Atlanta. When it becomes clear that she can no longer safely drive to the store or social activities, her son (played by Dan Aykroyd), busy with his career and family, hires someone to drive her a couple of days a week. The driver (Morgan Freeman) takes the job because he himself is newly retired, slightly bored, and could use the money.

The movie provided some insight into a growing social issue. Many older people want to stay in the homes they know as long as possible—they age in place. Older women who stop driving, especially older white women, often live alone in suburban or rural areas far from transit and other transportation options. Although this is not exclusively a “white women” transportation issue, the data show that people of color are more likely to live in urban areas, closer to transit. Although African-American women are as likely as whites to live alone, Hispanic and Asian women more often live with others in the household.

It has been 20 years since *Driving Miss Daisy* first appeared on the big screen, and now the issue of aging drivers has become the focus of more and more planning and safety initiatives. However, the challenge of how to provide mobility options for older nondrivers is still vexing and becoming more and more critical as the size of the older population grows. Currently, there are approximately 5 million people over the age of 65 who are not licensed drivers. By 2020 that number will nearly double

to 9.5 million. For people who no longer drive, traveling to the store or the doctor's office or visiting friends and family is difficult, creating a risk for unmet needs, care, and social isolation.

Often a health issue forces older women to reduce their day-to-day travel, depend on others for rides, and finally cease driving. According to the 2009 National Household Travel Survey (NHTS), 6.4 million women have a medical condition that makes it difficult to travel (29% of all women 65 and older). Of these women, 84% have reduced their day-to-day travel, 49% limit driving to daytime, and 61% rely on others for rides. This is consistent with early research that has identified transportation service as a major component of elder care offered by adult children of elderly parents (Nichols and Junk 1997). This research finds that older nondriving women are heavily dependent on their husbands, first, then on non-household members, to help meet their daily mobility needs.

Still, the lack of mobility for nondriving older women is extremely high. According to the 2009 NHTS, more than half of nondriving older women did not leave the house on their assigned travel day.<sup>1</sup> This dearth of travel is not by choice; about half of these nontravelers have not made a trip in the past week and would like to get out more. These new data are the first indication of unmet mobility needs among the older population at a national level.

The NHTS data series provides a unique source of information on the characteristics of older women's travel, and the large sample of U.S. households allows one to analyze specific segments of the older women non-driver population. This paper begins with an overview of

<sup>1</sup> The NHTS assigns a random travel day to report travel for all household members. Nontravelers did not make a single trip on that assigned travel day.

trends in women's travel and then looks at demographic factors (household size, income, and race) for older women drivers and nondrivers. Following that, household and mobility patterns are explored for nondriving women, by race and ethnicity. Finally, the vehicle occupant characteristics are examined to see who is driving when older women are passengers. Conclusions include a summary of the findings as well as thoughts on future research directions.

## TRENDS IN WOMEN'S OVERALL TRAVEL BEHAVIOR

Women of all ages drive fewer miles than men—on average women drive just 60% of the miles men drive. Vehicle miles of travel (VMT) is attributed to the driver's characteristics, so if a man and a woman are traveling together in a vehicle and the man is driving, the VMT for that trip is attributed to the man. Often, VMT is confused with travel in vehicles, so in this paper the terms "driver miles" and "person miles" are used to express miles of travel in private vehicles.

In regard to person miles of travel in vehicles, whether as a driver or as a passenger, men travel many more miles alone [single-occupancy vehicle (SOV)], whereas women travel slightly more miles in vehicles with more than one person [multioccupant vehicle (MOV)]. In total, women travel about 85% of the miles that men travel in vehicles (person miles of travel), as shown in Figure 1.

Although women of all ages drive fewer miles on average than men of the same age, trends indicate that women are narrowing the gap. In 1977 young women drivers (ages 20 to 34) drove 42% of the miles that men of the same age drove, but by 2009 young women drove 73% of young men's miles. Figure 2 shows the trends in

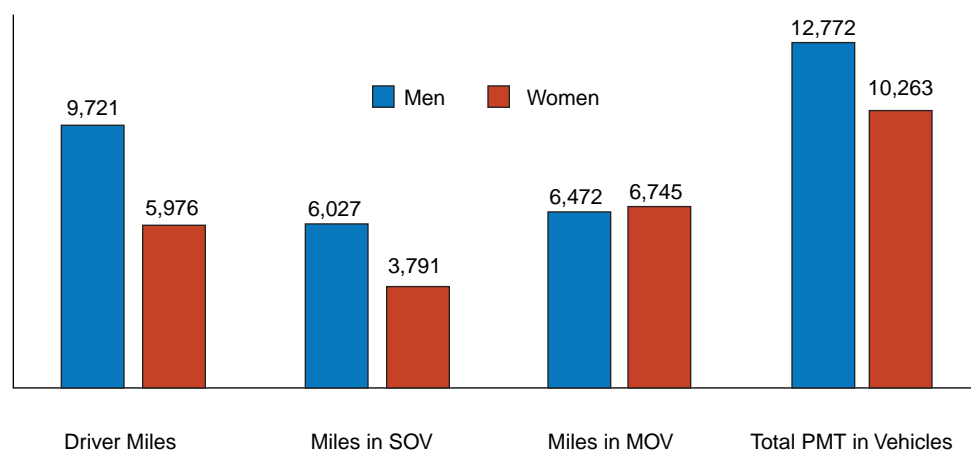


FIGURE 1 Women's and men's annual miles in SOV and MOV travel and total person miles of travel (PMT) in vehicles. (Source: 2009 NHTS.)



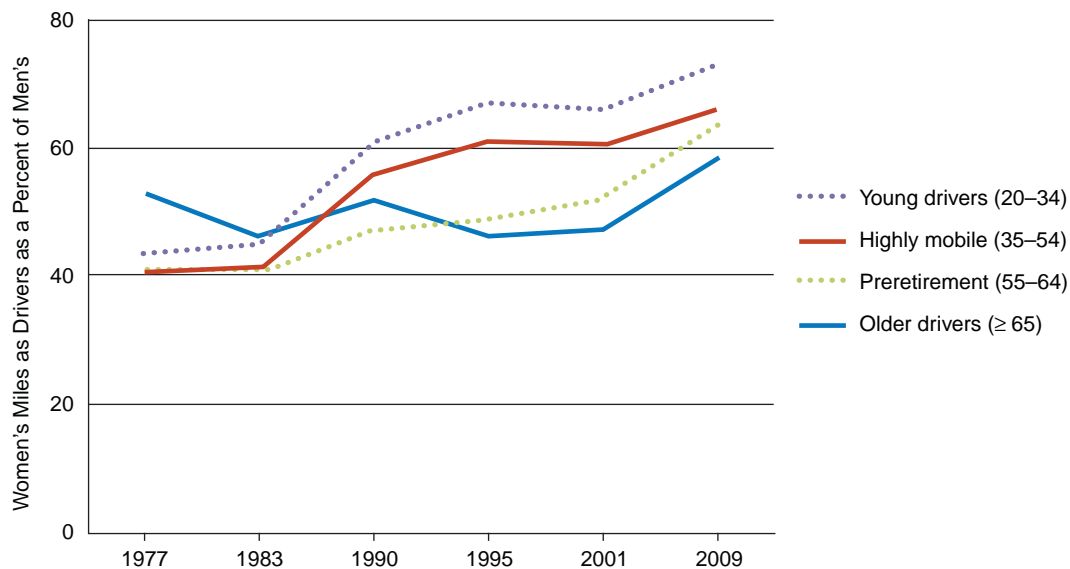


FIGURE 2 Trends in women's driver miles as a percentage of men's. (Source: NHTS data series.)

driver miles of women in four age groups as a percent of men in the same age group.

Social norms, employment levels among women, and other factors (such as the increased number of licensed women) have resulted in increased vehicle travel among women of all ages. Those young women who were 20 to 34 years old in 1977 are 51 to 65 years old today. In 1977 the average young woman drove just 6,500 mi per year, whereas in 2009 the same cohort (now 51 to 65 years old) drive 9,600 mi—nearly 50% more. And young women in 2009 (the older women of tomorrow) drive 11,650 mi per year, almost twice as much as the young women 30 years ago. Looking forward, the higher mobility expectations of the younger cohorts of women will play out as they age, possibly adding to increased driver miles by women.

Women's total travel in vehicles is much higher than their driver miles would indicate. The reason is that women of all ages are more likely to be sitting in the passenger seat when a couple travels together in a vehicle. The NHTS shows that eight out of 10 times when couples of any age travel together on a vehicle trip, the man drives.

Taking the role of passenger can contribute to a lack of confidence and practice in driving—referred to as efficacy. Rosenbloom notes that this is part of the reason older women have difficulty taking over driving responsibilities when their husbands can no longer drive (2003). In addition, lack of confidence may lead older women to give up driving prematurely, even when they have the ability to continue. Further research on the characteristics of shared vehicle trips might explore different age

cohorts to see whether younger ages follow the norm of “letting” men drive when couples travel together.

## HOUSEHOLD SIZE, INCOME, AND RACE

Living arrangements may influence driving cessation because elderly people may be more willing to give up driving if they live with a driver (Rosenbloom 2004). According to the NHTS, women 65 and older who do not drive are twice as likely as older women who drive to live in larger households—a total of 28.9% of older women nondrivers live in households with three or more family members (15.8% in three-person households and 13.1% in households of four or more). In comparison, 8.1% of driving women 65 or older live in households with three or more persons (Figure 3). As this research will indicate, the household composition is co-related with race/ethnicity.

For older women who do not live alone, the other household member is often a driver. Table 1 shows the percent of households for nondriving older women by whether the household contains at least one driver. Of all older women who do not drive, the majority live in a household with at least one driver. This supports the idea that women may be more willing to give up driving if they live in a household with another driver.

However, almost 40% of nondriving older women live alone. Of the 31.2% of two-person households that include a nondriving older woman, nearly one out of six (17.6%) have no drivers at all. Larger households are more likely to contain a driver, but 7.8% and 6.6%

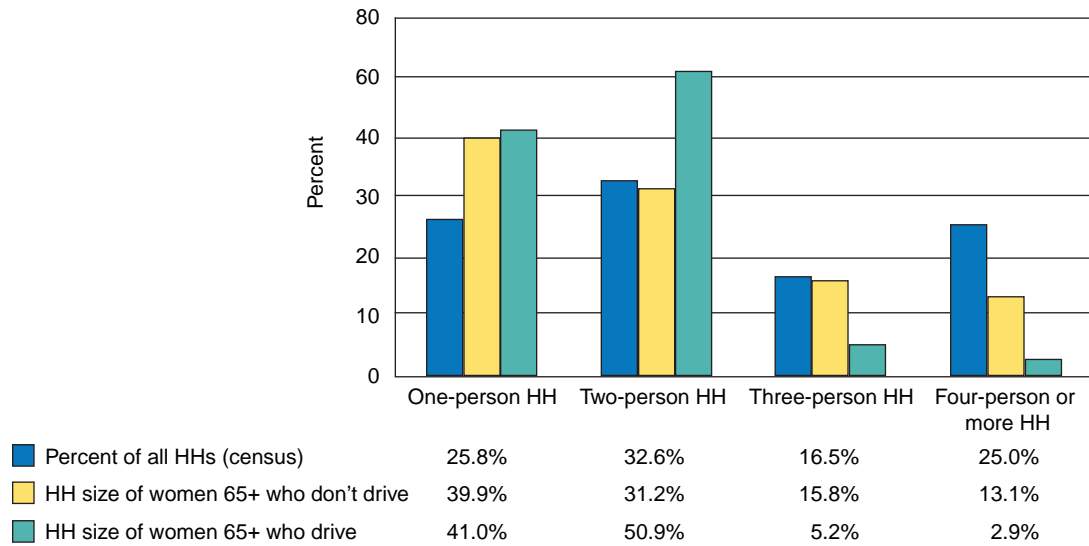


FIGURE 3 Household size distribution of older women drivers and nondrivers (HH = household).

of the three- and four-person households of nondriving women have no other driver in the household.

Significant variations in both household size and driving status exist by race and ethnicity. For example, Table 2 shows that 29.5% of all African-American households with a woman 65 years old or older are single-person households, and within those households nearly half are women who drive and half are women who do not drive. In contrast, Asian women are less likely to live alone, and if they do they are more likely drivers—21.2% of Asian households with a woman 65 years old or older are single-person households, and within those more than two-thirds of the older women are drivers. White women are the most likely to live alone—36% in single-person households—and the most likely to be a driver; 77.8% of those women drive.

Asian and Hispanic older women are more likely to live in larger households—31.5% and 25.7% of all Asian and Hispanic households with an older woman have four or more people. In contrast, only 5.4% of white households that have an older woman include four or more total family members. Older women of color may have greater mobility and access to goods and services as they

age and cease driving because of the support of extended family and other household members.

There are also economic benefits to living with other family members, as shown by the estimated mean income of households with older women who do not drive. Figure 4 shows that Hispanic older women who do not drive live in households with about the same income as other Hispanic households, but African-American older women who do not drive live in households with much less income than other African-American households.

As well as living in poorer households, women who do not drive are more likely than the general population to live in urban areas. Table 3 is based on the 2001 NHTS because the geocoded transit stop locations are not yet available on the 2009 data set. Just over three-quarters (78%) of all households in the 2001 NHTS sample are in an urban area, but 85% of households with an older woman who does not drive are located in urban areas.

Of those households in an urbanized area, Table 3 shows the distance to transit for households with an older woman who drives and households with an older woman who does not drive, again by race and ethnic category because these variables are highly correlated.

TABLE 1 Households of Nondriving Older Women by Whether the Household Contains at Least One Driver

Drivers Within Household	Percentage of Households				All
	One Person	Two Persons	Three Persons	Four or More Persons	
None	100.0	17.6	7.8	6.6	47.5
At least one	0	82.4	92.2	93.4	52.5
Percent of all	39.9	31.2	15.8	13.1	100.0

TABLE 2 Proportion of Households with Older Women, by Family Size and Race–Ethnicity

Race–Ethnicity	Household Size	Distribution of Women Ages $\geq 65$ (%)	Woman Is a Driver (%)	Woman is a Nondriver (%)
African American	1	29.5	49.4	50.6
	2	40.6	58.8	41.2
	3	15.0	29.6	70.4
	$\geq 4$	14.9	54.2	45.8
	All	100.0		
Asian	1	21.2	67.8	32.2
	2	25.8	65.1	34.9
	3	21.6	37.4	62.6
	$\geq 4$	31.5	15.7	84.3
	All	100.0		
Hispanic of any race	1	20.5	50.6	49.4
	2	36.6	60.1	39.9
	3	17.3	33.2	66.8
	$\geq 4$	25.7	20.3	79.7
	All	100.0		
White, non-Hispanic	1	36.0	77.8	22.2
	2	51.1	81.1	19.0
	3	8.4	57.0	43.0
	$\geq 4$	4.5	47.8	52.2
	All	100.0		

NOTE: Detail may not add to total because of rounding.

For example, Table 3 shows that 66% of all African-American households in urban areas are within 0.25 mi of a bus line, but 78.7% of African-American urban households that include an older woman who does not drive are located within 0.25 mi of a bus line. In contrast, only 40.4% of white households in urban areas are located within 0.25 mi of a bus line, and only 53.2% of white urban households with an older woman who does not drive are located within 0.25 mi of a bus line.

#### DRIVING CESSATION AND UNMET MOBILITY NEEDS

Altogether, nearly three times as many older women are nondrivers than older men—5.7 million women compared with 1.8 million men. In each age decade after 65, twice as many women as men are nondrivers—15% of women and 7% of men 65 to 74 years old are nondrivers, 30% of women and 13% of men 75 to 84 years old are nondrivers, and 60% of women and 30% of men 85 years old and older are nondrivers. But some older

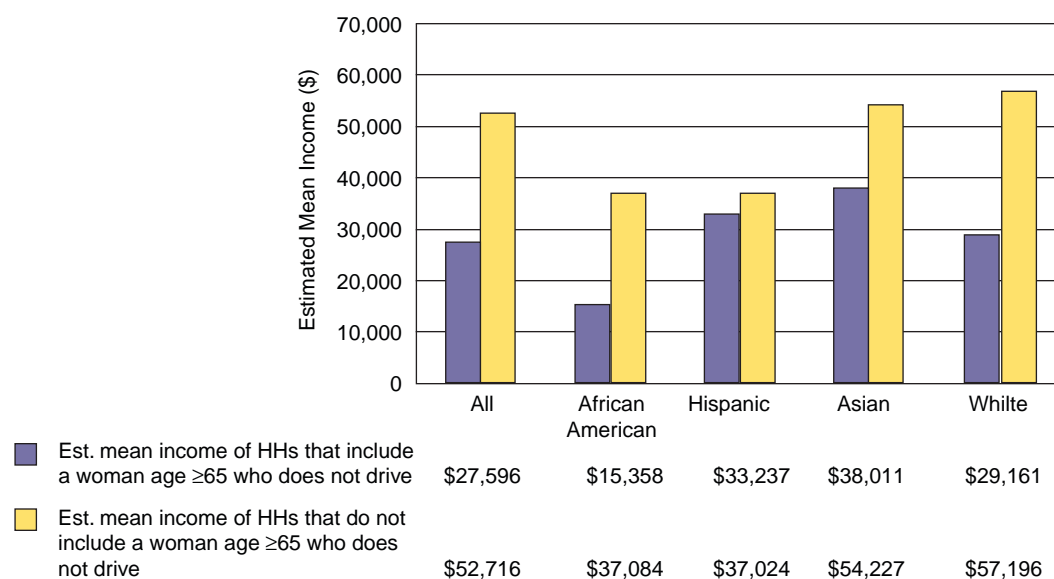


FIGURE 4 Estimated mean household income by older women's driver–nondriver status and race–ethnicity. Women nondrivers live in poorer households overall, with variation by race–ethnicity.

TABLE 3 Urban Households by Race–Ethnicity and Distance to a Bus Line

Race–Ethnicity	Household Characteristics	Distance to Transit (%)			
		0–0.25 mi	0.26–0.5 mi	0.51–1.0 mi	>1 mi
African American	Without older women	65.2	6.8	4.6	23.4
	With older women who drive	74.2	7.6	0.6	17.6
	With older women who do not drive	78.7	2.5	0.3	18.5
	Percent of all African-American urban households	66.0	6.7	4.3	23.1
Asian	Without older women	64.1	9.2	7.2	19.5
	With older women who drive	68.7	2.0	2.0	27.3
	With older women who do not drive	64.3	2.9	6.3	26.6
	Percent of all Asian urban households	64.2	9.0	7.1	19.7
Hispanic	Without older women	60.2	10.7	5.2	24.0
	With older women who drive	60.9	7.8	6.8	24.5
	With older women who do not drive	77.8	7.1	1.8	13.4
	Percent of all Hispanic urban households	60.5	10.6	5.1	23.8
White	Without older women	40.0	9.8	8.6	41.7
	With older women who drive	41.9	10.1	7.6	40.4
	With older women who do not drive	53.2	7.7	5.6	33.5
	Percent of all white urban households	40.4	9.8	8.4	41.4

NOTE: Detail may not add to total because of rounding.  
SOURCE: 2001 National Household Travel Survey.

women have never driven, and some have ceased driving. The 2009 NHTS added a question to determine whether nondrivers had ever driven.

Older men nondrivers are far more likely to have driven in the past—only one out of 10 never drove. In contrast, 40% of older women who currently do not drive never did; 60% have ceased driving. As they age more than twice as many women cease driving as men—for example about 600,000 men 75 to 85 years old have ceased driving compared with 1.3 million women in the same age group (see Figure 5).

The limited mobility for nondriving older women is striking—more than half of nondriving women (52.4%) report staying at home all day compared with fewer than one out of five driving women. About half of those who stayed home all day say that they would like to get out more.

### TRAVELING WITH FAMILY AND FRIENDS

Women’s role as passengers in vehicles has been well explored in safety analysis, underscored by the fact that women, especially in the front passenger seat, have different risks during crashes. Limited travel behavior research and research by gerontologists, along with anecdotal evidence, reflect the codriving experience of older drivers, such as spouses assisting each other with driving. One interesting study looked specifically at the safety of older drivers with passengers in the vehicle. Although the number of passengers for teenage drivers is associated with more crashes, older drivers had fewer crashes at night when carrying two or more passengers (Hing, Stamatiadas, and Aultman-Hall 2003).

A specific goal was to look at who was driving older women passengers—the mythical Miss Daisy. In the fol-

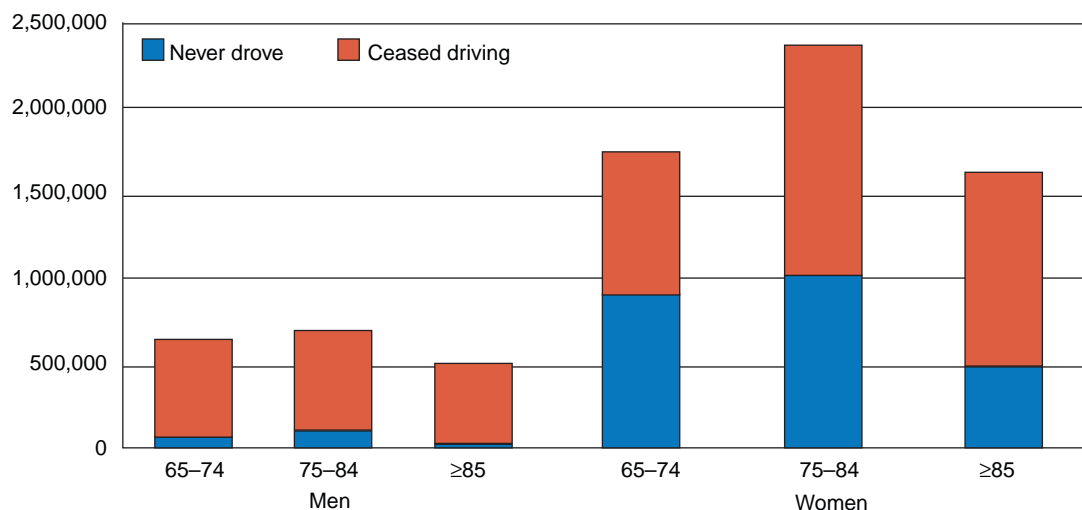


FIGURE 5 Number of nondrivers by whether they ceased driving and by age and sex.

lowing analysis, which includes vehicle trips made by all older women, regardless of driving status, an attempt is made to discern the relationship of the woman passenger to the driver on the trip. In the NHTS, the household respondent can be any person 18 or older who agrees during the recruit to participate. Because the relationship of everyone in the household is coded to the household respondent, the analysis is complicated.

As an example, say the household respondent is a 50-year-old male. He reports that the 75-year-old woman in his household is his "mother." When the vehicle trip is examined, the mother is being driven by the "spouse"—but this description would fit her daughter-in-law (who is the spouse of the household respondent), not her.

Figure 6 shows the relationship of the driver to women passengers 65 years of age and older. In the majority of vehicle trips (58.2%) the husband drives, but non-household members drive for a significant percentage of trips (30.9%). Data from Statistics Canada show that men are much more likely to provide transportation to an older relative, whereas women overwhelmingly provide more personal and in-home care (Williams 2004). This research finds that daughters that live in the household drive twice as often as sons, and other female relatives drive more often than other male relatives, although the percentage of trips for both is small.

**SUMMARY AND FURTHER RESEARCH NEEDS**

Trends in women's travel indicate that older women are driving more than comparable women in the past. But this

research found that women of all ages "let" their husbands drive when couples travel together. This social norm may have negative effects when older women must take on the responsibility of driving themselves—they may not feel confident and able to continue driving. Further research could look at age cohort effects, worker status, life cycle, and individual auto ownership, as well as race and ethnicity, to see whether there are variations.

Older women are living alone at historically unprecedented rates. Older nondriving women who live alone have the lowest household income, especially African-American women, which may limit their options for alternative transportation and their access to goods and services that might be delivered to the household. Asian and Hispanic older women nondrivers tend to live in larger households—but a fair proportion of those larger households do not contain another driver.

Access to goods and services is hard to measure, but the NHTS 2001 measures the distance from the household to the closest bus or rail line (this has not yet been coded on the 2009 data set). A large percentage of households that include an older, nondriving woman, especially white households, are located more than 1 mi from the closest transit service. This is far for an older woman to walk and also may affect the availability of special transit services (that serve the same area as public transit). In addition, being far from transit may also indicate that fewer opportunities, such as shops, libraries, clinics, and restaurants, are within walking distance. Further research could link women in communities with the local transportation services and measure the activities within walking distance.

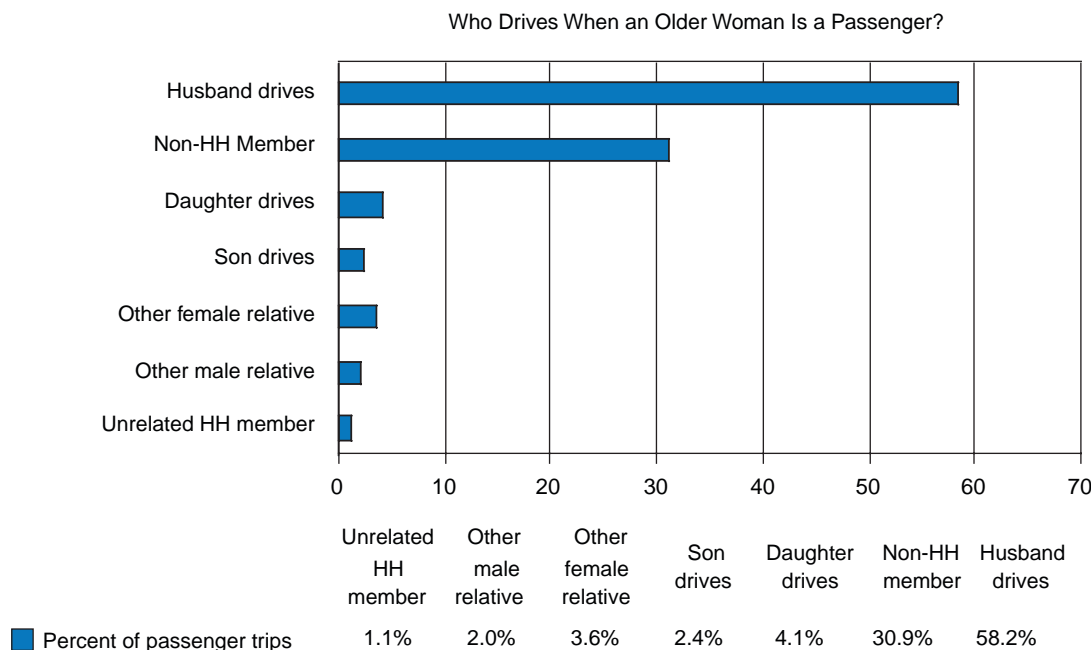


FIGURE 6 Relationship of driver to older women passengers.

If nondrivers live far from transit and live alone or with other nondrivers, they depend on friends and family for rides. In nearly six out of 10 vehicle trips in which an older woman is the passenger her husband drives, but three out of 10 trips have a non-household member as the driver. Information about these non-household members (relationship, age, sex) would help in gaining an understanding of the role of family, friends, and the community in support of older women's mobility.

Mobility is a key component of one's independence in the United States, but mobility, as measured by trips or miles per day, is an extremely imperfect estimate of how free and able an individual is to conduct daily activities outside the house (as Rosenbloom and Winsten-Bartlett point out) (1997). Likewise, typical single-day travel surveys ("snapshot" surveys) are a poor way to estimate the immobile or "shut-in" population that is suffering because of a lack of mobility. If an individual did not travel on the assigned day, it is virtually impossible to discern whether the person stayed home by choice or was unable to leave.

The 2009 NHTS obtained new data to help define unmet mobility needs, especially in the older population. The results show that older women, particularly those who do not drive, desire to get out more. More than half of nondriving older women do not leave the house on a given day, and about half of these women would like to get out more. These new data are the first indication of unmet mobility needs at a national level.

It is found that as society ages, mobility and access are impaired for a growing portion of the population. When older people give up driving, personal independence, social connection, and economic engagement can suffer. Urban areas can start planning now for older pedestrians, expanding special transit and taxi-voucher systems and eliciting volunteer drivers to provide a basic level of mobility for older nondrivers. Innovative research and policy ideas are vital to extend safe driving and provide alternatives.

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# Effects of Gender on Commuter Behavior Changes in the Context of a Major Freeway Reconstruction

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To study the commuter travel behavior impacts of a 9-week reconstruction of Interstate 5 in downtown Sacramento, California, a series of three Internet-based surveys was conducted. This paper offers a preliminary analysis of the first two of those surveys, focusing on the role of gender in commuters' responses. Avoiding peak hour and changing route were the most common responses, and women were more likely than men to employ them. Among the changes that reduce vehicle miles traveled, increasing transit use and increasing telecommuting were the most common. Overall, women were 21% more likely to make at least one change than men were. A binary logit model of the choice to increase transit use suggests that persuading current transit users to increase their transit use was easier than convincing nonusers to switch. Respondents who heard about the increased level of transit service were more likely to increase transit use. Employer transit subsidies supported increases in transit use (but only for women), whereas variable work hours (for women) discouraged them. Men in managerial-administrative occupations and women in larger households were also more likely to increase their transit use.

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In the 9 weeks between May 30 and July 31, 2008, a 1-mi stretch of Interstate 5 (I-5) in downtown Sacramento, California, was intermittently closed for a reconstruction project ("the Fix I-5 project" or "the Fix"). This portion of I-5 is part of a major north-south conduit for interregional traffic, as well as a key com-

muter route serving downtown Sacramento (the state capital) and other job locations in the region. To mitigate the impact of the Fix, a number of strategies were implemented by the California Department of Transportation (Caltrans) and other public agencies, including providing extensive information on the Fix and commute alternatives, increasing transit service, and offering reduced-rate parking at some facilities. Two weeks before the Fix (May 16), Gov. Schwarzenegger issued Executive Order S-04-08 (<http://gov.ca.gov/index.php?/press-release/9631/>, accessed Aug. 31, 2009) directing state executive agencies to promote commute alternatives for their employees to the fullest extent possible and encouraging other public agencies and private companies to do the same. The executive order also authorized a study of the effects of the Fix, with a view to evaluating the effectiveness of the commute modification strategies being promoted and the extent to which more sustainable commute patterns would be the longer-term result. As the Interstate highway system and other elements of the transportation infrastructure continue to age, reconstruction projects such as Fix I-5 will occur quite frequently. Therefore, it is important to learn as much as possible about commuter reactions to such projects, to enable future projects to be implemented in the most effective way. At the same time, such projects offer valuable opportunities to disrupt habitual behavior in a natural way and to use that disruption to motivate shifts toward more sustainable commute choices (Gardner 2009).

For both of those purposes, it is of interest to examine whether there are any significant differences by gender.



Do women, with generally more complex activity schedules (Bianco and Lawson 2000; Hjorthol 2004), experience adverse impacts of such reconstruction projects more heavily than men? Are they less likely than men to make changes, and if so is it because they have more constraints, or because they have already built in more flexible options such as flextime or telecommuting that allow them to absorb disruptions more robustly? Or are women more likely than men to make changes, and if so, is it because of experiencing more adverse impacts, a generally greater receptivity to change (Dobbs 2007), or a greater environmental sensitivity (Matthies et al. 2002) giving them a stronger internal motivation to change? The present study can provide some preliminary insights into those questions.

A series of three Internet-based surveys was conducted to evaluate the effects of the Fix on commuter behavior. The present paper offers an initial analysis of the first two of those surveys. Specifically, the active choices made by commuters to cope with the closure (e.g., taking vacation, telecommuting, or changing mode) are addressed, as well as the way those choices may differ by gender. In addition to presenting descriptive statistics, a binary logit model is developed of the most frequently adopted active choice that reduces vehicle miles traveled (VMT), namely the choice to increase the use of transit during the Fix.

The rest of the paper is organized as follows. The next section briefly reviews previous related research, and the following section describes the data collection. Subsequently, descriptive statistics for baseline work schedule-commute characteristics, and the active choices made by commuters are discussed. The binary logit model is presented in the penultimate section. The final section summarizes the study and suggests future research directions.

## LITERATURE REVIEW

Numerous studies have addressed gender differences in various indicators of travel behavior and likely reasons for those differences. Some key findings (especially in, although not limited to, the U.S. context) include the following:

- Women continue to exhibit shorter commute times and distances than men (Crane 2007).
- Nationwide, women are (still) more likely than men to commute by transit (Pisarski 2006) although their transit use has declined during the past 20 years, and the picture is more complex when controlling for race (Crane 2007). In a 1994 stated preference survey of suburban commuters in Montreal, Canada, authors Patterson et al. (2005) found that women were less likely to choose public transit than men, suggesting that their

higher revealed preference shares often represent constrained choices.

- Women do more child chauffeuring and make more household-serving trips (such as grocery shopping) than men [Mauch and Taylor (1997) using trip diary data from a 1990 survey of San Francisco Bay Area residents, with similar results found in Norway by Hjorthol (2004)].
- Women are more concerned about safety (Liss et al. 2005) and more likely to take safety considerations into account in making travel choices (Church et al. 2000; Kenyon et al. 2002).

Although women's travel patterns have changed dramatically during the past few decades, Crane (2007) found persistent gender differences in a nationwide (U.S.) panel study covering the period 1985 to 2005. One Norwegian study (Hjorthol 2004) similarly found that gender differences did not diminish during the 1990s, noting that women's travel distances were (still) more local than men's, men had more work trips, and women had more nonwork trips.

In view of these and other differences, decision makers have been advised to consider the distinctive travel needs of women and men during transportation planning and operations (Kerkin 1995; Lu and Pas 1999). Tranter (1994) pointed out that gender-based role differences influence not only daily travel patterns but also economic and social status, which in turn affects the choices available for women, which consequently affect mobility. The Women's Planning Network, Inc. (1995), also indicated that there is an absence of transportation policies directed at women's transport needs. Law (1999) suggested the need for further research on "gender and daily mobility," incorporating it within a larger theoretical project.

Interestingly, no studies were found that focused specifically on the subject of this paper: gender-based effects associated with the execution of a planned freeway reconstruction. However, several (linked) literatures are generally relevant. Many or most strategies associated with mitigating the disruption of a freeway reconstruction fall into the category of transportation demand management (TDM) policies, and a sizable literature exists on the adoption and effectiveness of TDM measures. Although TDM policy seldom addresses gender differences in travel behavior, within that field some gender-based observations have been made. For example, Bianco and Lawson (2000) suggest that TDM strategies may be more burdensome on women than on men, because women are more likely to be in the lower-income strata. Other analysts also argue that the numerous policies aimed at discouraging car use may run counter to the transportation needs of women, particularly in instances in which complex, multdestination trip making is required (Women's Planning Network, Inc., 1995).

The disruption occasioned by a freeway reconstruction may be severe enough to trigger the reconsideration of habitual behavior, and thus another literature relevant to this study deals with voluntary behavior change and habit disruption. Research on voluntary behavior change is often directed to reducing the use of private motor vehicles in urban areas (Taylor et al. 2003; Fujii and Taniguchi 2005; Rose and Marfurt 2007). In one study that investigated gender differences in travel mode changes, Rose and Marfurt (2007) found (using 2003–2004 Australia “Ride-to Work” annual event travel survey data) that female first-time transit riders were more likely (30%) than men (22%) to continue riding transit 5 months after the event. Finally, a third relevant literature deals with environmental concern and related behaviors. For example, Matthies et al. (2002), using a survey of 187 inhabitants of a German city, found that women were more likely than men to report an intention to reduce their car use, as a result of their stronger ecological norms and weaker car habits.

## DATA COLLECTION

Because the study was conducted just a few weeks before the closure, there was not time to draw a rigorous, geographically based random sample and recruit participants by mail. Instead, respondents were recruited via e-mail invitations, disseminated through numerous state agencies, the Fix I-5 listserv, transportation management agencies, and a press release from the University of California, Davis. Given the ad hoc nature of the recruitment process, a response rate cannot be computed, nor can a completely representative sample be expected. It is likely that state workers are overrepresented, as well as Internet-literate workers, workers with burdensome commutes, those heavily affected by the Fix, and those who made environmentally beneficial behavior changes. However, self-employed and small-business workers are probably underrepresented, some of whom (together with the less computer literate) may also have been heavily affected by the Fix, so biases in the sample are counteracting each other to an unknown extent.

Accordingly, the subsequent descriptive statistics should be viewed with caution. Nevertheless, it is suggested that some data are better than no data, and it is also thought that comparisons in the data should be largely robust (particularly the comparison of men and women). Thus, the reader is encouraged to focus on trends, conditional relationships, and the model (which is a specific type of conditional relationship): in these cases, it is less critical to have a sample that is representative of the total population (Babbie 1998).

Two Internet-based surveys were administered during the period of the Fix: the first, hereafter referred to as the

Wave 1 survey, sought information on behavior during the first closure of the freeway, of all lanes in the northbound direction (Monday, June 2 through Sunday, June 8, 2008, for the purposes of this paper). The second survey (Wave 2) addressed the first closure of the freeway in the southbound direction (June 16 through June 22). Another paper (Ye et al. 2009) includes selected comparisons between the two waves, but the present paper will focus on comparisons by gender, without regard to wave. To avoid the complication of having a sizable fraction (about a third) of the sample not being independent across waves, in this analysis all of the Wave 1 cases have been retained (4,520 after screening for completeness), and among the Wave 2 cases, only those who did not complete Wave 1 (2,414) were retained, for a pooled sample of 6,934 cases. The pooled sample contains 2,247 (32%) men, 4,160 (60%) women, and 527 (8%) respondents who declined to state their gender. The sizable proportion of women in the sample is not as unbalanced as it may seem, in view of the preponderance of state employees in the study population, and the fact that in general some 60% of state and local government workers are women (Caldwell 2009).

Table 1 presents the sample statistics for some selected characteristics. The “average” characteristics are age 47, female, college graduate, in a household with 2.7 members, 2.1 cars, and having an annual income of \$75,000 to \$99,999. Women tend to have lower (household) incomes than men, at least in part because on average they have less education, are slightly younger, are more likely to hold clerical positions, and are more likely to work part time. They also tend to have smaller households (hence, generally fewer wage earners). However, number of vehicles and commute distances and times are relatively similar across gender.

Three filters were applied to the data at various points in the analysis: (a) 344 respondents (118 men, 210 women, 16 unknown) who were out of the region for the entire week of the closure were excluded from the rest of the analysis; (b) also excluded from the analysis of commuters’ active choices (see section on commute-related active choices) were 28 respondents (9 men, 19 women) who did not commute to work during the closure week; (c) finally, also excluded from the model of the choice to increase transit use (see section on the “increase transit use” model) were 1,123 respondents (406 men, 646 women) who already used transit for all or almost all of their commuting trips. The remaining sample for the “increase transit use” model is 5,439 cases (1,714 men, 3,285 women).

## BASELINE WORK SCHEDULE– COMMUTE CHARACTERISTICS

Information on respondents’ baseline work schedule–commute patterns was collected through a series of ques-

TABLE 1 Selected Characteristics of the Sample, by Gender

Characteristic (sample sizes)	Pooled Data		Men		Women	
	Number	Percent	Number	Percent	Number	Percent
Number of cases	6,934	100.0	2,247	32.4	4,160	60.0
Average age (years) (6,053, 2,067, 3,965)	46.5		47.3		46.1	
Average educational level <sup>a</sup> (6,291, 2,192, 4,038)	4.06		4.3		3.9	
<b>Annual household income</b>	5,977	100.0	2,112	100.0	3,817	100.0
<\$15,000	29	0.5	14	0.7	15	0.4
\$15,000–\$29,999	106	1.8	25	1.2	80	2.1
\$30,000–\$44,999	493	8.2	112	5.3	374	9.8
\$45,000–\$59,999	715	12.0	176	8.3	535	14.0
\$60,000–\$74,999	1,070	17.9	312	14.8	752	19.7
\$75,000–\$99,999	1,243	20.8	490	23.2	740	19.4
≥\$100,000	2,321	38.8	983	46.5	1,321	34.6
Average household size (6,328, 2,184, 4,092)	2.72		2.83		2.67	
Driver's license possession (6,387, 2,215, 4,109)	6,333	99.2	2,200	99.3	4,071	99.1
Average number of household operational vehicles (5,722, 1,991, 3,683)	2.08		2.17		2.03	
<b>Walking time from home to the nearest bus stop or light-rail station (min)</b>	6,356	100.0	2,210	100.0	4,081	100.0
<5	1,680	26.4	676	30.6	992	24.3
5–10	1,729	27.2	592	26.8	1,123	27.5
10–20	1,042	16.4	352	15.9	674	16.5
>20	1,501	23.6	482	21.8	1,002	24.6
Don't know	404	6.4	108	4.9	290	7.1
Average commute (min) (6,878, 2,231, 4,134)	31.9		32.8		31.4	
Average commute (mi) (6,872, 2,231, 4,130)	17.8		18.4		17.4	
<b>Primary job work schedules</b>	6,920	100.0	2,245	100.0	4,152	100.0
Part time <sup>b</sup>	388	5.6	84	3.7	274	6.6
Conventional <sup>c</sup>	3,221	46.5	1,065	47.4	1,899	45.7
Variable <sup>d</sup>	1,461	21.1	509	22.7	858	20.7
Compressed 9–80 work week <sup>e</sup>	1,504	21.7	470	20.9	921	22.2
Compressed 4–40 work week <sup>f</sup>	261	3.8	82	3.7	158	3.8
Other	85	1.2	35	1.6	42	1.0
<b>Occupation</b>	6,914	100.0	2,242	100.0	4,150	100.0
Manager or administration	1,591	23.0	541	24.1	929	22.4
Professional or technical	3,929	56.8	1,432	63.9	2,211	53.3
Services or repair	47	0.7	29	1.3	13	0.3
Clerical or administrative support	1,184	17.1	175	7.8	916	22.1
Sales or marketing	71	1.0	20	0.9	43	1.0
Production, construction, crafts	42	0.6	27	1.2	12	0.3
Other	50	0.7	18	0.8	26	0.6
<b>Number using transit as primary commute mode (6,595, 2,160, 3,945)</b>	1,183	17.9	484	21.5	609	14.6
Number currently using transit but not primary commute mode (6,595, 2,160, 3,954)	1,098	16.6	368	16.4	654	15.7
Awareness of Fix strategy that increases number of buses (6,544, 2,228, 4,116)	3,798	58.0	1,291	57.9	2,397	58.2
Employer-provided reduced-rate transit passes (6,575, 2,236, 4,139)	4,122	62.7	1,383	61.9	2,636	63.7
Employer-provided variable start and end times (6,575, 2,236, 4,139)	4,109	62.5	1,376	61.5	2,617	63.2

NOTE: Boldface designates traits that differ significantly by gender (at the .05 level or better). Detail may not add to total because of rounding.

<sup>a</sup> 1 = some grade school or high school; 2 = high school graduate; 3 = some college or technical school; 4 = four-year college, university, or technical school graduate; 5 = some graduate school; 6 = completed graduate degree(s).

<sup>b</sup> Less than 35 hours per week.

<sup>c</sup> 7.5 to 8 hours per day, with a start time between 8:00 a.m. and 9:00 a.m.

<sup>d</sup> 7.5 to 8 hours per day, with a variable start time.

<sup>e</sup> Nine 9-hour days in 2 weeks.

<sup>f</sup> Four 10-hour days per week.

tions focusing on a “typical 28-day (4-week) period” “before Fix I-5 began.” Respondents were asked for the number of days out of 28 on which they

- Worked at home as the regular location of their job,
- Worked at home instead of commuting to their regular workplace, and
- Physically traveled to a regular workplace outside their home.

Those with a nonzero answer to the last question were asked how many days out of that number they

- Drove alone for most of the commute,
- Carpooled or vanpooled for most of the commute,
- Rode a bus for any portion of the commute,
- Rode light rail for any portion of the commute,
- Rode Amtrak (commuter train) for any portion of the commute,
- Walked for the entire commute, and
- Rode a bicycle for any portion of the commute.

Thus, only the drive-alone, car–vanpool, and walk modes are mutually exclusive, and walking (for the entire commute) in principle excludes any other mode. The transit and bicycle modes can occur in any combination with each other or with the car modes. Accordingly, the sum of the mode-specific answers can exceed the total number of commute days for a given respondent.

The sample’s baseline participation was analyzed in each of these commute options, together with compressed work schedules, because they also reduce the number of vehicle commute miles traveled (for more details, see Mokhtarian et al., in press). Engagement (at least 1 day out of 28) in compressed work schedules (26%), both types of working at home (5% as regular workplace; 9% telecommuting), and physical commuting (97%) is relatively similar across gender; the main differences appear with respect to mode choice. Women are considerably more likely than men to drive alone (75% versus 68%). Women are also slightly more likely to car–vanpool. But [in contrast to Pisarski (2006)] they are substantially less likely to use transit (30% versus 34%), as well as less likely to bicycle (6% versus 18%) or walk (2% versus 3%).

Computing the average share of physical commute days on which each mode is used—the measure closest to a true commute mode split available in the sample—reveals that the drive-alone share is relatively small at 55%, with car–vanpooling at 18%, transit about 25%, and walking and biking about 7% (combined). These shares are quite different from those in the region as a whole, which are 82%, 10%, 3%, and 5%, respectively (Sacramento Area Council of Governments 2008).

However, the latter set of shares is for all passenger trips during the weekday peak, whereas the authors’ is for commuting only (and disproportionately downtown oriented), but without regard to time of day.

## COMMUTE-RELATED ACTIVE CHOICES

The literature identifies a number of possible active choices that can be made in these circumstances (Giuliano 1992; Möser and Bamberg 2007; Shiftan and Suhrbier 2002). Making fewer commute trips (via any or all of the following: telecommuting, alternative work schedules, and vacation), changing mode, and changing departure time or route are discussed in the subsections below. An analysis of teleconferencing and non-work-related trips can be found in Mokhtarian et al. (in press). As discussed above, this portion of the analysis excludes respondents who did not commute at all during the closure week.

### Making Fewer Commute Trips

Respondents were asked whether during the closure week they made “fewer commute trips than you normally would,” with response options “Yes, because of Fix I-5,” “Yes, for some other reason,” and “No.” Only the changes made because of the Fix are discussed. Some 14.1% of respondents made fewer commute trips (because of the Fix) during the closure week (see Table 2). It was estimated [see Mokhtarian et al. (in press) for details] that increased telecommuting, compressed work schedules, and vacation days were adopted by about 5.6%, 3.1%, and 3.1% of the sample, respectively.

Women were significantly more likely than men to reduce their commute travel because of the Fix (15% versus 11%); interestingly, however, they were about 16% less likely than men to do so by compressing their work schedules [in contrast to Mokhtarian et al. (1997)]. Instead, women were more likely than men to reduce their commute travel by taking some vacation days (28% versus 23%).

### Changing Modes

Respondents were asked whether during the closure week they traveled “to or from work using a different means of transportation than you normally would,” with the same response options listed in the subsection above on making fewer commute trips. Again, only the changes made because of the Fix were analyzed. Respondents reporting such changes were then asked which mode(s) they used on more occasions than normal and what they would

TABLE 2 Commuters' Work-Trip-Related Active Choices, by Gender

Choice (sample sizes)	Number Making Choice <sup>a</sup>			Variable (sample sizes)	Average Number of Times (by those who made this choice)		
	Pooled data	Men	Women		Pooled Data	Men	Women
<b>Made fewer commute trips</b> (6,552, 2,118, 3,925)	923 (14.1)	240 (11.3)	578 (14.8)				
Made fewer work-related trips (6,552, 2,118, 3,925) <sup>b</sup>	3 (0.1)	1 (0.0)	2 (0.1)				
Made fewer trips; trip purpose not specified (6,552, 2,118, 3,925) <sup>c</sup>	36 (0.5)	10 (0.5)	24 (0.6)				
Means of avoiding the commute trips (627, 180, 391) <sup>d</sup>	627 (100.0)	180 (100.0)	391 (100.0)	Means of avoiding the commute trips (433, 125, 271)	2.63	2.56	2.59
Telecommuted	297 (47.4)	85 (47.2)	186 (47.6)	Days avoided commuting by telecommuting (290, 84, 182)	2.17	2.24	2.04
Adopted compressed workweek	163 (26.0)	52 (28.9)	95 (24.3)	Days avoided commuting by compressed workweek (157, 51, 93)	2.92 <sup>e</sup>	2.63 <sup>e</sup>	3.01 <sup>e</sup>
Took some vacation	165 (26.3)	42 (23.3)	109 (27.9)	Days avoided commuting by taking vacation (99, 26, 63)	1.8	1.73	1.83
Other	2 (0.3)	1 (0.6)	1 (0.3)				
Missing responses for means of avoiding the commute trips <sup>f</sup> (923, 240, 578)	315 (34.1)	75 (31.3)	192 (33.2)				
Changed mode (6,356, 2,073, 3,837)	493 (7.8)	148 (7.0)	318 (8.1)				
<b>Avoided peak hour</b> (5,506, 1,745, 3,428)	2,642 (48.0)	751 (43.0)	1,725 (50.3)	Days avoided peak hour	3.90	3.87	3.91
<b>Changed route</b> (5,254, 1,650, 3,282)	2,371 (45.1)	681 (41.3)	1,540 (46.9)	Days changed route	3.44	3.40	3.45

NOTE: Boldface designates traits that differ significantly by gender (at the .05 level or better). Detail may not add to total because of rounding.

<sup>a</sup> Percent is given in parentheses.

<sup>b</sup> The survey directly asked about changes to commute trips and to non-work trips, but not about changes to (noncommute) work trips (such as business meetings). The responses reported here were obtained from write-in descriptions to the "other (please specify)" option on the commute reduction question described in Footnote b. As such, they certainly understate the actual level of changes made to noncommute work trips in the sample and are included here only for completeness.

<sup>c</sup> These responses were also write-ins to the "other (please specify)" option on the commute reduction question.

<sup>d</sup> Question: "During the week of [June 2–8 or June 16–22] (Mon–Sun) . . . , how did you avoid the commute trips that you would have otherwise made?" Options: telecommuted to work; adopted a compressed work week; took vacation time; other. Categories are not mutually exclusive.

<sup>e</sup> This unexpectedly high average suggests that a number of respondents failed to read the word "avoid" in the question ("how many days did you avoid physically travelling to and from work by . . .") and responded with the number of days they commuted to work. The same could be true of the telecommuting and vacation strategies as well.

<sup>f</sup> Cases that reported they made fewer commute trips but did not indicate how they avoided the commute trips.

have ordinarily done on those days (multiple answers were possible for both questions).

The vast majority (at least 93%) of those making commute mode changes increased their use of more sustainable modes, most often at the expense of driving alone. Increasing transit use was the most common change: 64.9% of those who altered their commute mode patterns made that choice (5.3% of the total eligible respondents), among which 70.1% would otherwise have driven alone to work. About 2.5% of eligible respondents increased their walking or biking, and 1.4% increased ridesharing; only 0.6% increased driving alone.

There are substantial differences in these patterns by gender, however. Taking all modes together, women were 16% more likely to change modes (8.1%) than men (7.0%). Among changers, women were considerably more likely than men to increase their use of tran-

sit (73% versus 58%) and car–vanpooling (20% versus 12%), and much less likely to increase bicycling or walking (21% versus 49%).

### Changing Departure Time or Route

The active choices discussed so far are considered to be potentially somewhat costly, in that they may require lifestyle adjustments, affect other people, or both (Salomon and Mokhtarian 1997). By contrast, the remaining changes shown in Table 2 are considered relatively low cost, entailing minimal change to established patterns. Accordingly, a number of studies have found such changes to be the most common responses to increasing congestion or disrupted commute patterns (Mokhtarian et al. 1997), and the present analysis is no exception.

Nearly half the respondents reported making a special effort to avoid peak hour during the closure week (on an average of 4 days out of the week), and 44% of those driving or carpooling to work that week reported making planned changes to their commute route (on an average of 3.4 days). Women are considerably more likely than men to use each of those strategies, consistent with the findings of Mokhtarian et al. (1997) for changing departure time.

Altogether, about 60% of respondents adopted at least one of the active changes to the commute, which have been analyzed in the section on commute-related active choices. However, women were 21% more likely to make at least one change than men were (64% versus 53%). At least two explanations for this greater activism on the part of women present themselves. The first is that women were more adversely affected by the Fix and thus had a greater need to make a change. Mokhtarian et al. (in press) found that women were more likely than men to report passive impacts, both good and bad, resulting from the Fix. The greater reported incidence of negative impacts on women lends credence to the idea that they had a greater external motivation to make changes. The second explanation is that women may have a greater internal motivation to make changes, that is, that they may be more inclined to make socially or environmentally beneficial changes to their commute in general. This interpretation is consistent with the independent findings of Matthies et al. (2002) and Rose and Marfurt (2007) discussed in the literature review section.

### THE "INCREASE TRANSIT USE" MODEL

Although it is helpful to see descriptive statistics on how commonly various changes were made, it is also desirable to better understand the types of people who make a given change. This is perhaps best done in the context of a model in which multiple covariates can be controlled for simultaneously. Space does not permit providing models for all the changes seen in the sample, but a model is presented for the most commonly chosen change that reduces vehicle travel, namely, the choice to increase the use of transit for commuting.

The dependent variable is created from the survey question that asks [of those who previously indicated "travel(ing) to or from work using a different means of transportation (during the closure week) than you normally would," because of the Fix], "During the week of ..., which did you use on more occasions than you normally would have?" with seven possible response options: "carpool or vanpool," "bus," "light rail," "Amtrak train," "walking or biking," "driving alone," and "none of the above." In the model, "bus," "light rail," and "Amtrak train" are combined into a single "transit"

variable, equal to 1 if respondents selected any of those modes, and 0 otherwise. Among the "0" respondents are included those who did not change modes because of the Fix, on the basis of the previous question, but exclude those who (a) were out of the region the entire week, (b) did not travel to work any days that week, or (c) already take transit for all or almost all of their commute trips, because in none of those cases would increasing transit use be a feasible option. This left 5,439 cases, including 249 (4.6%) who increased their transit use as a result of the Fix. A number of potential explanatory variables are available, including sociodemographic traits and the availability of various employer-based commute modification instruments.

To identify gender-related differences in the choice to increase transit use, first, best models for each gender were developed separately, and for the pooled sample. On the basis of those models, a fully gender-specific single model was created (i.e., a single equation in which every variable was interacted with gender, so that coefficients of each variable could differ by gender). Then, as indicated by statistical tests and conceptual considerations, insignificant variables were deleted and coefficients were constrained to be equal across genders, resulting in a final hybrid model in which some coefficients are gender-specific and others are based on the pooled sample. The final sample necessarily excludes cases in which gender was not reported.

Because of missing data on gender and other variables, the preferred model (Table 3) has 214 (4.6%) respondents who increased their transit use during the closure week and 4,422 who did not. Overall, as mentioned previously, women were considerably (45%) more likely than men to increase their use of transit (6.1% versus 4.2% in the final estimation sample), perhaps because, using it less than men to start with (see section on baseline work schedule-commute characteristics), they had more room to do so.

The  $r^2$  goodness-of-fit measure (Ben-Akiva and Lerman 1985), with the equally likely model as base, is 0.766, which, taken at face value, is considered quite good in the context of disaggregate discrete choice models. With shares this unbalanced, however, the market-share model alone (the model containing just the constant term) has a  $r^2$  value of 0.730, initially suggesting that the true explanatory variables add only 0.036 to the goodness of fit. However, the final model is significantly better than the market-share model ( $c^2 = 232$  with 7 degrees of freedom,  $p = .000$ ). Further, when the same model is reestimated except without the constant term (not shown), a  $r^2$  value of 0.499 is found, which indicates that most (65%) of the explanatory power of the full model lies in the "true" variables. That is, the true variables are substantively helping to explain why the shares are so unbalanced.

TABLE 3 Binary Logit Model of Increased Transit Use, Pooled Data

Variable	Coefficient	P-value
Constant	-4.302	0.000
Sociodemographics		
Household size (female)	0.120	0.019
Manager/administration occupation (male)	0.644	0.022
Transit usage		
Use transit as primary mode	1.350	0.000
Currently use transit but not primary mode	2.229	0.000
Awareness of Fix impact mitigation strategies		
Increased number of buses	0.378	0.027
Employer-provided commute strategies		
Reduced-rate transit passes (female)	0.569	0.002
Variable start or end times (female)	-0.434	0.013

NOTE: 1 = increased transit use; 0 = did not increase transit use.

Summary statistics:

Valid number of cases, N	4,636 (yes: 214; no: 4,422)
Final log-likelihood, LL( $\beta$ )	-751.21
Log-likelihood for market share model, LL(MS)	-867.168
Log-likelihood for equally likely (EL) model, LL(0)	-3,213.43
Number of explanatory variables, K (including constant)	8
$\rho^2_{ELbase} = 1 - LL(\beta)/LL(0)$	0.766
Adjusted $\rho^2_{ELbase} = 1 - [LL(\beta) - K]/LL(0)$	0.764
$\rho^2_{ELbase} = 1 - LL(\beta)/LL(MS)$	0.134
$\rho^2_{MS} = 1 - LL(MS)/LL(0)$	0.730
$\chi^2$ (between the final model and the EL model)	4,924.44
$\chi^2$ (between the final model and the MS model)	231.916

Seven variables besides the constant are retained in the model: two mode usage variables, one awareness variable, two employer strategies (gender-specific), and two (gender-specific) sociodemographic variables. Each of these is discussed in turn.

It is hypothesized that people who (had) already used transit to some extent would be more likely to increase their use of it than others would be to start using it. Accordingly, several indicators of transit use were tested. Two dummy variables, marking those who use transit as their primary commute mode and those who currently use transit but do not have it as their primary commute mode, were strongly significant and positive, as expected. That is interpreted to mean that people who currently use transit are familiar with the schedule, stop-station locations, and riding experience and would therefore find it easier to step up their use. Those who already use transit as their primary commute mode, however, have less room to increase their use than respondents who currently use transit but do not have it as their primary commute mode. By contrast, nonusers may have already firmly concluded that transit is not suitable for their needs, whether based on erroneous impressions [e.g., an overestimation of travel time by transit, as found by Fujii et al. (2001) and van Exel and Rietveld (2010)] or on accurate ones.

It is valuable to realize that it may be more effective to try to persuade current transit users to increase their use than to try to convince nonusers to switch—although

it is recognized that both potential markets are important. However, it could also be argued that including user history variables is not as insightful as identifying the “first principles” that influence whether one does currently use transit or not, and including those in the model instead. Thus, excluding these two variables from the model was also tested (results not shown). In the best alternative model, the only difference is that the female-specific household size variable also dropped out, and the  $\rho^2$  value fell to 0.73. This indicates that the transit experience variables are not dominating the explanatory power of the model.

One awareness variable is significant in the model, with the expected sign: it is unsurprising that respondents who had heard about the increased number of buses were more likely to increase their transit use.

Two employer strategies were significant in the preferred model, with expected signs. Not surprisingly, the availability of reduced-rate transit passes substantially increased the probability of using transit more, but it is interesting that the case was only for women, whereas the availability of reduced fares had no significant effect on men. It is possible that men's higher incomes make them less sensitive to transit costs. Similarly, the availability of flextime decreased the propensity to increase transit use, but again only for women. The interpretation of the latter result is that if people could change their departure times to avoid congestion caused by the Fix, then their current commute mode might remain viable,

giving them less incentive to switch to transit. This may be true for women but not for men for the same reasons, leading fewer women than men to use transit in normal times.

Finally, two gender-specific sociodemographic traits were also significant. Men in managerial-administrative occupations were substantially more likely to increase their use of transit than other groups. It is possible that men in high-end, white-collar occupations are more likely to live in locations better-served by commuter train, light rail, and express bus service. The positive coefficient of household size (for women only) was initially unexpected, but is also saying something meaningful. It is assumed that people in larger households have more complex activity-travel patterns, and therefore the original expectation was that commuters in such households would be more likely to find the car to be most practical and would be more likely to stick with the car. Further reflection and comments on open-ended questions of the survey suggest another possibility, however. It may be that the more complex patterns of larger households are more vulnerable to disruption and have less ability to absorb a disruption without much change. Thus, commuters in larger households may have a greater need to change than those in single- or two-adult households, and, at the same time, there might be more limitations on the ability of such commuters to choose other actions such as changing route or departure time. The fact that the variable is significant only for women suggests that it may also reflect an income effect, because women in smaller households are more likely to be single mothers.

Besides the seven variables just discussed, a number of other variables were tested, including work schedule type, commute time and distance, the distance of the nearest bus stop or light rail station from home, income, number of vehicles per household member and per licensed driver, and a geographically based indicator of how strongly the respondent's commute might have been affected by the Fix. However, none of these variables were significant in the final model.

## SUMMARY AND SUGGESTIONS FOR FUTURE RESEARCH

This study offers a preliminary analysis of commuters' responses to the Fix I-5 reconstruction project, focusing on gender differences. The easiest options (such as avoiding peak hour, adopted by 48%, and changing route, 45%) were the most common responses, and women were considerably more likely than men to use each of those strategies. About 8% of eligible respondents altered their commute mode choices during the closure week. The vast majority (93%) of those increased their use of more sustainable modes, most often at the expense of

driving alone. Increasing transit use was the most common change (made by 5.3% of the eligible respondents), and there were substantial differences in mode change patterns by gender (with women considerably more likely than men to increase their use of transit and car-vanpooling). Overall, women were more likely to make at least one change (64%) than men were (53%).

A binary logit model was built to better understand the choice to increase transit use (the most popular VMT-reducing option) during the Fix. Two mode usage variables, one awareness variable, two employer strategies (gender-specific), and two (gender-specific) sociodemographic variables were significant. Being a current transit commuter positively influenced the propensity to increase transit use, suggesting that persuading current transit users to increase their use may be easier than convincing nonusers to switch to transit. The availability of reduced-rate transit passes and flextime decreased the propensity to increase transit use, but only for women. The latter result in particular illustrates the conflict that sometimes arises among policy instruments: Making work hours more flexible is considered beneficial for reducing congestion and for balancing work and family needs, but the increased flexibility in avoiding peak-period congestion may enhance the appeal of continuing to commute by driving alone. Finally, men in managerial-administrative occupations and women in larger households were more likely to increase their use of transit. The latter result is interpreted to reflect a greater vulnerability to disruption of the complex activity patterns in larger households, with the result that commuters in such households have a stronger impetus to make a change when disruption occurs.

Several directions for future research are indicated. Using the same data set, one can model not only other behavioral changes beyond the one explored here (increased transit use), but also the reported likelihood of continuing to use a strategy adopted (or increased) during the Fix. With the addition of geocoded home and work location information (for those who reported nearby street intersections), one can explore a number of geographic relationships with observed outcomes. Ultimately, the attitudinal and behavioral data collected in Wave 3 will be merged with Waves 1 and 2, to provide a rich basis from which to further investigate the persistence of behavioral changes prompted by the Fix.

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## RESOURCES

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# A Commitment to Continue?

## Comparing Women and Men Commuters Who Choose Transit over Driving Alone

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This study tracks results from an employer-sponsored travel reduction program to explore whether there are gender-related differences in how men and women select and use public transit. Although women ride public transit more than men, it is not clear that this effect would be found in a study of middle-income women with full-time jobs. Their responsibilities and roles might lead these women to favor the flexibility and convenience of an automobile. The study follows 381 commuters, 144 men and 237 women, who chose to give up their drive-alone commuting for a 3-month period in Southern California. More than two-thirds of both the men and the women remained as transit riders when the time came to make a commitment to continue with transit. The analysis found few differences between men and women. However, the women who chose to participate in the transit experiment in the first place had distinct characteristics: they had fewer children at home, were from select age groups, and had smaller households. The study provides insight for future social marketing experiments in transportation and provides results for public transit providers who wish to attract busy commuters who have family and household responsibilities.

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**A**s more women have entered the workforce full time, the mode share for public transportation has declined. There is interest in reversing this trend, but also widespread recognition that public transit may not be conducive for workers who have multiple family and household responsibilities. This study reports on an

employer-sponsored travel reduction program. Men and women who voluntarily chose to switch from drive-alone commuting to public transit were longitudinally tracked during a 3-month period. Their willingness and ability to ride public transit are examined at two separate points in time. There are a number of reasons that the decision to switch from a drive-alone mode to public transit might be associated with gender. The paper begins with speculations on some of these factors (see Table 1) and then returns to them in reviewing the literature.

### OVERVIEW OF THE TRANSIT EXPERIMENT

A social experiment was conducted at the University of California, Los Angeles (UCLA), to recruit full-time single-occupancy drivers and provide them with free commuter transit passes. Although the university had an employee transit mode share of nearly 14% (1), it was felt that more aggressive transportation promotions were needed during a time of rising gasoline prices. A 3-month experiment was conducted between June and September 2008. Participants received a commuter transit pass at no cost if they turned in their parking permit. At the end of the 3-month trial, employees could regain their parking allocation or elect alternative transportation. Regular bus riders then received a transit fare subsidy of 50%. The experiment was found to be an unusually successful demonstration of transportation demand management (TDM). At the end of the 3-month period, only 30% of the men and women who enrolled decided to return to drive-alone commuting.

TABLE 1 Comparison of Transit Versus Car

Travel Characteristic	Transit vs. Car	Potential Impact on Household
Time to travel	Usually longer and often less frequent transit service	Transit rider may spend more time in travel and less time with family. Also reduces family time together in car.
Flexibility of travel	Reduced flexibility to pick departure	Transit rider may be less able to get home or to school "on demand."
Trip chaining	Particularly hard for groceries, packages	Need to take additional trips for certain errands, shopping, and leisure. Little ability to engage in "serve-other" trips.
Exercise	Transit provides more opportunity to walk	Transit riders may spend less time at gym and reduce other exercise regimes, leaving more time for other activities.

In July 2008 gasoline prices reached nearly \$4.60 a gallon in California, and most employees were attracted to the program so that they could mitigate the fuel costs, as well as the cost of monthly parking, which was about \$70. However, many participants cited a secondary reason for enrolling: they wanted to explore new travel modes without risking their parking allocation.

### PREVIOUS RESEARCH ON WOMEN'S CHOICE OF TRANSIT FOR COMMUTING

Studies of "single-occupancy vehicle (SOV) conversions" and voluntary travel behavior programs have not focused on gender issues, *per se* (2–4). The outcomes are generally favorable and show that the perception of public transportation is improved. However, the literature incorporating self-selection in travel choices underscores that decisions depend on abilities, needs, and preferences. There is a different stream of literature suggesting that participation in TDM and car-reduction schemes will generally be biased against participation by working women (5).

Historically, women took more transit trips than men (6), and employed women were more likely to ride transit, although even by the late 1970s it was observed that gender differences in the use of public transportation were not large (7). There are underlying and interrelated labor factors related to transit use: women workers live closer to their jobs, have lower salaries, and are more likely to work part-time. However, during the past 30 years there have been "complex social changes" in women's work roles. During this period, the proportion of women using public transit and carpooling has declined, while the proportion of women depending on private cars has increased (8). There is recent evidence from urban metropolitan areas of a convergence of men's and women's modal share for transit (9, 10). But, overall, there are still important gender differences.

Specifically, analysis of data for the period between 1985 and 2005 indicates that across all travel modes, average commute lengths and travel time have increased for both men and women (8). There continues to be a gender gap in both distance and travel time, and commutes for women are shorter. The patterns of transit ridership vary

by race: there has been a large decline in ridership among black female commuters, but their commute distance and commute times have increased, signaling a spatial mismatch between jobs and housing. For other women riders, the commute length on transit has increased slightly and the duration (time) has declined. Their transit mode share is less than 10%. Crane observes that a shift in commute trips from transit to car has occurred because women prefer cars, or need them for work, or live in areas with a poor transit level of service.

Some factors that discourage women from using transit more are that they cannot trip chain or engage in "serve-other" trips. Trip chaining allows busy working women to balance their domestic and child care obligations and makes personal vehicles a more convenient and efficient choice. The need to make transportation choices congruent with the fulfillment of household duties is evidenced by multilinked travel trips (11–13). In principle, the spatial distribution of schools, shopping, leisure, and medical facilities should be factors that influence the frequency and need for trip chaining. However, McDonald found that higher-density neighborhoods are not necessarily associated with a reduction in vehicle miles traveled among households with children (14); one reason is that many urban areas are not necessarily safer for children to traverse alone.

Safety has an important link to women's travel choices for a separate and distinct reason. The characteristics of neighborhoods where transit boarding takes place are closely related to the issue of security and crime (15). Concerns about safety are associated with both waiting for transit and actual time in transit. There are complex social reasons that give rise to these perceptions, delineated in a recent study by Loukaitou-Sideris et al. (16). For female commuters who take transit, one might predict that security concerns would be more acute among those who work at night, among those who live in poorer neighborhoods, and those in neighborhoods with less frequent service.

Rosenbloom and Burns have conducted one of the most extensive studies of gendered issues among employee commuters (17). They found that women commuters were more favorable to TDM strategies than men, but were also less likely to be able to switch to

alternative modes because driving helped them serve family needs and responsibilities. Their data show that having an automobile is important to employed women, particularly those with lower incomes. One conclusion is that "having a car is a necessity and not a luxury for most working women and their families, given current land use, housing, employment, and service patterns." Specific to TDM programs and transit passes, they note that transit passes cannot compensate for time lost to travel on longer commutes, added hours or child care or elder care expenses, the lack of current transit service, and associated security issues.

It has been suggested that many decisions about using TDM are local because of wide variations in service levels and availability. In the Los Angeles area, 60% of Metro riders are currently women (18). This percentage is for all travel, not just commute trips. Among studies that have focused on Los Angeles commuters, Sarmiento examined panel data for Southern California commuters (19). She found that gender had a role in predicting the frequency and types of car trips and carpool use in the region. She did not ask specifically about transit versus carpool use. In another Southern California study, Novaco and Collier found in a telephone survey, that women with longer commutes (>20 mi) perceived more stress, and those who said they found commuting stressful were also more inclined to try rail or carpooling (20).

## RESEARCH METHODOLOGIES AND PROCEDURES

The social experiment took place during a 3-month period, from June 2008 through August 2008. A longitudinal data set was created based on recordings at three different times. At the initial data capture in June an online survey was used to gather the commuting address for each respondent and some basic demographic information. In August 2008 a follow-up was done with an online survey that asked respondents about their experience and attitudes while riding transit. In October 2008 the database for the study was updated and finalized by using parking records to classify each participant's subsequent parking decision.

This study is organized around reporting the results from these three periods. First, the characteristics of those who signed up for the trial are described, and with the use of geographic information system (GIS) tools, their travel distances are reported. Also reported are the demographic and household characteristics of those who self-selected for the transit experiment.

In the second part, the opinions and attitudes these riders expressed toward transit are presented. When this survey was administered, riders were still engaged in the social experiment and had not made a final mode decision. The online survey had a response rate of 48%.

In the third and final part, the outcome is reported: whether or not respondents returned to drive-alone commuting. The dependent variable was measured as the decision (yes-no) to regain employee parking. Letting  $\pi$  denote the probability of an employee regaining parking, the binary logit model investigates the sensitivity of this response to a posited vector of explanatory variables  $X$  by the following specification:

$$\text{logit}(\pi) = \log\left(\frac{\pi}{1-\pi}\right) = \alpha + \beta'X + \varepsilon$$

where

- $\alpha$  = intercept,
- $\beta$  = vector of parameters, and
- $\varepsilon$  = error term.

Two different logit regression models were run because the sample sizes were different and doing so avoided having too many missing values. The first logit used geographic variables, keyed from the respondents' home address. Density was classified by using a GIS overlay of 2006 census tract information for Los Angeles County, and the coding for distance was accomplished by using a shortest path function in TransCAD. There are also data on the number of direct bus routes serving the respondents' home address.

The second logit model, which relies on self-report and attitudinal preferences, is based on the survey data only. There were data for approximately 185 respondents, one-half of the study group. Their demographic characteristics and personal ratings of transit are used as predictors. These ratings of transit are essentially qualitative but are measured on conventional scales. In the final section of the data analysis, an alternative method was explored. A brief textual analysis of open-ended statements was performed to explore what riders "said" when they completed the open-ended portions of their questionnaires.

## MEASUREMENT AT TIME 1: WHO SIGNED UP AND WHAT ARE THEIR GEOGRAPHIC CHARACTERISTICS?

During a 3-week period, 381 commuters ( $n = 381$ ), 144 men and 237 women, signed up for the social experiment. Sixty-two percent (62%) were female. This rate corresponds with the underlying population. According to a 2006 workforce study, 64.4% of the university workforce was female (21). The same report notes that only 33% of women were in senior management.

In Table 2 the demographic characteristics of participants are presented. Although none of the overall relationships are statistically significant at the  $p \leq .05$  level,

TABLE 2 Comparison of Male and Female Participants in Social Experiment (Survey Data)

Variable	Male (%)	Female (%)	$\chi^2$	Degrees of Freedom	Significance
Household Size	( <i>n</i> = 62)	( <i>n</i> = 122)	1.72	3	.632
1	34	27			
2	26	34			
3	21	18			
≥4	19	21			
Children age ≤ 16 yrs	( <i>n</i> = 62)	( <i>n</i> = 121)	4.546	3	.208
0	66	74			
1	15	16			
2	18	7			
3	1	3			
Age	( <i>n</i> = 62)	( <i>n</i> = 122)	8.99	4	.061
20–25	7	3			
26–35	26	35			
36–45	29	20			
46–55	29	20			
55+	10	23			
Number of cars in household	( <i>n</i> = 61)	( <i>n</i> = 122)	4.157	3	.245
1	44	33			
2	43	44			
3	7	16			
≥4	6	7			
Salary band (thousands)	( <i>n</i> = 114)	( <i>n</i> = 190)	2.760	3	.430
0–30	4	3			
30–60	49	58			
60–100	40	33			
>100	7	6			

there are suggestions that gender differences did influence who volunteered to give up their SOV commute. First, there was no statistical difference in income levels, and on the basis of the university workforce report, it appears that the majority of participants, both men and women, came from administrative jobs and hospital support functions (21).

However, women at both ends of the age spectrum, those between 26 and 35 years of age and those over age 55, were more likely than men to elect the mode change. Likewise three-fourths of the women who chose to participate did not have any children at home, compared with just two-thirds of the males. Nearly two-thirds of the transit riders (both genders) did not have children under 16 at home and their households were small. Women who had fewer child-raising responsibilities were more likely to preselect as transit riders.

When respondents signed up, they self-reported their level of transit experience, so a travel packet could be customized. The men who enrolled indicated somewhat more transit experience than the women. Sixteen percent of the men and 31% of the women said that they had no experience riding transit, and 19% of the men and only 10% of the women said that they had a great deal of previous experience ( $\chi^2 = 6.696$ , degrees of freedom = 3,  $p = .082$ ). About one-third of both the men and the women asked for assistance with transit routing, schedules, and maps.

During the initial sign-up, each person was individually matched with the transit provider that had the closest routes and best served the person's home address.

Approximately 50% rode the Big Blue Bus or Culver City Bus; 37% used Los Angeles Metro buses; 8% rode on Los Angeles Department of Transportation vehicles an average distance of 15 to 20 mi; and 5% came on City of Santa Clarita Transit, a coach-style bus with a 35-mi one-way commute. Figure 1 maps the addresses of participants and the residential "hot spots."

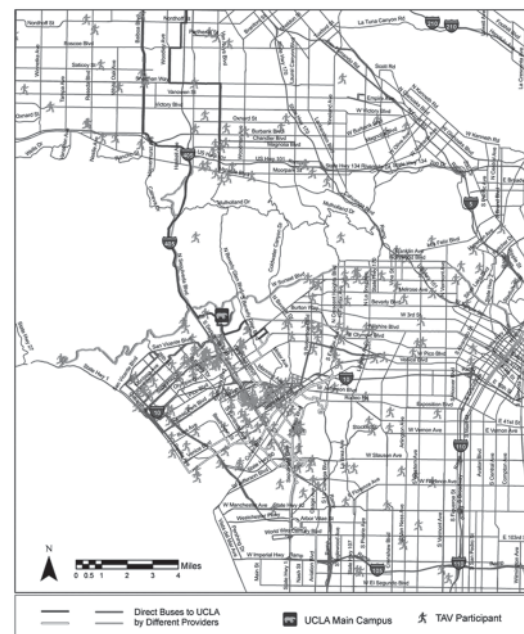


FIGURE 1 Direct bus routes to UCLA and hot-spot locations for take-a-vacation participants.

The median length from home to work was found to be 10 mi, by applying the shortest path function in TransCAD. Additional travel information is reported in Table 3. Women did not live closer to work than their male counterparts, and men and women had equal length trips. By using self-reports from survey data, it was found that the average time to get to the bus stop from home was only 8 min, but the range was large. Some respondents drove to a park-and-ride, but the majority walked from their residences. The self-reported time to get from the bus stop to the office was 6.2 min. The average time spent riding the bus was 42 min, but with large deviations in travel time. Respondents were not asked about the amount of time spent waiting for the bus, because it was assumed that regular commuters learned to time their departure times to the transit schedule.

### MEASUREMENT AT TIME 2: ATTITUDES AND OPINIONS WHILE PARTICIPATING IN TRANSIT

This section reports on participants' attitudes and opinions about 8 to 10 weeks after they began the transit experiment. The riders had not decided yet whether they would continue with transit, return to SOV travel, or find another alternative.

Although the increase in gas prices was the primary reason people said they enrolled, participants cited other rationales: they wanted to try transit, it was more sustainable, and driving was stressful (Table 4). There were no gender-related differences, and both men and women strongly agreed that transit was more relaxing than driving. Furthermore, neither group wished to vanpool or

carpool instead. There was also some agreement that the buses are too crowded and that transit provides a good way to get more exercise. Even on a critical variable about travel flexibility, "did respondents mind the fixed schedule of transit," the mean score was 3.2 on the 5-point scale. Likewise, with regard to the statement "Transit in Los Angeles has come a long way," the response tipped toward favorable, and the mean score was 2.8.

A separate set of questions asked respondents to rate the place where they waited for transit (the bus stop), in regard to its safety, cleanliness, and comfort. There were no significant differences by gender. Only 17 survey respondents, in total, said their bus stop was unsafe.

### MEASUREMENT AT TIME 3: THE DECISION TO RETURN TO DRIVING ALONE (QUANTITATIVE AND QUALITATIVE ANALYSIS)

The substantive interest was whether participants returned to drive-alone commuting after their "free" transit pass expired. This outcome was measured a full 6 weeks after the experiment ended, in case a vacation or payroll-timing delayed the sign-up. Overall, only 114 of the social experiment participants requested parking again ( $114/381 = 30\%$ ). In the experiment, there were 144 men, and the number that requested parking and returned as drivers was 41 ( $41/144 = 29\%$ ). There were 237 women, and 73 regained parking ( $n = 73/237 = 31\%$ ). A chi squared test indicated no significant gender differences ( $\chi^2 = .232$ , not significant at the .05 level). There were also no significant differences among transit carriers (e.g., Metro versus Los Angeles Department of Transportation).

TABLE 3 Actual Travel Distance and Self-Reported Travel Times, by Gender

Variable	Men	Women	t-statistic	Significance
Travel distance in miles (mean)	10.2 (8.58)	10.0 (7.57)	.308	.758
Self-report travel time to bus stop	7.8 (6.6)	9.32 (8.3)	-1.238	.217
Self-report travel time on bus(s)	42.02 (23.2)	42.03 (20.4)	.005	.996
Self-report travel time from bus to work or office	6.0 (3.9)	6.4 (4.6)	-.643	.547

NOTE: Standard deviation is given in parentheses.

TABLE 4 Attitudes About Transit and Driving

Attitude	Male (n = 62)	Female (n = 122)	t-statistic	Significance
Transit is more relaxing than driving	1.1	1.1	1.24	.214
I get more physical exercise when I take transit	2.2	2.1	.632	.181
I might consider carpooling as a commuter option	3.9	3.9	.001	.999
I hate to be tied to the fixed schedule of transit	3.2	3.2	.041	.886
I might consider vanpooling a commuter option	4.3	4.2	.015	.901
The buses are too crowded	2.7	2.6	.287	.787
Transit in Los Angeles has come a long way	2.8	2.8	.194	.845
I still need to drive	4.1	4.1	.018	.894

NOTE: Five-point scale, where 1 = strongly agree, and 5 = strongly disagree.

## PREDICTING THE TRANSIT-SOV CHOICE

Many factors were reviewed, and a smaller set was then identified, which it was expected might predict whether users continued to commute via transit or switched back to driving, particularly geographic influences (22). If women were more constrained by their household duties, then they would be less likely to keep the transit pass, particularly if it involved longer travel times or if they lived further from work. It was also posited that neighborhood density might be a factor because women who lived in denser urban areas might have less need to trip chain for shopping and errands. There were also data on the number of direct bus routes that served the home-to-work commute (for most riders, it was only one). A binary logit regression with this set of geographic variables is presented in Table 5.

Initially 73% of the cases for men were correctly classified. In the final model, the geographic variables, such as distance, number of bus routes, and residential

density, did not show any impact. No additional cases were classified. Among women, 67% of the cases were correctly predicted both before and with the model. The geographic variables were not shown to be additional predictors of mode choice for either men or women.

By using the online survey data from the Time 2 measurement (Aug. 2008), a separate logit analysis based on behavioral and sociodemographic inputs was undertaken. The indicators included the respondent's age (chronological), children under age 16 (0/1), household size (one member to four members), and salary (lowest = 1). Also tested in this model were ratings about the bus stop safety and comfort, the attitudinal variables (1 = strongly agree, 5 = strongly disagree), and whether respondents said they continued to commute by car during the trial.

Table 6 reports the outcome. For this analysis there were not many men ( $n = 57$ ) after cases with missing variables were excluded. The model for men classified 63% of the cases with no information and improved to a classification of 83% on the basis of almost a single variable: whether the

**TABLE 5 Binary Logit of Commute Choice with Geographic Variables**

Variable	Men ( $n = 132$ )			Women ( $n = 217$ )		
	B	Exp b	Significance	B	Exp b	Significance
Constant	-1.110	.329	.081	-.382	.682	.471
Commute distance	-.010	1.010	.759	-.026	.975	.370
Number of bus routes	.101	1.106	.667	-.139	.870	.506
Density high (d3)	-.248	.780	.637	-.097	.908	.807
Density medium (d2)	-.031	.970	.948	.205	1.228	.561
Cox and Snell $R^2$	.003			.009		
Nagelkerke $R^2$	.005			.013		

NOTE: 0 = transit, 1 = car.

**TABLE 6 Binary and Logit Model of Commute Choice with Demographic Attitude Variables**

Variable	Men ( $n = 57$ )			Women ( $n = 117$ )		
	B	Exp b	Significance	B	Exp b	Significance
Constant	5.618	275.3	0.219	-1.463	0.232	0.497
Pay level 1 <sup>a</sup>	-2.938	0.053	0.121	1.621	5.057	0.371
Pay level 2	-3.208	0.04	0.065	2.131	8.421	0.099
Pay level 3 (highest)	—			2.046	7.738	0.109
Statement: Bus stop is safe	-0.089	0.914	0.93	-0.329	0.72	0.498
Statement: Bus stop is pedestrian friendly	0.052	1.054	0.956	-0.092	0.912	0.859
Household size (1)	-1.101	0.332	0.471	0.622	1.864	0.476
Household size (2)	-0.798	0.45	0.59	-0.167	0.846	0.829
Household size (largest)	1.372	3.943	0.367	-1.03	0.357	0.213
Any children <16 (binary)	-0.406	0.666	0.724	0.156	1.169	0.819
Age (chronological)	0.41	1.507	0.387	0.39	1.477	0.122
Statement: Get more physical exercise	0.727	2.066	0.067	-0.266	0.766	0.177
Statement: Hate ties to fixed schedule	0.398	1.489	0.259	-0.149	0.862	0.43
Statement: Drive to UCLA = more than twice a week	-1.12	0.326	0.015	-362	0.696	0.052
Statement: Buses are too crowded	-0.276	0.388	0.588	0.003	1.003	0.989
Statement: LA transit has come a long way	0.138	1.148	0.696	-0.144	0.866	0.553
Cox and Snell $R^2$	0.37			0.21		
Nagelkerke $R^2$	0.5			0.28		

NOTE: 0 = transit, 1 = car, — = no cases.

<sup>a</sup> Number of cases < 7.



respondent drove to work at least twice a week throughout the trial. For women, there was more modest improvement, from a baseline classification of 61% to 66%.

Gender-related variables, such as household size and the presence of children, were not decisive factors. Even the statement "I hate to be tied to the fixed schedule of transit" was not a good predictor. Men tended to cite more the exercise benefits of taking transit, and salary level was somewhat associated with the transit benefit, particularly for women.

The most important result is the influence of continuing to drive a vehicle to work during the 12-week trial. These respondents, both male and female, were far more likely to leave transit at the end of the trial. Another way of stating it is that they never invested in transit to begin with.

One can only speculate on why some participants continued to drive throughout the trial. Perhaps they were less invested in the trial to begin with, and after they signed up, never made the necessary schedule changes or accommodations to successfully use transit. That is a psychological interpretation of their behavior. A more objective approach is to say that there was some unmeasured variable—these participants had needs or preferences that could not be accommodated during the transit trial, and what these were was not captured in the surveys.

A third interpretation, an economic one, is that these participants were never fully vested in the trial; perhaps they were really on vacation away from work for much of the summer and did not commute at all, or perhaps they had settled on a carpool as an alternative.

### QUALITATIVE ANALYSIS OF THE TRANSIT-SOV DECISION

Because the binary logit analyses could not identify why these few participants continued to use their automobiles during the trial, the written, open-ended survey responses were examined for clues. Perhaps respondents would explain, using their own words, some concept or idea, to explain their dependence on driving.

A small textual analysis was carried out of written responses of 41 participants who wrote in a comment and

responded that they frequently drove to campus during the experiment. Through this short textual analysis, it was observed that the most frequently cited reason by women was that their work schedule did not suit the bus schedule, particularly for weekends and evenings, or that they never "got into" transit because they used a different mode or traveled infrequently. For men, the most frequent reason was that they needed a car at work or during the daytime. The written responses are reported in Table 7.

The qualitative analysis suggested that this could be a promising avenue for future research: men and women voice, in their own words, the characteristics of transit riding. In this short analysis, women were more likely to cite atmosphere or onboard conditions, and men mentioned time and schedules. The qualitative analysis was expanded to include the written comments of all respondents who participated in the social experiment and used the open-ended question. A textual analysis was used to identify keywords, but only those that did not have ambiguous meaning (e.g., "flexibility" or "time" were excluded because they are context-dependent and would have required human coders, e.g., during this "time" I take the bus, the "time" I wait, I take a "flexible" bus, my schedule is "flexible"). The statements were assigned on the basis of the keywords, and only the first, or primary, reason was coded per statement.

It appears that the descriptors used by men and women do vary (see Table 8). Women actually mentioned the savings from the program more frequently than men and also mentioned concerns that might be captured in bus-stop safety; namely traveling during the fall, when it was colder, wetter, or darker. A few women mentioned a carpool as an alternative to transit, but men did not. Most of the statements by the men would have involved coding in context for terms such as "travel time," "flexibility," and "schedules."

### SUMMARY AND CONCLUSIONS

This study tracked 381 commuters, 144 men and 237 women, who chose to give up their drive-alone commuting for a 3-month period, in return for a free transit pass. Many of these individuals used the pass only for com-

TABLE 7 Frequency of Mention of Keywords Used Just by Those Who Drove Frequently

Keyword	Men ( <i>n</i> = 12)		Women ( <i>n</i> = 29)	
	Number	Percent	Number	Percent
Not financially viable	2	17	3	10
My work schedule ≠ bus schedule	2	17	7	24
Mobility needs; parking	4	34	3	10
Reliability of bus; travel time	3	25	3	10
Bus seating; comfort on bus	1	8	4	14
Used a different mode; part time			6	21
Don't know; keep parking spot; other			4	14
Time change in fall (gets darker)			1	3

**TABLE 8** Qualitative Analysis of Keywords Used in Open-Ended Comments About Mode Choice Decision in the Larger Sample

Keyword	Male ( <i>n</i> = 41)		Female ( <i>n</i> = 73)	
	Number	Percent	Number	Percent
Safety; darker; time change; crime	4	10	13	18
Children; son; daughter; kids; pregnant; elder care	3	7	6	8
Carpool	0	0	5	7
Household chores; errands; extra trips	0	0	0	0
Gas price; savings; economic; cost	5	12	18	25
Other words	29	70	31	42

mute trips, but others tried it for other types of travel. Although there are differences, what this population shares in common is that they all owned vehicles and for transit companies, they are so-called choice commuters.

Because of gender-related responsibilities, different patterns were expected in how men and women might choose, and then use, the free transit pass. Although women ride buses more than men, it is not clear that this effect would be found in this California study of middle-income women with full-time jobs. That is because their many responsibilities and roles might lead them to favor the flexibility and convenience of an automobile.

In this study, few differences between men and women were actually found. Much of this can be attributed to self-selection. When the respondents initially signed up, they had several days to complete the enrollment process for the driving-transit exchange. During this time, they were likely to look up the bus routes, times, and schedules and examine how feasible it was for them to use transit. It is probable that both the men and women who opted into the program had successfully prescreened themselves and were able to make adjustments, say, in travel time or departure-arrival schedules. At Stage 1, there were no statistically significant differences between the demographics of the men and women who enrolled. The groups were similarly matched on salary, household income, and so on. The men and women were also similar in geographic factors, such as transit time and travel distances. Even those with longer travel times did not ultimately return to SOV commuting.

In the second part of this analysis, survey data were used to explore whether the male and female respondents reported different attitudes and opinions about using transit. Both men and women rated the transit program favorably and said that taking the bus reduced stress. Neither men nor women were more likely to view where they waited for the bus as dangerous or unsafe.

In the third part of this study, two separate binary logit regressions were used to explore factors that might explain whether a respondent returned to single-occupancy driving or stayed with transit after the experimental period. Overall, just 29% of the men and 31% of the women returned to the drive-alone mode. None of the geographic factors, such as

density or travel time, were good predictors of the decision to return to SOV commuting. According to the self-reported survey data, neither were factors such as the presence of children in the household, household size, or perceived travel time. The logit presented an interesting result, nonetheless, which is that the 13% of respondents who continued to drive during the trial were among those who then tended to reclaim parking at the end of trial. It is not known whether the reason is that they could not make the accommodation or would not make the accommodation.

A few gender-related differences were perceived primarily in the open-ended analysis of write-in data. Women commented more about the crowding and discomforts of taking transit, and there was a hint that they were concerned about bus stop safety. Men focused more on their car and how they used it. There is a caution to overinterpreting the qualitative results, because some people may have a propensity to write more if English is their first language, and others will skip write-ins entirely.

There has been speculation in transportation studies that women and men are becoming more alike in their travel for certain markets and for certain trip characteristics (23). This study shows that similar travel choices are made by male and female commuters who are fairly matched on salary, household size, geographical location, travel distance to work, and other characteristics. The key in this study, is that participants self-selected a new travel mode (transit), and those that self-selected had smaller households, less need for a car during the day, and few or no children under age 16. Perhaps these factors were "transit enablers." Surprisingly, once people preselected, distance and travel time were not important factors in their final choice of commute mode. This study lends strong credence to a social experiment approach to transit marketing. More than two-thirds of both the men and the women remained as transit riders when the time came to make a commitment to continue.

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# What Is the Role of Mothers in Transit-Oriented Development?

## The Case of Osaka–Kyoto–Kobe, Japan

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The majority of mothers in Japan are not employed outside the home, but their role in chauffeuring and accompanying children on their trips is much less than in Western societies. Cultural expectations and the built environment in the Osaka region of Japan contribute to children as young as 10 and 11 traveling without adult accompaniment for the majority of trips. This independent travel in turn reduces the chauffeuring burden on parents. The chauffeuring of children in the United States and other Western countries is conducted mostly by mothers, but the role of mothers in the travel context of their children's travel has not been investigated for Japan. Children ages 10 and 11, from nine different schools in varying neighborhoods, were surveyed about their travel by using a child-friendly diary. The survey results show that parents accompanied children for less than 15% of their trips on weekdays, whereas data from the United States indicate that children are accompanied by a parent on more than 65% of weekday trips they make. The average daily travel time was 40 min for children in Japan versus 72 min for their American counterparts, despite a similar number of trips per day. The paper further examines children's trips with the accompaniment of parents, by sex of parent, by time of day and mode, and by destination. The influence of various built environment measurements and car ownership on accompaniment and the accumulated time burden on parents is also examined. This research contributes to land use planning through examining the built environment and mobility management through discussion on cultural values.

This paper examines the role of parents, in particular mothers, in children's travel in Japan. Children's travel in Japan is highly independent of adults (1), which reduces the chauffeuring burden for parents. Children in North America travel frequently by car (2, 3), and mothers in many Western countries provide the majority of that mobility (4). Chauffeuring can be very time consuming (5) affecting other areas of life such as work (4–6) and leisure (7). Considering that, McDonald's comment that "any efforts to improve children's travel options should reduce the burden on mothers" seems appropriate (4).

Besides being a burden on parents, chauffeuring children decreases the independent mobility of children and contributes to low valuation of nonmotorized modes (8). This has an overall negative societal effect because nonmotorized modes are more environmentally sustainable and contribute to health through greater physical activity.

Previous researchers have suggested that built environments that allow for greater nonautomotive mode use could reduce the burden on mothers (9, 10) through improving independence for children (11). Transit-oriented design (TOD) and New Urbanism aim to improve conditions for nonautomotive travel, which potentially could increase children's independence, thus lowering the chauffeuring burden. However, little research has been done on the chauffeuring burden within TOD regions, but mostly comparing differences between pre-WWII neighborhoods and suburban developments in the United States.

The Japanese study area of this paper is highly similar to TOD, with mixed land use, transit-node centered devel-

opment, and high population density. In that context, this paper considers children's trip generation and accompaniment by parents by time of day and mode, parents' time spent chauffeuring by school type, accompaniment by destination, the influence of various built environment measurements and car ownership on accompaniment and the accumulated time burden on parents. It increases the understanding of the role of mothers in a TOD region, land use planning, mobility management, and transportation modeling in transit-oriented development.

## LITERATURE REVIEW

### Culture and Travel

Women have different travel needs and restrictions than men (9, 12). Concerns related to family, health, and safety influence how women travel, including modes used and distances traveled (9). Those concerns must be understood in a cultural context. Mattsson wrote that in parallel with increased concerns over traffic and strangers, the way Western countries view parental involvement and control of children has led to reductions in children's independent travel (7).

Valentine examined the culture of parenting in the United Kingdom and more broadly in Western culture (5). She wrote that what makes an ideal mother is a cultural construct that changes over time and affects the conduct of mothers. How children are viewed will also affect the level of childcare activities that mothers undertake. Valentine wrote that children in Western society are seen as being vulnerable and incompetent in public space, leading parents to feel that children must be supervised for any out-of-home activities. Unfortunately, the romanticized culture of motherhood (how society believes mothers should act) pushes the conduct of motherhood (what mothers actually do) to unrealistic expectations. As a result, mothers in the United Kingdom felt pressure to be the idealized mother, which included accompanying their children to and from activities.

Mothers in the United States most likely face similar peer pressures to chauffeur their children. The result appears to be that women with children make more trips (4, 13) and drive more miles (9) than those without. Many of those additional trips are likely serve-passenger trips for the child (13).

McDonald summarized a number of studies related to mothers shouldering the majority of the chauffeuring burden (4). She found that it was consistent across the United States and a number of European countries. However, the degree to which the mother is burdened does vary. Rosenbloom in a study of parents in the Netherlands [1996, in McDonald (4)] found that Dutch mothers chauffeured children less than their American

counterparts. She associated this with the greater ability for independent travel that Dutch children had. Whether that independence was due to differences in the built environment, socioeconomics, or cultural norms was not mentioned.

Culture and local norms will affect how mothers act with respect to their children (5) and where they choose to live (7, 14). Racial groups can be a reflection of localized cultural factors and can be seen to have different travel patterns from the majority White within the United States (12) as well as in the United Kingdom (5). Valentine found that mothers from South Asian countries stressed the importance of strong local "family" and "community" networks that reduced the burden of childcare. This can also be seen in Japanese families, with 30% of married couples living with parents in 2000 (15).

Household makeup will also most likely affect the burden on mothers. Valentine writes of how single mothers experience particular difficulties in meeting expectations of the West's idealized mother. Rosenbloom wrote that families headed by a woman alone had considerably higher poverty rates in the United States (12). If the community design does not allow for nonmotorized travel, there is an increased financial burden of operating a vehicle. Along with a financial burden, if travel is limited primarily to the car, single mothers will quite likely also suffer an increased burden of chauffeuring for their children. Considering that a chauffeuring burden has been associated with arriving late to work (6), restricting work hours (4, 7), and possibly preventing work (5), any decrease in that burden should improve conditions for mothers, particularly single mothers.

In many Western cultures, the number of stay-at-home mothers has significantly decreased. During the 1950s in the United States 60% of mothers stayed at home, but in 1987 that number had decreased to 7% (5). In Japan, the number of stay-at-home mothers was greater than 80% in 1965 and hovered between 60% and 70% from 1975 to 2000 (15). The majority of Japanese mothers now quit work after the birth of their first child rather than when they marry (as was the case in 1965) (15).

American research found that mothers who did not work full time made more chauffeuring trips (4). If all things were equal, then the Japanese situation of more than 60% stay-at-home mothers coupled with co-residing with grandparents would suggest that children would be chauffeured more frequently as a result of an increase in available time and number of adults. In a previous study on Japanese households grandparents were found to assist with preschool children (16). Rosenbloom wrote that more Asian immigrants were entering the United States than European, so an understanding of the cultural differences and expectations about chauffeuring of children should help policy advisors and planners with the provision of transportation to this group (12).

Parents may view chauffeuring as good parental behavior. Weston did a qualitative study involving teens in Austin, Texas, 13, 14, and 15 years of age in which she found that two of the parents mentioned that their children did not travel alone as they were "Christian" families (8). No further explanation was given as to why that might matter.

The above review indicates that the Western culture of motherhood expects mothers to accompany children, but that they likely have less time than most Japanese mothers because of greater participation in the workforce. Last, in the 2004 TRB Conference on Women's Issues, Meyer wrote that "national and cultural factors will likely have significant effect on women's roles in society and on women's transportation issues," and that "this topic has not received much attention in the literature" (17). Further, he mentioned the importance of including both urban and rural studies. This paper addresses cultural factors in Japan that affect women with children's travel in both rural and urban areas.

### Built Environment and Travel

Ewing and Cervero found in a review of empirical studies that trip lengths were a function of the built environment, trip frequency a function of sociodemographic characteristics, and mode choice a function of both (18). Considering whether that applies to Japan, a study in Japan looked at trip generation and automotive use during a four-decade period with consideration of the life cycle of households and their residential built environment (19). It found that trip generation (frequency) did not significantly vary across the built environment, but with life-cycle stages. Further, it was the built environment that explained mode use more than life-cycle stage. That paper did not look directly at the role of mothers or children's travel as distinct from the household.

A separate paper that looked at children in that same built environment of Japan found that for children 10 and 11 years of age greater population density was correlated with more "near" trips (could be walked in roughly 15 min) (1). Those results suggest that Japanese travel follows the same patterns as summarized by Ewing and Cervero. Further, the children traveled independently of parents for the majority of the time, and quartile increases in population density were correlated with more independence. That suggests that despite the high percentage of stay-at-home mothers in Japan, accompanying young children is infrequent. However, the role that mothers play in the children's travel was not examined in that paper.

An environment that reduces the burden of chauffeuring on parents also improves the ability of children to travel independently. Children in the United States

typically begin to walk or cycle alone at about 8 to 10 (4), but children in other countries such as Sweden (7) may do this at an earlier age. Culture likely has a role as parents in the United Kingdom felt that they had more freedom of mobility when they were young (20), but the parents in Mattsson's study in Sweden did not feel there was a difference. Both countries have seen increased levels of traffic, but perhaps the culture of motherhood differs between the two nations.

Children's independent travel is limited to nonmotorized modes and mass transit, and so aspects of the built environment that contribute to those modes can facilitate an increase in such travel. One aspect of the built environment that may improve conditions for nonmotorized modes is the number of intersections in an area. As intersections increase, the "connectivity" of the area increases, meaning that it is easier to reach different destinations by shorter paths. However, Crane and Crepeau argue that a connection between a decrease in driving and "connected" blocks was not supported empirically (21). They further argue that land use explained little in regard to travel behavior and that no evidence was found for the effect of the street network.

Later studies by Ewing et al. found that density and the intensity of development, mixing of land uses, compactness (proximity of buildings), and density of the street network (the number of intersections per square mile) were associated with less driving (22). Another study led by Ewing et al. (23) found that the built environment was related to pedestrian activity. Their results suggest that factors such as "human scale," "imageability," "enclosure," "transparency," and "tidiness" (in order of decreasing effect) were correlated to walking for adults.

Some research in the United States has suggested that density was not a factor in travel for children (4) or had little impact (10). In Clifton and Dill's work, the maximum density examined was 5,000 or greater people per square mile (2,000 people/km<sup>2</sup>), which means that all other densities would correspond to the lower quartile of density in the Japanese data used here. McDonald's paper used centiles related to population densities in the United States. However, no range of densities was given, and it is unclear whether the range of density was sufficient for the analysis.

Handy showed that the amount of travel by mothers with children in comparison with those without was not statistically different in "traditional" neighborhoods, but was greater in suburban areas (9). That suggests that in a car-oriented area, the burden of chauffeuring is more substantial for mothers.

Although the exact role that the built environment plays in travel is not understood, long distances to destinations most likely encourage motorized mode use. The availability of mass transit works on economies of density, meaning that greater service levels are possible with

higher population density. Therefore, lower densities restrict options for children to travel independently. That lack of accessibility leads to dependence on parents for chauffeuring, which typically falls on the mother (4).

## STUDY AREA

The participants of this study come from the Kei-Han-Shin area (Japanese abbreviation for the metropolitan area consisting of Kyoto, Osaka, and Kobe, Japan). Kyoto and Osaka are historically major cities, and rail-based mass transit began before 1900 in both cities. The area continued to develop and expand on a rail-based transit system throughout the 20th century (24). Most rail transit is run privately, although Japan's major rail lines were previously owned by the government and subways are still run mostly by the cities themselves.

Japan uses a planning system based on the German system (24), which allows for mixed land use. The majority of travel in the study area is not by private motor, and previous research suggests that the built environment is a strong factor in explaining private motor use for the area (19). For further discussion on the Japanese built environment and culture, see Appendix A.

The area is consistent with definitions of compact, transit-oriented development having a strong backbone of rail-based travel, extensive bus routes, mixed land use, and high population densities (central areas are typically above 40 people per acre, and noncentral urban areas are typically in the range of eight to 24 people per acre).

The elementary schools that participated in the research came from a variety of different built environments. They were selected for the built environment that they represented and were contacted through intermediaries (a system of introductions is expected in Japanese culture). Grade 5 students (10 and 11 years of age) were chosen because they were felt (by the teachers) to be able to complete the children's travel diary (1) and were of an age commonly used in international studies on children's travel. For details on the diary, see Waygood and Kitamura (1).

The local schools (public schools located in the community) were from a farming community, a town, a planned urban expansion of a major city from the 1960s, and an unplanned high-density urban area. For more details on those schools, see previous work (1).

The nonlocal Japanese school (elite public school that was not in the majority of attending children's neighborhood) is located in a historically old (existing for more than a 1,000 years) urban area, and the children come from a range of areas from within that same neighborhood to low-density, peripheral development.

The three non-Japanese schools (nonpublic school in which the students identified themselves with a non-Japanese culture) were all located in urban areas. One was near a central train station, and the other two were located in noncentral locations, but were still within walking distance of train stations and had frequent (less than 20-min intervals) bus service. The children at those schools lived in a range of areas similar to the nonlocal Japanese school.

Average characteristics for the children's neighborhoods are shown in Table 1. A neighborhood was defined as a 1-by 1-km (0.62- x 0.62-mi) square anchored by the child's home postal code. On weekdays there were 388 students from local schools, 68 from nonlocal Japanese schools, and 35 from non-Japanese schools who completed the travel diaries. On Sundays there were 332 students from local schools, 35 from nonlocal Japanese schools, and 36 from non-Japanese schools.

Population density and business density are anticipated to decrease the burden of chauffeuring because they increase the accessibility (by decreasing distance) of various destinations. Increased intersection counts, both three- and four-way, should decrease the chauffeuring burden because they should increase connectivity. The distance to city hall is a proxy measure for a decrease in mass transport service. Along with potential decreases in population density and business densities, a higher level of mass transit most likely exists as one approaches the center. Those assumptions result in the assumption that greater distances from the local city hall may be related to an increase in chauffeuring

TABLE 1 Average Characteristics of Children's Neighborhoods, by School Type

	Influence on Chauffeuring	Local		Nonlocal Japanese		Non-Japanese	
		Weekday (N = 388)	Sunday (N = 332)	Weekday (N = 68)	Sunday (N = 35)	Weekday (N = 35)	Sunday (N = 36)
Population density (people per acre) <sup>a</sup>	Negative	21.7	19.1	29	27.9	26.7	28
Business density (businesses per acre) <sup>a</sup>	Negative	0.25	0.22	0.37	0.32	0.37	0.37
Three-way intersections <sup>b</sup>	Negative	229	220	214	189	269	259
Four-way intersections <sup>b</sup>	Negative	59	56	67	57	74	79
Distance to local city hall (mi) <sup>b</sup>	Positive	1.7	1.7	3.8	3.5	3.2	3.2

NOTE: All children were age 10 or 11.

<sup>a</sup> Japanese census bureau, 2000.

<sup>b</sup> www.mapion.co.jp.

as this will most likely correspond to reduced transit service among other factors.

### COMPARISON BETWEEN UNITED STATES AND KEI-HAN-SHIN

This section compares some of the travel metrics obtained from the survey of children from the Kei-Han-Shin area with comparable available data on children's travel from the United States (2) and Calgary, Canada (3), where possible. The data from the United States come from the 2001 National Household Travel Survey (NHTS). The average number of trips by mode, total trips, and travel time per day are shown in Table 2.

For mode use, there are strong differences. The dominant mode in the United States is by automobile, whereas in Japan it is walking. Japan does not rely on school buses, except for some children attending private preschools and kindergartens. The children in the Kei-Han-Shin area also had considerable "other" trips, which in their case were composed of cycling, train, and bus use. Children ages 10 and 11 in Calgary, Canada, made 42.5% of their home-based school trips by foot, with 28.2% by car and 25.5% by school bus. However, after school, more than 75% of their travel is by car and walking falls to 18.1%.

The number of trips per day was greater in the United States, 3.52 versus 3.44. This might suggest greater participation in activities, but in McDonald's paper a purpose category that represented 0.4 trips on a school day was "serve-passenger" trips. By her definition, those trips are when the child only accompanies a parent or sibling somewhere suggesting that child-focused trips may be fewer. Unfortunately, in both data sets it is not clear whether trips were for the child. Children ages 10 and 11 in Calgary, Canada, made roughly 3.2 trips per weekday.

The amount of time spent traveling each day is far greater in the United States (72 min on average) than for the children in the Kei-Han-Shin area (40 min on

average). If time is a measure of convenience, the Kei-Han-Shin area would appear to be more convenient. As a further source of comparison, children ages 10 and 11 in Calgary, Canada, also spent more than 70 min a day on travel.

With the companion definitions from McDonald's paper, the results for the two groups are shown in Table 3 (2). In that table, the clear difference is in the number of trips made with a parent. In the United States more than 65% of trips were with a parent, but Kei-Han-Shin had only 14.6%. Considering that, it can be assumed that most trips for the Japanese children were for them and not "serve-passenger" trips as defined by McDonald [this definition differs from that used by Kitamura (25) and Cooperman and Bhat (26)]. The non-household (non-HH) person for the Kei-Han-Shin children were overwhelmingly (94.9%) other children. The results for the United States are unknown.

Further considering convenience, parents in Bonner's study commented that reduced chauffeuring was highly desirable and any reduction freed the parents (14). That was echoed by results in a paper on mothers' chauffeuring in the United States (4). Children in Calgary ages 10 and 11 made roughly 67% of their weekday trips with a parent for all or part of their trips.

Comparison of travel metrics of children's travel from Japan, the United States, and Canada indicates that the Japanese children appear to have much greater freedom, relying on parents and cars far less often, while retaining similar levels of trip generation. The Japanese children also spent less time traveling, which combined with the low levels of parental accompaniment suggests a more convenient transportation system for both children and parents and an overall more environmentally sustainable transportation system.

Considering research that links the chauffeuring burden of mothers in the United States and the United Kingdom, and in particular single mothers, such reductions should be highly desirable. Not only are the majority of trips nonmotorized, which cost little, the overall travel time is small. The amount of travel that is related to chauffeuring is examined next.

**TABLE 2** Average Number of Trips by Mode, Total Trips, and Total Travel Time per Day for Children Age 10 and 11 in the United States and the Kei-Han-Shin Area of Japan

Mode and Travel Time	United States <sup>a</sup>	Kei-Han-Shin <sup>b</sup>
Auto passenger	2.6	0.4
Walk	0.5	1.8
School bus	0.4	0.0
Other	0.1	1.3
Total	3.52	3.44
Travel time per day (min)	72.0	40.0

<sup>a</sup> National Household Travel Survey, Federal Highway Administration, United States, 2001.

<sup>b</sup> Children's Travel Diary, Osaka Metropolitan Area, Japan, 2007–2008.

**TABLE 3** Weekday Companion Percentages for Children Age 10 and 11 in the United States and the Kei-Han-Shin Area of Japan

Companion	United States <sup>a</sup>	Kei-Han-Shin <sup>b</sup>
Alone	8.5	28.8
With parent	65.5	14.6
With sibling	7.5	5.7
With nonhousehold person	18.5	51.0

<sup>a</sup> National Household Travel Survey, Federal Highway Administration, United States, 2001.

<sup>b</sup> Children's Travel Diary, Osaka Metropolitan Area, Japan, 2007–2008.



## ANALYSIS AND DISCUSSION OF JAPANESE CHILDREN

Children's trip generation and parental accompaniment by time of day and mode, parents' time spent chauffeuring by school type, accompaniment by destination, the influence of various built environment measurements and car ownership on accompaniment and the accumulated time burden on parents are examined next. All data come from the children's travel diary. Weekdays and Sundays are examined separately.

### Weekday

#### Mode Use and Trip Generation by Time of Day

Three figures are presented in this section that show information related to children, travel with a parent and travel with the mother only. Children's travel is shown first in Figure 1. For multimodal trips the trip was coded by a hierarchy of nonmotorized (lowest), mass transit, and private vehicle (highest). This means that if one segment was by private vehicle, the trip was considered private vehicle. Mass transit took precedence over nonmotorized. A nonmotorized trip was only by foot or bicycle.

Children's travel in this area was seldom by private motor (Figure 1). All children are expected to get to school by walking, and those that live beyond walking distance (e.g., attending a specialized, nonlocal school) used mass transit for the most part. As a result of the coding system, children who were driven to the train station near their homes were counted as private motor

trips, thus the percentage of private motor trips is overestimated. Children's travel peaks in the morning before school starts and then again after school. The period from 3 to 6 p.m. sees considerable trip generation, suggesting more than just a return home.

Comparing those results with those for children ages 9 to 11 in Calgary, Canada (3), more trips were made by the Japanese children after the initial trip home. This may suggest that the Japanese children are more able to make excursions. This may be connected to their low reliance on parents for postschool travel.

The magnitude of the number of trips in Figure 2 is about 15% that of Figure 1. The majority of travel with a parent or parents was by private motor (90.7%); however the majority of children's travel was by nonmotorized modes (79.1%, Figure 1). Parents accompanied children on only 14.7% of all trips on weekdays, of which 82% were with only the mother. This suggests a very low burden on parents, although disproportionately on mothers.

Accompanied trips peak between 6 and 7 p.m., and the top three trip-generation hours were between 4 and 7 p.m. Considering Figure 1, this suggests that parents make trips with children after they have returned home from school.

The results shown in Figure 3 are very similar to those in Figure 2. Of the travel during which only the mother accompanied children, 70.3% was by private motor, 24.3% by nonmotorized, and 5.4% by mass transit modes. Of those, 25.2% were with more than one child, but that represents only 32.7% of all trips in which the children traveled with a sibling for weekdays. That means that although there is a positive correlation

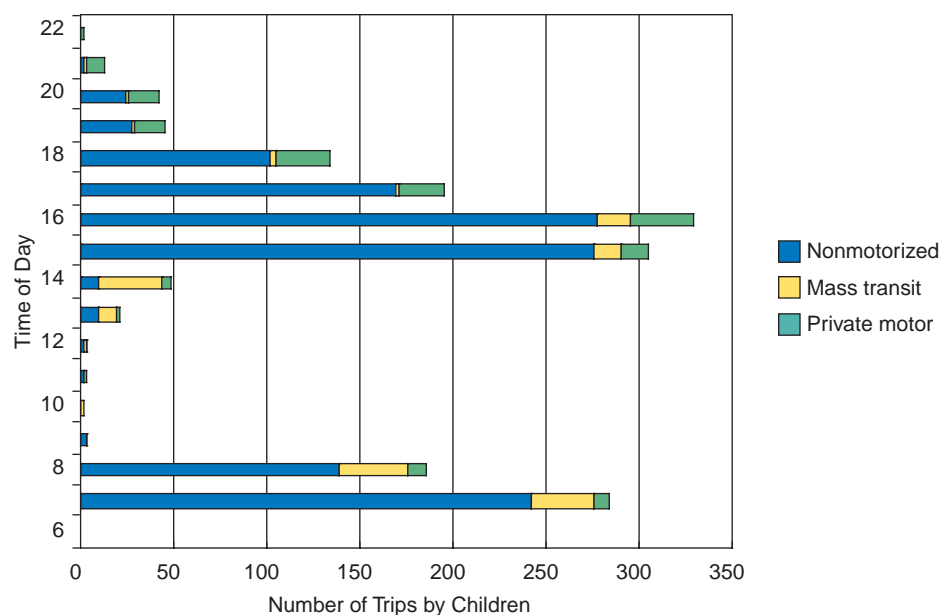


FIGURE 1 Children's mode use on weekdays, by time of day ( $N = 491$  children).

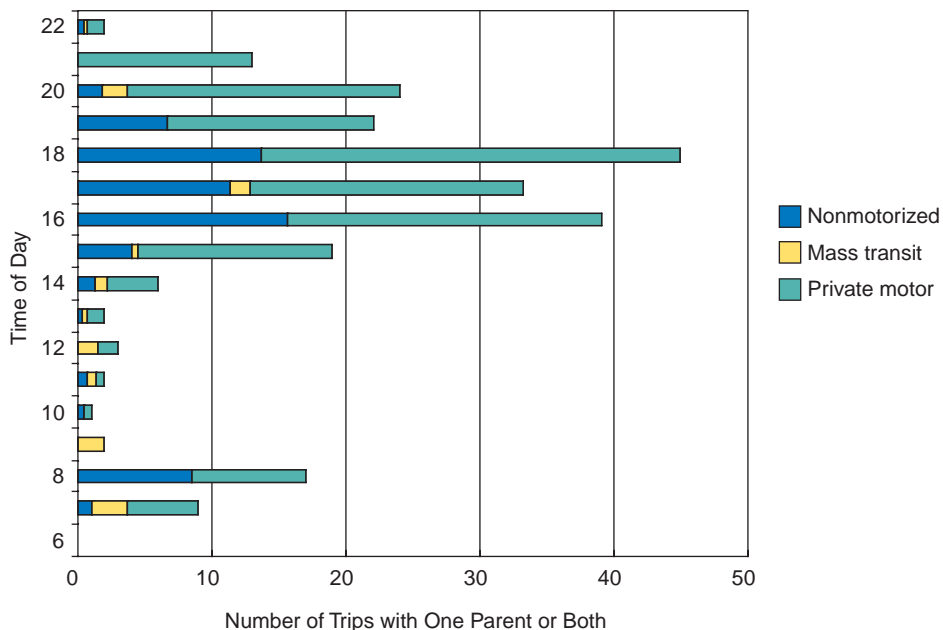


FIGURE 2 Mode use of children when one or both parents are accompanying the child on a weekday, by time of day.

for trips by only the mother with siblings (0.203,  $p < .001$ ), mothers do not accompany the majority of trips in which both children are going to the same destination, nor are they on the majority of trips (12.8%).

Comparing Figures 2 and 3 with Figure 1, it can be seen that the number of trips that parents are involved in were quite small, and the large presence of private

motor trips with parents in Figures 2 and 3 shows only as a small fraction in Figure 1. Mothers alone made the vast majority (81.6%) of chauffeur trips during the week. From McDonald's work, roughly 40% of trips by children ages 10 and 11 in the United States were with only the mother and roughly 12% with only the father (2).

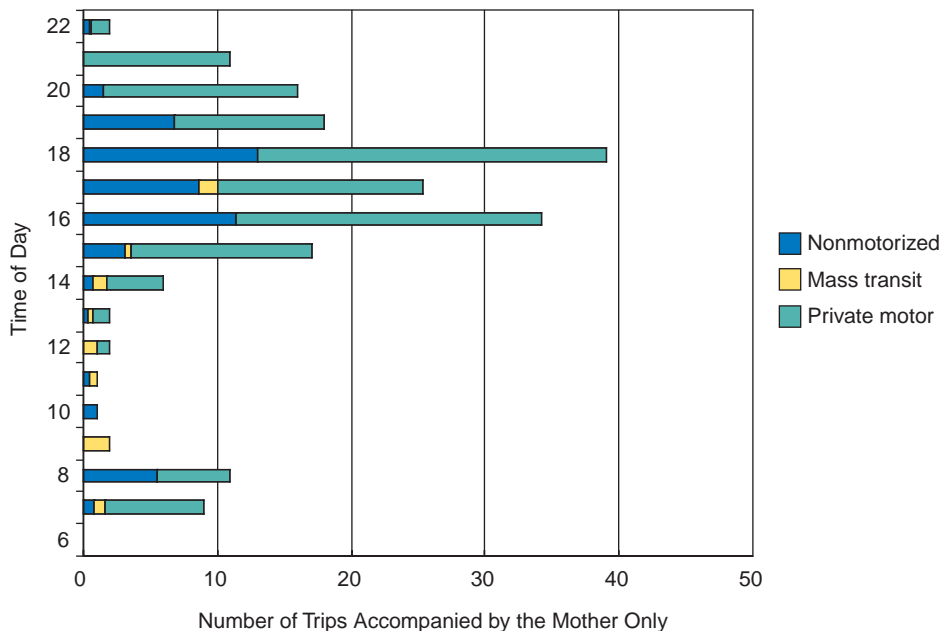


FIGURE 3 Mode use when only mother accompanies child on a weekday trip, by time of day.

**Time Spent on Accompanied Trips**

The average time spent accompanying a child on trips during a weekday are shown for three different school types available in this data set in Table 4. For the local schools very little time is spent accompanying a child (<5 min), and the nonlocal schools average 14.6 min and 15.6 min for the Japanese and non-Japanese schools, respectively. Although this time is still minimal, the effect of sending a child to a nonlocal school apparently increases the chauffeuring burden on parents, particularly mothers.

It can be seen from Figures 2 and 3 that chauffeuring for the most part is in the evening, by private vehicle, and by only the mother. However, the cases in which only the mother accompanies are less than 13% of all trips, suggesting a low overall burden.

**Destinations**

The relation between destination and accompaniment are shown in Table 5. Restaurants and shopping were the top two destinations by frequency of accompaniment, and both of these could be considered as non-serve-passenger trips (serve-passenger trips are defined as trips made for the passenger).

For trips in which only the mother accompanied the child, shopping followed by restaurant were the destinations most frequently accompanied. Again, the argument could be made that these trips would be made by the mother regardless of the child.

McDonald showed the percentage of trips by parents with accompanying children in the United States to vari-

ous destinations (4). Although it is not clear from the paper whether the NHTS includes both weekday and weekend data, the top four purposes were serve passenger, shop, visit friends/family, and meals. As McDonald highlights, aside from serve-passenger trips, all of those top destinations or purposes could be classified as family trips. Interestingly enough, trips to school represented only 2% of all accompanied trips.

For the Japanese children, the most frequent trips were to home, school, other home (another person's home), other (unclassified destination), and park. Aside from unclassified destinations, all of those destinations were among the least frequently accompanied. As those are the most frequent trips for children, it is important that children can make them independently of parents to reduce the chauffeuring burden.

**Sundays**

This subsection presents information for parents' trips related to children for Sundays and follows the same organization as weekday information presented above.

**Mode Use and Trip Generation by Time of Day**

Three figures are presented in this section that show information related to children, travel with a parent, and travel with only the mother. Children's travel is shown first in Figure 4.

From Figure 4 on children's travel for Sundays one can see that private motor mode share does not represent

**TABLE 4 Results of Analysis of Variance on Weekday Chauffeuring Burden, by School Type**

	Chauffeuring Burden (min)			P-value
	Local (N = 388)	Nonlocal Japanese (N = 68)	Non-Japanese (N = 35)	
Parent(s)	4.3	14.6	15.6	< 0.001
Mother only	3.7	11.6	12.6	< 0.001

NOTE: Table shows the sum of all time spent over a weekday accompanying a child (regardless of mode).

**TABLE 5 Weekday Accompaniment, by Destination**

Destination	Percentage of All Trips (N = 1,653)	Person Accompanying Child (%)	
		Parent(s)	Mother Only
Restaurant	0.5	55.6	22.2
Shopping	4.1	37.3	32.8
Other	5.9	26.5	21.4
Cram school	4.1	20.9	19.4
Religious place	0.3	20.0	0.0
Convenience store	1.0	18.8	12.5
Home	43.3	16.5	13.1
Other home	7.6	12.8	12.0
School	28.9	5.2	4.0
Park	4.3	4.2	4.2

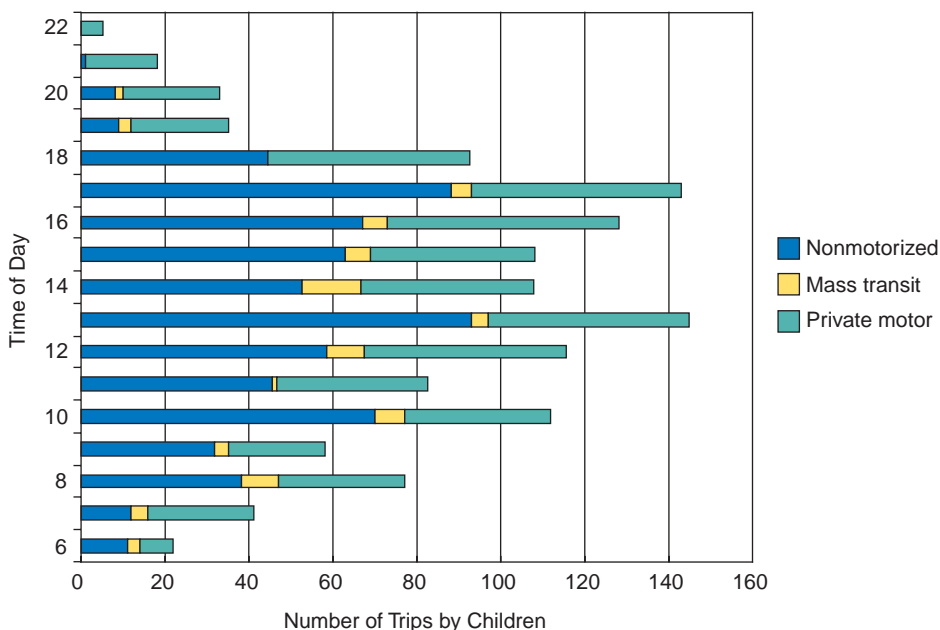


FIGURE 4 Children's mode share for Sunday trips, by time of day ( $n = 405$  distinct children).

the majority of trips until 6 p.m. The majority of trips for children occur between 10 a.m. and 7 p.m. The same peaks can be seen for travel with parents in Figure 5. That suggests that travel for children and children with adults is more related on Sundays than on weekdays. This suggests that during the week when the children have school obligations and adults have work or home management obligations, each conducts travel independently, but on

Sundays when those obligations are reduced, travel by the family is more likely.

When parents were involved, the majority of travel at all times of day was by private motor (Figure 5). For Sunday travel the magnitude difference between trips made by children (Figure 4) versus those made with a parent (Figures 5 and 6) is roughly 50% compared with only 15% on weekdays. This shows that parents were

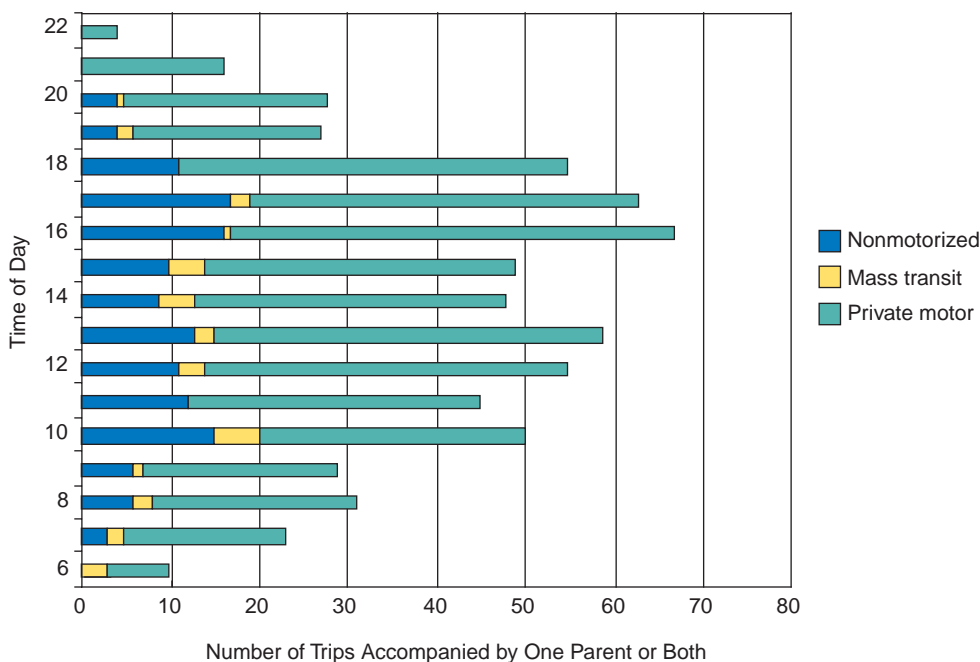


FIGURE 5 Mode share for children's Sunday trips accompanied by one or both parents, by time of day.

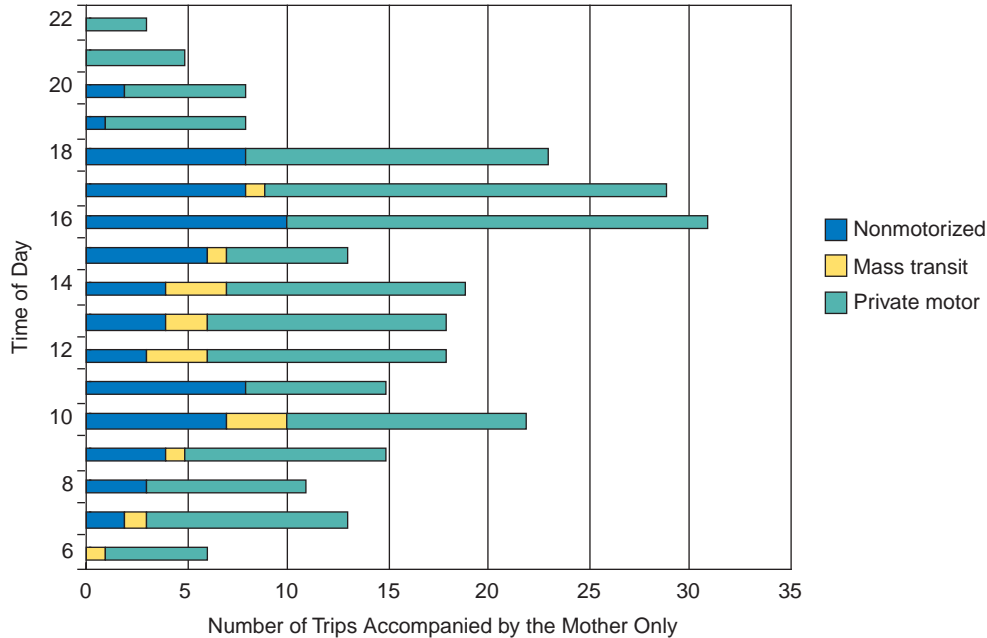


FIGURE 6 Mode share for children's Sunday trips accompanied by mother only, by time of day.

involved in more trips on a Sunday, which is consistent with the cultural behavior of family-centered activities on Sundays.

The peak number of trips when only the mother accompanied a child was from 4 to 7 p.m., which was the same as during the week. A similar, though less distinct peak can be seen in Figure 5, suggesting that in general more accompanied trips occurred at that time of day.

Sunday travel was significantly different from weekday travel, with the children making 52.0% of trips by nonmotorized modes, 41.2% by private motor, and 5.8% by mass transit. Of those, 48.6% were with a parent or both, and 19.0% were with only the mother. In contrast, fathers accompanied children on 7.4% of trips without the mother. Mothers again are involved in the majority of accompanied trips (41.4% of all trips), but most of those appear to be trips with the family (48.6% - 19.0% = 29.6%).

With respect to mode share when a parent accompanies, 73.8% were by private motor, 21.0% were nonmotorized, and 5.2% by mass transit. Trips in which only the mother accompanied the child, 65.6% were by private motor, 27.2% were nonmotorized, and 7.2% by mass transit.

*Time Spent on Accompanied Trips*

The average chauffeuring burden for parents on Sundays is shown in Table 6. Unlike weekday travel, the school averages are not statistically different. For parents, the average times spent traveling with children for the two Japanese schools—both local and nonlocal—were roughly equivalent, but the average for the non-Japanese school was roughly 12 min more. This may relate to social connections being at greater distances for the non-Japanese children and their families.

For trips with only the mother, the amount of time spent traveling was quite different from that by the parent(s) variable. This is different from the results for weekdays in which the two values were similar (as mothers did 81.6% of accompanied trips). However, the total amount of time increased for two out of the three schools in comparison with weekday travel burdens. The result that the nonlocal Japanese school decreased may be related to a larger percentage of those children living in higher-density areas than for the local schools. Increasing independent travel was correlated with higher population density in a previous study (1).

TABLE 6 Results of Analysis of Variance on Sunday Chauffeuring Burden, by School Type

	Chauffeuring Burden (min)			P-value
	Local (N = 332)	Nonlocal Japanese (N = 35)	Non-Japanese (N = 36)	
Parent(s)	38.3	38.0	50.8	0.512
Mother only	15.7	9.8	26.4	0.262

NOTE: Table shows the sum of all time spent over a Sunday accompanying a child (regardless of mode).

### Destination

Similar to on weekdays, the most commonly accompanied trips were to restaurants or shopping and the same argument could be made that they are likely not serve-passenger trips, but family trips (Table 7).

However, for trips in which only the mother accompanied the child, the most frequent were to a cram school, shopping, and then school (this could be a school other than the one the child attends). Two of those, cram school and school, were likely serve-passenger trips. So here one sees that mothers are more likely to be involved in serve-passenger trips, whereas parents on Sundays are most likely involved in trips that are not serve-passenger. This corresponds with Valentine's analysis of the conduct of fatherhood in which fathers accompany children as a family unit rather than as a service to the child (5).

### Correlations

In this section trips with one parent or both and with only the mother are correlated (Pearson's  $r$ ) with measures of companions, gender, household car ownership, built environment measures, and institutional associations. Correlations that are statistically significant ( $p < .001$ ) and are at least a low correlation (0.100) are shown in Table 8. Correlations that are between 0.300 and 0.500 may be considered medium correlations. These are linear relationships between the two measures being considered. For example,  $-0.327$  for weekday trips between parent(s) and with friend(s) suggests that there is a medium-strength relation between not traveling with a parent and with a friend. Correlations that are consistent across both weekday and Sundays will be considered stronger results here as they exist despite the different constraints on those days (e.g., available time) and are discussed.

TABLE 7 Sunday Accompaniment, by Destination

Destination	Percentage of All Trips	Person Accompanying Child (%)	
		Parent(s)	Mother only
Restaurant	5.0	80.9	19.1
Shopping	17.5	71.5	25.1
Cram school	1.1	53.3	33.3
Other	15.1	51.0	18.5
Home	33.4	50.4	21.1
School	4.4	38.3	21.7
Convenience store	2.5	38.2	11.8
Religious place	2.0	32.1	17.9
Other home	12.2	29.5	17.5
Park	6.8	6.5	2.2

Considering the results shown in Table 8, children travel with friends typically without parental accompaniment. This is likely linked to a safety concern from the parents, but could also be a desire to socialize from the children.

Travel with siblings is correlated to travel with parents, but not consistently to travel with only the mother. That difference may suggest that travel with siblings may be family related and during the week the father may not be present.

Boys do not travel with only the mother as often as girls do. This may be related to boys being allowed more independent travel, but could also be that mothers and daughters may have a stronger desire to travel together for interaction or have similar interests.

An increase in household car ownership was positively correlated to more accompanied trips. Considering that population density was not correlated, this may be the result of the physical ease of travel by car, but could also be what is seen as "normal." Advertisements on television for vehicles have catch phrases such as "I am a father," suggesting that a father drives his family places.

TABLE 8 Correlation Between Being Accompanied (Was or Wasn't) by Parent(s) or Mother Only and Presence of Companions, Built Environment Measures, and Institutional Associations

Measure	Parent(s)		Mother Only	
	Weekdays	Sundays	Weekdays	Sundays
With friend(s)	-0.327	-0.468	-0.291	-0.168
With sibling(s)	0.214	0.337	0.203	n.s.
Boy	n.s.	-0.114	-0.104	-0.102
Household car ownership	0.133	0.107	0.124	n.s.
Population density	n.s.	n.s.	n.s.	n.s.
Business density	n.s.	n.s.	n.s.	n.s.
Three-way intersections	-0.136	n.s.	-0.124	-0.133
Four-way intersections	n.s.	n.s.	n.s.	-0.117
Distance to city hall	n.s.	n.s.	n.s.	n.s.
Local school	-0.201	-0.107	-0.194	n.s.
Japanese nonlocal school	0.147	n.s.	0.153	n.s.
Non-Japanese school	0.126	0.337	0.107	n.s.

NOTE:  $N = 1,692$  for weekdays and  $1,385$  for Sundays. All values shown are  $p < 0.001$ ; n.s. = not significant.



FIGURE 7 Maps showing (a) a more “organic” area with a majority of three-way intersections, although major roads have been widened and straightened, and (b) an area with some three-way intersections, but overall greater organization, or planning of all roads. Both images are drawn to the same scale and are roughly 400 m by 300 m.

The negative correlation between three-way intersections and travel with only the mother may be related to the type of built environment. Within this built area, higher counts of three-way intersections were associated with older, more “organic” (meaning less planned) built environments (Figure 7). Those areas developed with nonmotorized travel as the primary means of travel and so may naturally facilitate children’s travel (being dependent on nonmotorized travel) and reduce the need to accompany children due to distances or traffic danger caused by high-speed vehicles. Travel that is not family oriented may not need accompaniment in those areas.

Further to three-way intersections, the author’s experience suggests that the more “organic” areas may have a greater number of small stores dispersed around the neighborhood as opposed to a more clustering or “main street”–“high street” type of shopping. However, that was not investigated in this research.

The difference in correlations for the types of schools may be related to both distance and community connections. Children attending nonlocal schools must travel farther distances, and parents may drive the children to the local train station (they were not driven to school), which would count as a chauffeured trip by the definition used in this research. The other possibility is that the children who attend nonlocal schools establish friends who live at greater distances, and parents then drive them to a friend’s home. This may be true especially for children attending non-Japanese schools potentially because of further separation from the dominant culture.

The correlations between the accumulated chauffeuring time burden for parents and only the mother with gender, household car ownership, built environment measures, and exercise measures are shown in Table 9. The exercise measures used were the number of recorded occurrences of vigorous physical activity per day and

the accumulated minutes of nonmotorized travel over the day. The exercise measures used were the number of recorded occurrences of vigorous physical activity per day and the accumulated minutes of nonmotorized travel over the day. Of the results, only a few were consistent over weekdays and Sundays. Those results are discussed below as they are likely stronger because they retain correlation despite the different obligations that those days have.

For parents, higher household car ownership was positively correlated to more time spent chauffeuring. What exactly that shows is not clear, but it may be that those families are more “car oriented” and travel to destinations that accommodate such travel. As in other countries, such development is often in low-density areas where land costs are lower and as a result, the longer traveling distance may result in greater time conducting similar activities, as seen in Kitamura et al. (27).

Increased three-way intersection counts were negatively correlated with time spent traveling by parents with children. As mentioned previously, higher three-way intersection counts most likely relate to more “organic” neighborhoods that grew with walking as the core mode of transportation. That factor is likely to enable more children to travel independently of parents, reducing serve-passenger trips and the overall travel time burden for parents.

For trips in which only the mother accompanied the child, only population density had consistent results. An increase in that measure was negatively correlated with increases in accumulated travel time. Referring to Table 8, no correlation was found for accompanied trips with population density. That result suggests that parents are still making accompanied trips, but just that the time spent is reduced. What may be happening here is that in higher densities, destinations are closer and that overall

**TABLE 9** Correlation Between Accumulated Chauffeuring Time Burden and Gender, Household Car Ownership, Built Environment Measures, and Exercise Measures

Measure	Parent(s)		Mother Only	
	Weekdays	Sundays	Weekdays	Sundays
Boy	-0.116	n.s.	-0.114	n.s.
Household car	0.153	0.130	0.139	n.s.
Population density	n.s.	-0.132	-0.104	-0.150
Business density	n.s.	n.s.	n.s.	-0.142
Three-way intersections	-0.113	-0.171	n.s.	-0.229
Four-way intersections	n.s.	n.s.	n.s.	-0.153
Distance to city hall	0.125	n.s.	n.s.	n.s.
Vigorous physical activity per day	n.s.	-0.133	n.s.	n.s.
Nonmotorized travel (min per day)	n.s.	n.s.	n.s.	n.s.

NOTE: All values shown are statistically significant at  $p < 0.01$ ; n.s. = not significant.

time is reduced despite lower average travel speeds (by traveling with nonmotorized modes or through greater congestion).

## GENERAL DISCUSSION

This paper showed that children's travel in Japan takes less time than for children of the same age in the United States and the children are seldom accompanied by parents. The overall results suggest a system that has a low chauffeuring burden on parents and one in which destinations that are most frequently accompanied are "family destinations" as opposed to serve-passenger ones (such as dropping a child off at a soccer game). The reasons for this low burden are most likely twofold. One is that the built environment is more accommodating to nonmotorized travel. The second is that children are expected to travel independently.

Previous research (1) found that children ages 10 and 11 in more urbanized areas (higher density) were more independent than those in lower-density areas (particularly below eight people per acre). This research found that increases in population density were associated with lower time burdens for trips in which only the mother accompanied the child and that areas that were more "organic" in their design were linked to less time for parental accompaniment.

Parents in this area of Japan did use cars more frequently than other modes when they accompanied children, as did parents in the North American examples, but the frequency of accompaniment was far less. That situation is what the parents in Bonner's study were likely referring to when they spoke of the high burden of chauffeuring in major urban settings in Canada (14). The reduced chauffeuring burden that exurbanites felt existed in a rural setting was what led them to believe that a rural setting was easier for raising children. However, this research suggests that urban settings do not

need to be such a burden on parents and that low levels of chauffeuring are evident in highly urbanized settings.

That view is supported by both Hillman et al. (20) and Mattsson's (7) work on children of non-English cultures. The children in Mattsson's work in Sweden had independent mobility, but the more rural were more car dependent and mothers were the ones to suffer that lack of independence. The parents of that study did not believe that their children had less independent mobility than they themselves had when they were young, compared with English parents who did in the work of Hillman et al.

In Hillman's study, German children had much higher independence than English children. The authors attributed that difference to both land use and cultural differences. German planning allows for mixed land use, and the children quite likely had more nearby destinations (improved accessibility). On the cultural side, the role of unknown parents was different between the cultures. English adults are expected to "mind their own business," whereas German adults have the responsibility to observe and admonish children who are out in public.

The greatest issue may be trying to change people's expectations and what they view as "normal." In Japan, "normal" is that children should get to school without relying on their parents. "Normal" is the use of bicycles by the young, the working, and the old for functional trips as opposed to leisure. In that situation, the burden of children's travel does not rest on the mothers' shoulders; independent travel by children is normal and widespread.

The youth in Weston's (8) thesis (based in Texas) were highly reliant on parents, despite being young adults (13 to 15). She described their travel as "lacking," and described how many did not know how to reach the nearest store. An aversion to mass transit was evident, along with ceasing the use of nonmotorized modes when they observed that the social norm at high schools was not to travel by such modes. If independent modes such as nonmotorized and mass transit are ostracized then the



children must rely on their parents or others that are of driving age. Considering the fatality rates of young drivers (28), a societal push toward such travel behavior is less than desirable.

Increasing children's independence should decrease the mother's chauffeuring burden. A major aspect of enabling children's independent travel is to make non-motorized travel possible. A fundamental aspect of that is to reduce distances. In North America, zoning practices segregate uses and promote low density. Those two factors combine to create a situation in which most destinations are considerably far away. If a car is available, travel will most likely be by that mode, which then contributes to traffic danger, which is another factor that reduces nonmotorized mode use for children (20). A major hurdle that must be addressed is the appropriateness of the current zoning practices to modern realities such as sustainable travel that contributes to people's well-being.

## CONCLUSIONS

This paper examined the role of parents, and specifically trips in which only the mother was present, in children's (ages 10 and 11) travel for transit-oriented development. The initial comparison between children in North America and Japan showed that children's travel in North America could be characterized as highly reliant on parents and cars, whereas the Japanese children's travel was highly nonmotorized and independent.

Focusing on the Japanese data, the results showed that although mothers did escort children more frequently than did fathers, the overall frequency of accompaniment on weekdays was quite low and approached 50% only on Sundays. Of trips in which parents did accompany children, the top two destinations were for trips that were likely not serve-passenger trips. However, for trips with only the mother, two of the top three destinations were likely serve-passenger, suggesting that in this culture mothers are more relied on for children's travel than are fathers. When parents accompanied the children, it was often by private motor.

Households with more cars were correlated with more time spent chauffeuring per day, and more chauffeuring was associated with parents whose children attended nonlocal schools. Overall however, within this system, children rarely relied on parents and the burden of chauffeuring was quite small.

This research was a preliminary investigation into the role of mothers in children's travel within a transit-oriented developed area of Japan. Future research should look at travel by women with or without children during the day considering residential built environment, education levels, economic status, and workforce involvement.

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## APPENDIX A

### FURTHER DISCUSSION ON THE JAPANESE BUILT ENVIRONMENT AND CULTURE RELATED TO TRAVEL

There are obviously differences in the built environment and culture between North America and Japan. Japan allows for mixed land use and, combined with higher levels of population density, that supports local shops and increases the chance of destinations being on a local level. This allows for nonmotorized travel by both adults and children. Most shopping trips are still by nonmotorized modes in the Kei–Han–Shin area (Kitamura et al. 2008), and those local trips increase a sense of place (Suzuki and Fujii 2009). If more local adults are traveling by nonmotorized modes, the children will see this as a social norm. Further, local adults being out in public

likely reduce anxiety for parents over independent travel by children.

In a Scottish study, the authors cited work that suggested adults who were not mass transit users in their youth were less likely to use it (Atkins 1996 in Derek Halden Consultancy 2003). In Japan, societal expectations are that children will walk to school. This overrides any built environment variables (Waygood and Kitamura 2009). Junior high school is reached by either nonmotorized modes or mass transit; similarly for high school. This results in a population in which most adults have considerable experience with nonprivate motor modes. This eliminates a number of barriers such as unfamiliarity with a mode and possibly the social stigma associated with transit use evident in the United States where users are referred to as "captive users" (they have no other choice).

No stigma against cycling is evident in Japan. Businesspeople, monks, toddlers, couples (young and old; on the same bicycle), elderly, and mothers with children can all be seen cycling around. It is the social norm.

Children in Japan are taught to greet people (*aisatsu*) by parents, teachers, and older children. Signs can be seen that encourage people to greet each other with a smile on their faces. As well, people still greet strangers walking in their neighborhoods.

Returning to built environment factors, the local shops offer a place for interaction with people who are established in the neighborhood (Suzuki and Fujii 2009). Coupled with local festivals, *matsuri*, in which neighbors mingle and interact, a strong sense of community is established. Considerably more responsibility to one's neighborhood is evident with locals sweeping streets, attending to public gardens, and going on regular group clean-up walk arounds.

Building setbacks, a feature of North American zoning regulations, may be another factor. Japanese homes are built right up to the street traditionally, and have very small setbacks if they exist at all. Ewing et al. (2006) found that "enclosure" was an important factor in explaining walking behavior in adults. Setbacks may open an area up, but they also increase isolation from the street environment. Japanese stores traditionally were built right up to the street, and setbacks are still small even on major roads, which may help explain why nonmotorized travel continues even there. Large supermarkets and malls in Japan occasionally build hedges around their perimeter, which may reduce the visual blight of their parking lots. Unfor-

tunately, it appears to be a recent trend of convenience stores to build parking lots between the sidewalk and the store, reducing that "enclosed" feeling and encouraging travel by automobiles.

The factors mentioned above most likely all contribute to the high levels of independent travel by youth seen in previous studies (Waygood and Kitamura 2009). All of these factors contribute to increased community cohesion, which most likely lowers parental anxiety about "stranger danger." The increase in people walking and cycling may have a "critical mass" influence in which people see that it is normal to walk or cycle. Automobile drivers also appear more aware of these modes and drive with recognition of them.

This paper looks at how parents in that society are involved in children's travel on weekdays and Sundays. It considers the frequency of accompaniment by time of day, the modes used, time spent traveling on accompanied trips, destinations, and correlations with built environment measures, demographic measures, and institutional associations.

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# Changing Travel Patterns of Women in the Netherlands

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The Netherlands Institute for Transport Policy Analysis conducted a study to improve its understanding of the relationship between social developments, household composition, and women's travel behavior, with special focus on the travel patterns and daily activities of women. Information was obtained by quantitative data analyses of existing data sources and in-depth interviews with experts. Multilevel analyses were conducted to identify the most important explanatory factors of travel behavior on the household level. This study analyzed not only women's individual travel behavior, but also the travel behavior of women in different household types. Definitive results from this study will be available in May 2011. The study's initial results reveal that the travel patterns of men and women are increasingly similar. Women are increasingly more mobile, they travel for longer periods, and they travel greater distances. Women have contributed substantially to the rise in mobility in recent years. Their increasing labor force market participation is a driving force behind the fact that women must now travel more often, and travel great distances, to their workplaces. Because of the increasing number of two-income households, various activities must more often be coordinated with another member of the household.

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Various factors influence the mobility of the Dutch population. Employed people, for example, travel greater distances than unemployed people; car owners use public transportation less frequently; and people from two-income households travel more often

than people from one-income households. Recent decades have witnessed increasing numbers of women joining the workforce, sharp rises in the number of women who possess driver's licenses and own cars, and significant changes in women's roles in the family. These, and other developments, have ensured that women's travel behavior is no longer the same as it was 20 years ago.

The Netherlands Institute for Transport Policy Analysis (KiM) therefore conducted a study on the relationship between various social developments and women's travel behavior. This study focuses specifically on women's daily activity patterns and travel behavior. The fundamental research questions are as follows:

1. How have certain key social developments, such as increased labor force participation and increased driver's license possession and car ownership, influenced women's daily travels?
2. What changes have occurred in women's daily activity patterns and travel routines?
3. How do household members coordinate their various daily activity patterns and how does this vary per household type? What consequences does this have for travel behavior?

## APPLIED DATA

KiM and the Netherlands Institute for Social Research (SCP) have jointly conducted this research, in which quantitative and qualitative approaches are taken to the subject.

KiM is responsible for the quantitative analysis; describing and explaining women's travel behavior. The Dutch National Travel Survey (MON), which is an annual study of the travel behavior of residents of the Netherlands, is a primary source used in this analysis. The MON data, which are available from 1985 to the present, offer insights into the number and types of trips undertaken, the travel times, the distances traveled, and the modes of transport used, as differentiated according to the various travel purposes.

A second source of data is the Time-Budget Survey (TBO), which is a 5-year study of the Dutch population 12 years of age and older. The TBO aims to provide a comprehensive picture of the ways Dutch people spend their time during a week. Where required, other supplementary sources, such as, for example, Statistics Netherlands (CBS) data, are referenced.

SCP conducts in-depth research of the travel behavior of families with children and of the fundamental deviations and choices made concerning mobility.<sup>1</sup> To support this research, in autumn 2009, SCP conducted 30 in-depth interviews with various types of households with children.

## SOCIAL POSITION OF WOMEN

### Substantial Increase in Women's Labor Force Participation

Women's labor force participation increased substantially during the past 20 years. Between 1987 and 2007, women's net labor force participation<sup>2</sup> rose by 22 percentage points (Figure 1). In comparison, men's labor force participation in 2007 remained at the same level as in the late 1980s.

<sup>1</sup> The SCP research results will be available in early 2011.

<sup>2</sup> The share of the working population as a percentage of the total potential workforce.

Women's labor participation enjoyed particularly robust growth in the late 1980s and late 1990s, a fact attributable largely to changes in the labor market behavior of married women (Tijdens 2006): women continued to work after marrying and also after having their first child. Moreover, women who stopped working to care for children reentered the labor market at a later age.

The Dutch labor market shows a high rate of part-time employment among women and men. In particular women work part-time. In the Netherlands about 75% of the women's workforce is engaged in part-time jobs (Organisation for Economic Co-operation and Development 2007; Eurostat 2009; CBS 2009). Compared with other countries in the world, this figure is high (see Table 1). Boschet al. describe the underlying forces contributing to this high rate of women's part-time employment (2008).

At present, women who have children increasingly continue working. In 2006, fewer than one in 10 women stopped working when they had their first child, whereas between 1985 and 1989, more than half of all women stopped working after having a first child (CBS 2003). More highly educated women, in particular, continued working after childbirth. As of 2006, however, approximately 25% of women worked fewer hours after having a child (Mol 2008). Part-time jobs (20 to 27 h per week) are especially popular among women with children, and this also corresponds to the degree to which the Dutch population finds it acceptable for mothers to continue working. Approximately 50% of the population regards a 2-day or 3-day working week appropriate for women whose children are not yet of school age, whereas, for men, a large majority of the population regards a 4- or 5-day working week as appropriate (SCP 2006).

Because women more often have jobs, and work longer hours, an increasing number of men and women combine paid work with unpaid work, such as household duties and care providing. The percentage of people

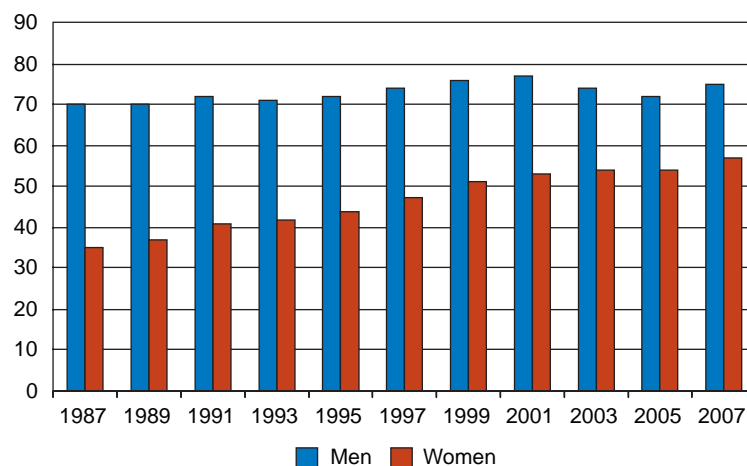


FIGURE 1 Net labor force participation, by gender, 1987–2007.  
(SOURCE: CBS *Statline*.)

**TABLE 1 Labor Force Participation: Part-Time Employment in 2009**

	Women (%)	Men (%)
Netherlands	75.3	23.9
Belgium	40.9	7.9
Germany	45.4	9.4
Spain	22.7	4.2
France	29.4	5.8
Italy	27.9	5.3
Finland	18.2	8.9
Sweden	41.4	13.3
United Kingdom	41.8	11.3
Norway	43.6	14.4
Switzerland	59.0	13.5
United States	17.8	—
Australia	40.7	—

NOTE: — = not available.

SOURCE: Eurostat.

who combine a minimum of 12 h of paid work with 12 h of unpaid work rose from 16% in 1980, to 38% in 2005. Approximately four out of 10 women are multitaskers, while that figure is nearly one-third for men.

### Women Increasingly More Highly Educated

There is a correlation between net labor force participation and education levels, especially among women. Consequently, nearly eight out of 10 women who have polytechnic or university degrees are employed, compared with the 17% of mothers with basic high school diplomas that are employed (SCP 2006). For men, there is rarely a correlation between education levels and labor force participation. In 2005, nine out of 10 men with higher education degrees and high school diplomas were employed.

The difference in education levels among men and women has continued to decrease during the past two decades. Over the years, both men and women have become more highly educated, although women have clearly gained ground in this respect, which is particularly apparent in the sharp decline in the number of women who possess only primary school or high school diplomas. Between 1985 and 2007, the number of women between 25 and 49 years of age who completed a higher vocational or higher technical education degree program quadrupled. The 2006–2007 academic year marked the first time in Dutch history that more women than men were enrolled in universities (CBS 2008).

### Income Inequality Remains

Given the development of education levels and increases in women's labor force participation, one could assume that women's earning power has also improved, and

this is indeed the case, according to Dutch Emancipation Monitor (SCP 2006). In 1990, women earned 28% of all the personal income in the Netherlands, whereas by 2004, that figure had increased to 34%. Because of rising incomes, women now have greater influence on family expenditures. Yet, the annual income of women who live together with a partner nevertheless remains two times lower than for men (CBS 2007). Moreover, only one-fifth of income-earning women earn more than their male partners. Income inequality between men and women has not decreased since 2003 (CBS 2009). That women earn less than men is partly a result of the fact that women often work part-time. Moreover, average salaries for women are lower than for men.

### Increasingly More Single Women

Feminism has also affected women's roles in the family. Marriage is no longer self-evident, and both women and men live alone for longer periods of time. With regard to families with children, women now give birth later in life, and the number of children per family is declining. Moreover, the past two decades have seen increases in the number of single women and childless couples. The percentage of single people has increased among all age groups, with nearly a fifth of all women now single, compared with one in 12 women in the late 1980s.

### Gaining in Driver's License Possession and Car Ownership

More men than women possess driver's licenses, but the discrepancy by gender in possessing driver's licenses has continued to decrease in recent decades. In the late 1980s, eight out of 10 men possessed driver's licenses, whereas for women that figure was 56%. Driver's license possession among men has remained relatively constant, whereas women, conversely, have made substantial gains: in 2007, nearly three-quarters of all women had driver's licenses. In the future the difference in driver's license possession between men and women will be negligible. For the groups ages 25 to 34, nine out of 10 women and men currently possess driver's licenses.

There is also a clear discrepancy in car ownership among men and women 18 years of age and older. Men in all age groups are more likely to own a car than are women (Figure 2), and that is the case particularly for the group ages 50 and over; however, women are indeed quickly "catching up" to men. In the late 1980s, men were three times more likely to own a car than were women, whereas, 20 years later, men are only one and a half times more likely to be car owners.

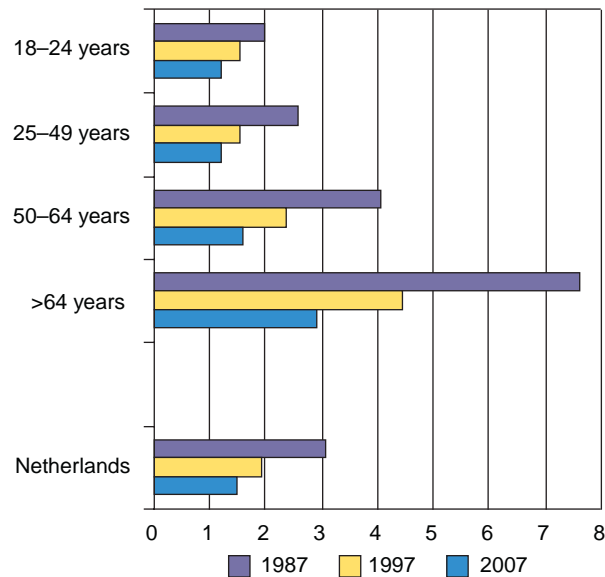


FIGURE 2 Ratio of car ownership for men and women by age group, 1987–2007. [SOURCES: CBS 1987, 1997; Dutch Ministry of Transport's Centre for Transport and Navigation (DVS) 2007.]

## WOMEN AND MEN TRAVEL DIFFERENTLY

Women and men do not exhibit the same travel behavior, and this disparity in travel behavior is apparent not only more or less in kilometers traveled, but also in the choice of alternative modes of transport, in the time spent traveling, and in the reasons that men or women travel.

### Women Continue Traveling Longer and Farther

In 2007, males and females, ages 12 and older undertook the same number of trips: an average of three trips per day, per person; however, females traveled significantly shorter distances and spent significantly less time traveling than men did. Women spent, on average, approximately 60 min traveling about 30 km per day. Men, meanwhile, spent an average of 70 min traveling 42 km per day (see Table 2).

During the past 22 years, the number of trips undertaken per day increased slightly for women, and

decreased for men. Women, moreover, are also traveling increasingly greater distances and spending more time traveling.

Men still travel for longer periods of time and greater distances than women, but the difference is decreasing. Women's travel behavior generally is becoming increasingly similar to that of men (Figure 3). Gossen and Purvis (2004) and Rosenbloom (2000) report more or less the same trends.

### Longer Home-to-Work Distances

In 2007 men on average traveled 7 km more per day than women for commuting, largely a result of the fact that more men are employed and have longer home-to-work travel distances. Working women have an average home-to-work travel distance of approximately 13 km, whereas for working men that figure is 20 km. This agrees with the findings of Molnár (2005), whose research revealed that women, on average, worked 8 km closer to home than men did. Turner

TABLE 2 Trip Rates, Distance, and Travel Time, by Gender: 1985–2007

Variable	1985		2007		Percent Change for Women
	Women	Men	Women	Men	
Trips per person	2.9	3.3	3.1	3	7
Total distance per person per day (km)	20.8	38.5	28.9	42.2	39
Total travel time per person per day (min)	50.9	72.4	59.4	70.5	17

SOURCES: Statistics Netherlands (CBS) 1985; Dutch Ministry of Transport's Centre for Transport and Navigation (DVS) 2007.

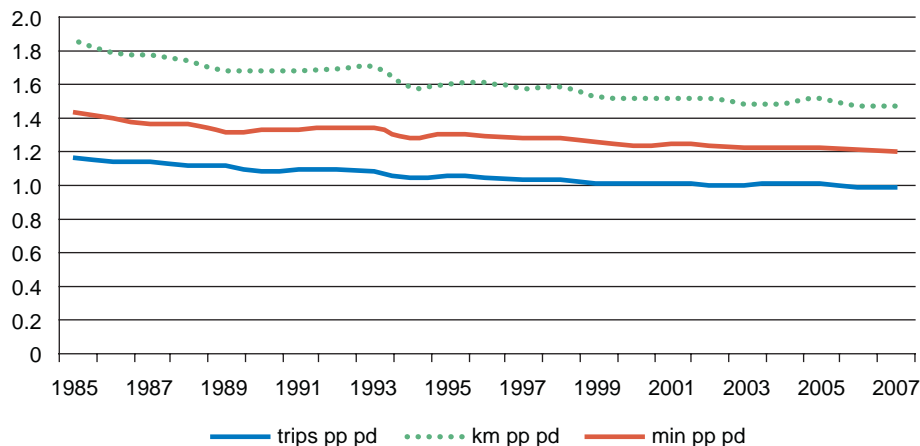


FIGURE 3 Ratio of number of trips, kilometers traveled, and travel times for men and women, 1985–2007 (pp = per person, pd = per day). (SOURCES: CBS 1985–2003; Dutch Ministry of Transport's Centre for Transport and Navigation (DVS) 2004–2007.)

and Niemeier (1997) and Rosenbloom and Burns (1994) found similar results. Women work closer to home because they need to balance work and household responsibilities and promptly respond to family emergencies. Since the late 1980s, the difference in home-to-work distances between men and women has slightly increased.

There has been little change in the travel times to and from work (Harms 2008). Men spend approximately 4 h per week traveling to and from their workplaces, whereas women spend approximately 3 h per week traveling to and from their workplaces, which, as a proportion of the total number of working hours, accounts for approximately 10% of the total working hours (Table 3) of both men and women. On the basis of an 8-h working day, this means that men, on average, spend 50 min per day traveling, or roughly 25 min to and 25 min from their

workplaces, which was the case in 1975 and remained so in 2005. The only major difference is that there are now more people employed; consequently, per head of the population (employed and unemployed), more time is now spent working and traveling.

Although there has been little change in the time spent for home-to-work travel, people have, over the years, begun traveling more often by car and less often by public transportation and bicycle (Table 3). Once again, the greatest changes have occurred among women: in 1975 cars accounted for 30% of home-to-work travel times, whereas in 2005 that figure had risen to more than 50%. Meanwhile, in contrast, walking and traveling by bicycle sharply declined: this percentage fell from nearly 50% in 1975, to just over 30% in 2005. From the point of view of sustainable transportation this is a serious development.

TABLE 3 Time Spent Traveling for Work by Population Ages 20 to 64, by Gender: 1975–2005

Year	Labor Market Participation (%)	Net Working Hours (hours per week)	Net Travel Time (hours per week)	Share of Travel Time (%)	Travel Time by Car (%)	Travel Time by Walking or Bicycle (%)	Travel Time by Public Transport (%)
<b>Total</b>							
1975	47.6	36.2	3.9	9.7	52	29	19
1985	47.5	35.3	3.7	9.4	61	25	14
1995	55.8	35.4	3.7	9.5	60	26	13
2005	64.5	35.6	3.7	9.4	63	24	13
<b>Men</b>							
1975	76.5	37.9	4.1	9.7	56	26	18
1985	69.4	37.6	3.8	9.2	66	23	11
1995	76.1	38.9	3.9	9.2	65	25	11
2005	76.3	40.2	4.1	9.2	69	20	12
<b>Women</b>							
1975	18.4	29.1	3.0	9.3	30	47	23
1985	25.2	28.8	3.2	10.0	43	32	26
1995	36.4	28.5	3.2	10.2	48	31	21
2005	52.7	28.9	3.1	9.7	53	31	16

SOURCE: SCP, TBO.



### Much Shorter “Care-Providing” Trips

The past two decades have revealed increasingly marked differences in the travel behavior of childless women and women with children. Women with children undertake more trips: they first bring their children to day care or school and then travel to work; after work they pick up their children, shop, and take their children to after-school activities such as music lessons or sports—all of which, in some cases, can account for more than six trips per day. This trip chaining is substantially a female characteristic of everyday mobility (Nobis and Lenz 2004; McGuckin and Murakami 1999; Hunecke 2000). Men with children also undertake more trips than childless men.

During the past two decades, women's activity patterns have become increasingly similar to those of men. As a result of increased labor force participation, women more often travel to and from work; however, the responsibility of dropping off and picking up children remains a woman's task: mothers undertake the most “care-providing” trips. In more than 25% of all cases, women between the ages of 30 and 39 state their reasons for traveling as picking up or dropping off people (read: children), whereas the corresponding figure for men is less than 10% of all trips undertaken.

An average of 17 h per week (Table 4) is devoted to household duties (cleaning, shopping) and caring for children, and in this, too, significant differences exist between men and women: men spend approximately 10 h per week on these duties, whereas women spend an average of 23 h per week. Starting in the 1970s, however, this unequal sharing of duties based on gender has been somewhat rectified. Travel times devoted to performing household duties have substantially increased since 1975

(Harms 2008). In 1975, household and care-providing duties “cost” an average of 1 h and 20 min per week in travel time (7% of the total time devoted to household, care-providing duties, or both; see Table 4), whereas, 30 years later, that figure had increased to 2 h and 20 min (13%). People also more frequently used cars to perform these duties in half of all cases in 2005. In contrast, public transportation, as well as walking and cycling, has become less popular. On balance, people now travel longer distances than previously, and more often use cars, to perform their household duties.

### Women Increasingly Prefer Cars

Cars are men's preferred mode of transport, with half of all trips undertaken by car. Women are now using cars slightly more often, for more than four out of 10 trips. Men travel nearly 2.5 times more kilometers by car than women, and men also make one and a half times more trips by car than women (Figure 4). Since 1987, the number of trips women make as car drivers has risen sharply, which, conversely, has reduced the number of trips women make as car passengers (Figure 5). For men, the share of trips undertaken as car drivers has remained relatively constant since 1987. That women now undertake more trips as car drivers is partly the result of increases in women possessing driver's licenses and owning cars. According to the literature (Kwan 2000), the increase in female car use has to do with the female-specific daily routines characterized by high space–time rigidity. The car is more suitable to perform complex spatial–temporal activity patterns than any other means of transport (Nobis and Lenz 2004).

**TABLE 4** Time Spent by Population Ages 12 Years and Older Traveling for Household and Care-Providing Duties, by Gender: 1975–2005

Year	HH Share of Care Providing (%)	HH and Care Providing (hours per week)	Travel Time (hours per week)	Share of Travel Time (%)	Travel Time by Car (%)	Travel Time by Walking or Bicycle (%)	Travel Time by Public Transport (%)
<b>Total</b>							
1975	48.2	17.8	1.4	7.2	37	53	10
1985	53.2	17.8	1.6	8.1	43	50	8
1995	53.3	16.9	2.1	10.0	46	48	6
2005	55.9	16.5	2.4	12.6	50	45	5
<b>Men</b>							
1975	17.7	7.6	1.0	11.6	48	44	8
1985	27.2	9.1	1.2	11.4	52	41	7
1995	29.2	9.7	1.6	13.9	55	39	5
2005	35.1	10.3	1.8	14.8	58	36	6
<b>Women</b>							
1975	78.0	27.7	1.8	6.0	31	58	12
1985	78.5	26.3	2.0	7.0	38	55	8
1995	76.2	23.6	2.6	9.7	41	53	6
2005	75.9	22.6	3.0	11.6	45	51	4

NOTE: HH = household.  
SOURCE: SCP, TBO.

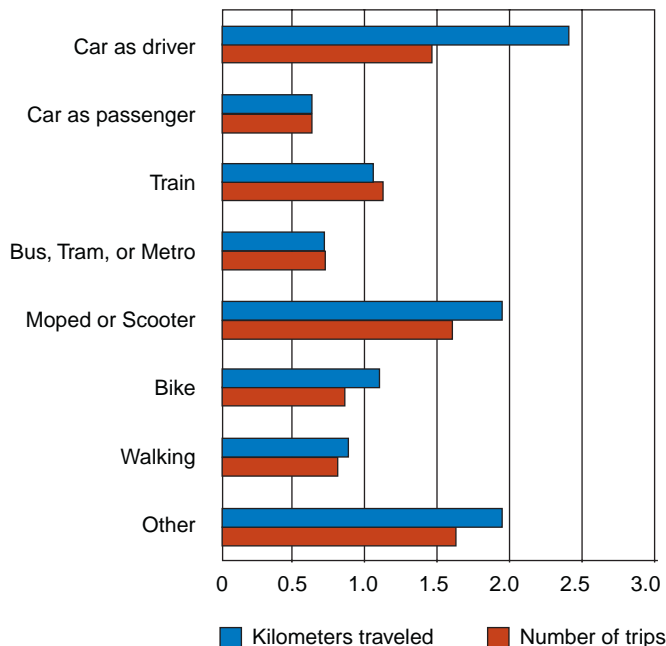


FIGURE 4 Modes of transport used by men and women in 2007, in relation to the number of kilometers traveled and number of trips undertaken by men and women, expressed as a ratio of men to women. [SOURCE: Dutch Ministry of Transport's Centre for Transport and Navigation (DVS) 2007.]

Concerning the changing position of women, this is also true for the Netherlands.

Men and women also differ in their use of other modes of transport. Men and women travel by train at relatively the same rate. Women more often travel by bicycle than men do, but men travel more kilometers by bicycle. The greatest difference in bicycle use is among men and women ages 35 to 39: women in this age group use bicycles for more than a quarter of all trips, whereas

men make only one out of six trips by bike. Although an increasing number of parents bring their children to school by car (Veilig Verkeer Nederland 2007), the high percentage of bicycle trips made by women ages 35 to 39 is attributable primarily to the fact that these women use bicycles to pick up and drop off their children at school (Harms 2008). This is specific to the Netherlands. Preissner and Hunecke argue that safety reasons play an important role for women's increasing car use (2002).

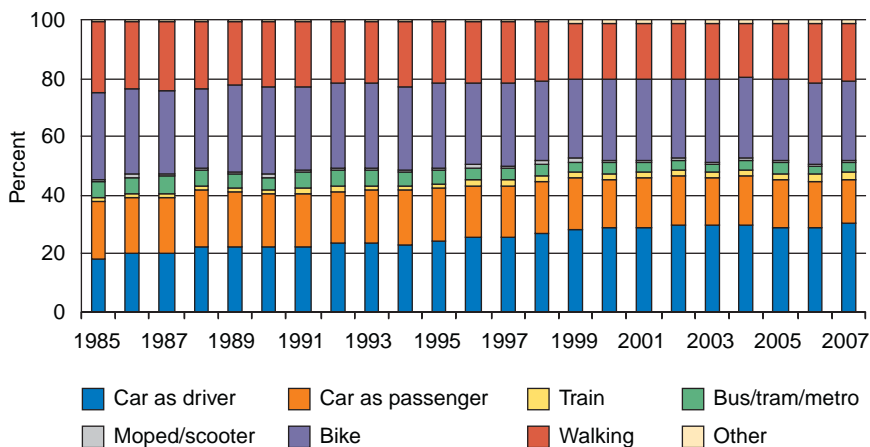


FIGURE 5 Modal split for women, 1985–2007. [SOURCES: CBS 1985–2003; Dutch Ministry of Transport's Centre for Transport and Navigation (DVS) 2004–2007.]

## WOMEN'S TRAVEL BEHAVIOR EXPLAINED

Since the mid-1980s the rate of mobility for females ages 12 and older has increased by 61% (Table 5), as expressed in the number of kilometers traveled. This growth is attributed particularly to a sharp rise in car use. Compared with 1985, the total number of trips women undertake by car has increased by nearly 50%, and the distance traveled per car trip has risen from 13 km in 1985, to 14.5 km in 2007. The sharp increase in car use among women is virtually wholly attributable to increases in car use by women as car drivers, which, when expressed in kilometers traveled, accounts for 85% of the total increase in car use since 1985. Because of the sharp rise in car use among women, the number of kilometers traveled by car will serve to intensify the explanation for women's increased mobility.

On a more abstract level, increased car use (expressed in kilometers traveled as car drivers) can be attributed to the following two factors:

1. Volume effect—an increase in the number of women undertaking trips (population growth), and
2. Behavioral effect—women, on average, undertake trips (*a*) more often and (*b*) of greater distances (because of economic developments, among other factors).

In addition, distinctions can be drawn between travel purposes, for example, between home-to-work travel and leisure-time trips.

To what extent can the growth in car travel among women be attributed to volume and behavioral effects and the purpose for undertaking trips? This is summarized in Figure 6, which reveals that, since 1985, a significant part of women's increased car use (+151%) is attributable to behavioral changes, namely, the fre-

quency of trips (+82%), but also an increase in the distances of trips (+42%). The volume effect of there being more women (population growth) accounts for approximately 7% of the total increase (+10%). Other factors (+17%) account for the remaining growth.

### Increase in Commuter Trips Equals 32% More Car Use

That women travel more to and from work is attributed to increased labor force participation. To illustrate this point: a third of all women in the 15- to 65-year-old age group held part-time jobs of at least 12 h per week in 1985, whereas in 2007 this figure was more than 50%.

### Increase in Commuter Travel Distances Equals 27% More Car Use

Various underlying factors account for the increase in distances traveled to and from work. The developments mentioned in the following paragraphs have contributed to the increase in work-to-home distances.

### Incomes, Car Ownership, and Car Use

Increased economic prosperity has led to a rise in personal incomes and a subsequent increase in the rate of car ownership. In 1985, there were 4.5 million cars in the Netherlands; in 1990, more than 5 million cars; and in 2009, approximately 7.4 million cars owned by 7.2 million households. In particular, second car ownership has increased significantly in recent years: 20% of Dutch households own two or more cars, and 2% of all households (more than 150,000 households) own three or more cars.

### Expansion of the Housing Market

People continue to set higher standards for housing and residential communities. People have more income to spend than in the past, and therefore they also demand higher-quality housing and residential quality of life. Meanwhile, regional disparities in housing prices continue to increase. In Amsterdam, for example, housing prices are far higher than in surrounding municipalities, and Amsterdam's housing prices have also risen much more steeply in recent years (de Jong et al. 2008). The same applies for housing markets in other urban areas. The growing price differential between housing in cities and in outlying areas is, presumably, a driving factor behind increases in home-to-work distances.

TABLE 5 Mobility Growth for Population Ages 12 Years and Older: 1985–2007

	Mobility Growth (billions of kilometers)		Growth Rate (%)
	1985	2007	
All modes of transport			
Total	124.4	171.1	37
Men	80.1	99.9	25
Women	44.3	71.1	61
Car driver			
Total	61.0	93.7	54
Men	50.1	66.2	32
Women	10.9	27.5	151
Car passenger			
Total	30.2	32.9	9
Men	11.1	11.0	0
Women	19.1	21.9	15

SOURCE: Statistics Netherlands (CBS) 1985; Dutch Ministry of Transport's Centre for Transport and Navigation (DVS) 2007.

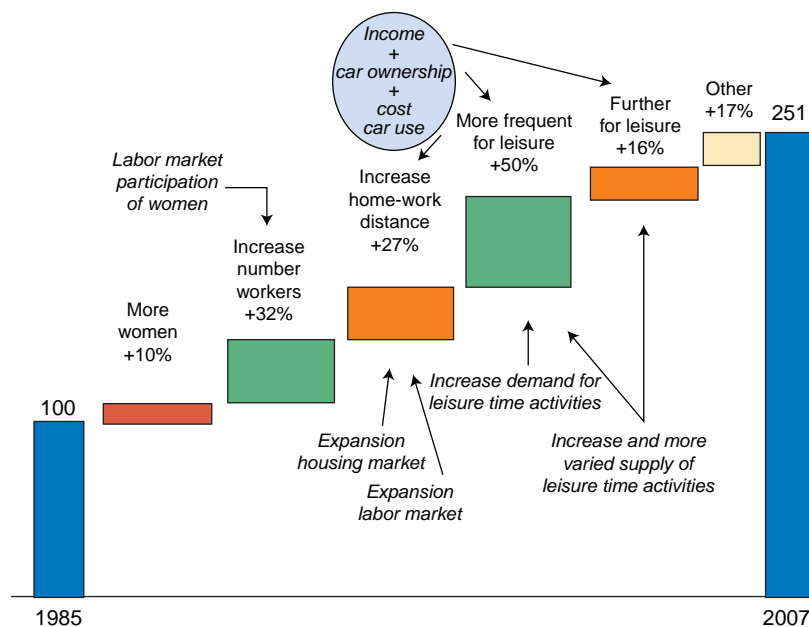


FIGURE 6 Explanation of women's car use, 1985–2007. [SOURCES: CBS 1985–2003; Dutch Ministry of Transport's Centre for Transport and Navigation (DVS) 2004–2007.]

### Expansion of the Labor Market

Increasingly more people, and especially women, have completed higher and specialized education programs, and this corresponds to the increasingly higher and more specialized requirements demanded of employees. This has decreased the likelihood of a person finding a suitable job within a given distance from home, which consequently has increased the average home-to-work travel distances (Vermeulen 2003; van Wee et al. 2002). The increase of two-income households has also led to labor market expansion. When choosing a place to live, two-income households must consider the one location in light of their two separate workplaces, and this too has led to increases in the average home-to-work distances (van Ham 2003). The German sociologist Beck identifies this phenomenon as the rise of the *Spagatfamilien* (“detached family”): the modern two-income household with one base or residence and several spatially divided workplaces, schools, or both (1986).

Moreover, because more women possess driver's licenses and own cars, women are able to travel greater distances to work. Women who possess driver's licenses and own cars are able to live farther away from their workplaces.

### Increase in Travel Distances and Number of Trips for Leisure Activities Equals 68% More Car Use

Rising incomes, increased car ownership, and the lowering costs of car use have also contributed to sharp increases in

the number and distances of leisure time trips. In addition, developments in the demand for, and the supply of, leisure time activities also play a role here. Briefly stated, people maintain increasingly more hectic and varied leisure time lifestyles, for which they are increasingly prepared to spend more money and travel greater distances to satisfy (Harms 2006). Moreover, the number of leisure time places and activities has rapidly expanded. An additional contributing factor is that women's attitudes toward leisure time have changed over the years (Harms 2003). Van Schendelen found that working women led more active leisure time lifestyles than nonworking women, and moreover working women were more orientated toward leisure activities undertaken away from home (1992).

### CONCLUSION

The “gender gap” refers to the differences between men and women with respect to mobility. Men, on average, have always undertaken longer trips than women; however, during the past 20 years, women have indeed closed the gap on men in this respect, and that is true especially for women with children, who have rapidly increased the distances they travel in their daily lives. The gender gap is the smallest with regard to younger women; there is a negligible difference in the travel behavior of young women and men.

During the past 20 years, Dutch people have become increasingly dependent on the car. The development of a

car-dependent society has intensified because more women are now gainfully employed and, consequently, more often must combine jobs and household tasks, and because women lead more active leisure time lifestyles. These changes have placed intense time pressure on the spatial and temporal planning and organization of daily life, leaving people feeling obliged to use a car, which many people regard as the most suitable mode of transport for flexibly combining all the various work and leisure time activities.

Research has revealed

- An increase in car use among women;
  - A decrease in cycling, public transport, and walking among women;
  - An increase in commuter distances among women;
- and
- An increase in short-distance trips by car in regard to care activities.

A large portion of the growth in car use can be attributed to increases in women's labor force participation: women travel more often and farther distances for their work, but not as far as men do. Previous studies in the Netherlands—Steg and Kalfs (2000), Batenburg and Knulst (1993), and MuConsult (1998)—have also established this relationship.

One important goal of Dutch policy concerning gender mainstreaming was (and still is) to increase women's labor force participation. Indeed this policy has been successful. The effects of this, among other factors, are still not tackled: increasing car use because of combining jobs and household tasks and several spatially divided workplaces, schools, or both. Awareness among national policy makers is growing as is cooperation between various administrative bodies. Solutions can be sought in concentrating public functions, such as schools and shops, to reduce travel distances and the use of the car. The trend of increasing car use and declining public transport use among women can be rather important for transport companies as well. They have to adapt their strategies to win new customer groups.

The decrease in cycling and the increase of short-distance trips by car, in regard to care activities, is from the point of view of sustainable transportation and health a serious development. Emissions of carbon dioxide and nitrogen oxide levels in metropolitan areas are rising and will continue to do so in the future, as mobility is rising as well. Car dependency has to be reduced by implementing policies aimed at promoting cycling again. Cycling is expected to be most effective when it focuses on trips of distances less than 7.5 km in metropolitan areas. Education campaigns, pricing policies, and spatial policies can contribute to this.

More important is the future role of men. Travel patterns are highly correlated with employment status

and family obligations. As long as women spend more time on household activities than men do, women's car dependency will not be reduced. The choice for other means of transport will diminish. In the Netherlands, there is a gender mainstream policy aimed at reducing these differences. Unfortunately little attention is paid to how to integrate this with transport and spatial policies. The only related policy by the Ministry of Transport is promoting e-work. This could have an impact on working women and men in the sense of combining household and work activities in a more efficient way. The number of short-distance trips by car could be reduced (less trip chaining) and moreover the use of the bicycle could increase again. Men could spend more time on household activities. For transport policy it is crucial to know what will happen if household responsibilities are shared equally by men and women. What impact will it have on modal choice? Will car use be reduced, and will it have an effect on congestion levels during peak hours? The same applies for housing and job choice decisions. They are crucial for the distances traveled. Spatial planning focused on land use and in particular on reducing suburbanization can play a role.

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# Travel Time and Distance Regarding Gender Patterns in the Paris Region

## Past Trends and Forecasts to 2030

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This paper investigates the specificities and the evolution of mobility patterns of women and aging people in the most densely populated region including Paris and the departments, which has the highest gross domestic product per capita in France. Four household travel surveys available from 1976 to 2001 allow a comparison to be made of travel time during those years and also a forecast of mobility up to 2030. The chosen focus is on the distinction between constrained trips and nonconstrained trips, constrained trips being defined as trips whose destination is work, university, or school. It is observed that the constrained trips have not increased recently in regard to time and distance, after a surge in the 1980s, except for women, whose travel time and distance budgets strikingly increased. In the same period, overall mobility increased dramatically, especially as a result of nonconstrained trips for both men and women. It appears, however, that nonconstrained and constrained trips for women increased more significantly.

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**T**his paper investigates the travel behavior of women and aging people in the most densely populated and wealthiest region of France [gross domestic product (GDP) per capita], which includes Paris and the departments. This empirical case study aims to identify the specificities of mobility patterns and their evolution over time (measured by

the average number of trips per individual per working day and distance and time budgets<sup>1</sup>) related to gender and age. Four household travel surveys available for 1976, 1983, 1991, and 2001 allow one to compare travel time for these years and also to forecast mobility up to 2030. This analysis is driven by the investigation of the assumption of recent converging patterns in a highly dense urban area.

The focus here is on the distinction between constrained trips and nonconstrained trips, constrained trips being defined as trips whose destination is work, university, or school. A study has been done of the mobility patterns related to demographic patterns but also to socioeconomic and geographic patterns to identify some key elements determining travel characteristics and choice differences between men and women and the evolution of these patterns during a long period.

In a standard approach, time budgets and distance budgets were then computed according to the purpose of the trip. Paris results confirmed that the Zahavi law (Zahavi and Ryan 1980) on the constancy of transport time among time and place has to be contested, particularly when density and urban patterns are taken into account, as shown especially for France by Wiel

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<sup>1</sup> Travel time budget computes a daily time dedicated to transport on a weekday per individual (in minutes, min/individual/day), and travel distance budget computes a daily distance (as the crow flies) dedicated to transportation between one location of activity and another (km/individual/day).



(2002). These budgets must be put into perspective with transport mode and housing location. As a result, it is observed that the constrained trips for Franciliens<sup>2</sup> have not increased recently in regard to average time and distance, after a surge in the 1980s, except for women, whose distance budget increased. In the same period, the overall mobility, measured by travel distance budget, is increasing. It appears that this increase is the result of the development of nonconstrained trips and of constrained trips for women.

Then, in regard to demographic patterns such as age and gender, the evolution is mixed when introducing gender and age patterns. Indeed, from 1976 in regard to distance, as constrained trips declined for men they strikingly increased for women, and in regard to time, the constrained trips are almost constant. The time dedicated for commuting is also changing according to age class, and huge differences appear between the 1970s and the 2000s. Aging people being far more mobile than their parents at the same age, and the most interesting point shown by census is that aging people, since the end of the 1990s and the beginning of the 2000s, are staying in the Paris region for their retirement period, which was not the case 30 years ago. Also being investigated are the discrepancies in trips and mode choice according to gender for aging people. It will then be seen that location matters.

Because of the relocation of economic activities outside Paris and because of poor accessibility to transit, women's travel time and distance budgets have significantly increased in the past years and are forecast to continue to surge. That is why the analysis has to be disaggregated according to the seven subareas of the Paris region and also according to socioeconomic factors. Are travel patterns the same for all socioeconomic categories of women, for all women over the area, for all age categories?

The first part of the paper is dedicated to the presentation of the survey that was used and the overall patterns of traveling for the Paris region between 1976 and 2001. In the second part, an analysis is carried out of women's and aging people's mobility patterns, with a special focus on constrained and nonconstrained trips. A disaggregated analysis in regard to location and socioeconomic factors helps to identify the determinants of these gender differences in travel time and distances but also in modal choices. In a third part, a forecast is developed for travel time, up to 2030, mainly on the basis of demographic patterns in the age-cohort modeling approach (Bush 2003, Berri 2005, Gallez 1994). As a result, this forecast supports the investigation of the recent convergence of mobility patterns between men and women.

<sup>2</sup> Name of the inhabitants of Ile-de-France.

## TRAVEL PATTERNS OF THE PARIS REGION (ILE-DE-FRANCE)

### Paris Region

The Paris region contains the major labor pool of France. This region is set in a cluster of eight departments: Paris and the inner belt including three departments (Val-de-Marne, Hauts-de-Seine, and Seine-Saint-Denis) close to Paris and directly surrounding it and the outer belt including four departments (Seine-et-Marne, Essonne, Yvelines, Val-d'Oise) up to 100 km from Paris. The subordination of the outer and inner suburbs to Paris is still outstanding in regard to administrative and business activities (see Figure 1).<sup>3</sup>

In 2008, according to the Organisation for Economic Co-operation and Development Regional Statistical Database, the Paris region, with a population of 11,490,969 inhabitants, accounts for one-fifth of the French population. With a GDP of 552,664 million euros, it is the wealthiest part of France (GDP per capita: 47,155 euros).

In 1996, the gross disposable income per inhabitant in Ile-de-France (the IDF) was 110,800 francs (16,891 euros) against 90,100 francs (13,735.65 euros) in the provinces. Given in an index relative to all of France, the GDP in the IDF was 152.9 in 1996, and ranked first in the list of the 22 French regions—the rank being confirmed in 2008. The Paris region's GDP rose during the period of interest from 983 billion francs (150 billion euros) in 1982 up to 1,750 billion francs (267 billion euros) in 1989, reaching 2,289 billion francs (349 billion euros) in 1996.

Between 1995 and 2005, even if other parts of France, especially in the south of the Loire Valley, were economically dynamic and attractive, the Paris region remained a dynamic pole with a GDP yearly growth of 2.5% and the major labor pool, with an employment rate of 59.5% and an unemployment rate of 9.5%.

Between 1995 and 2005, the annual growth rate was 2.5%, the activity rate was 59.5%, and the unemployment rate was of 9.5%, below the national average. The job market has been oriented mainly toward tertiary activities since the 1990s but still remains the main pole of industrial production. Brière and Guilbert (2001) showed that between 1976 and 2001 the working population of the IDF was deeply restructured: a decrease in the activity rate of the population, a rise in women's activity rate, an increasing share of white-collar workers and highly qualified workers in a context of the develop-

<sup>3</sup> All results presented in the tables and figures of this paper are derived from the authors' own computations (French National Institute for Transportation and Safety/Department of Economics and Sociology of Transportation).



FIGURE 1 Map of Paris and its inner and outer suburbs.

ment of the production of high value-added goods and services. Blanchard and Ferrer (2007) identified a Paris paradox: the working population of the IDF gathers very highly qualified and skilled individuals (5 to 6 years after graduation) as well as workers with no qualifications at all (who have not graduated).

According to the French National Institute of Statistics and Economic Studies (INSEE) the share of working inhabitants (International Labor Organization definition) decreased from 53% in 1976 to 49% in 2001 (with the longer time spent at university and a lower legal retirement age since the 1981 law). But for the period, the evolution for men and women was different, with a decrease in the share of working males (from 63% to 54%) while the share of the female working population remained almost constant (44% to 45%).

The inhabitants of the Paris region are people mainly between the ages of 20 and 24 years and those up to the age of 55 to 59, because Paris is still viewed as a place dedicated to education and work: the young people move to be educated in Paris (most of the famous graduate schools and universities are still located in the Paris region) and then move back to their native region (or the southern part of France) for retirement.

During the period, equality between men and women in regard to access to the job market improved in the Paris region. The share of the nonworking population increased as a result of new regulations concerning the legal retirement age and special incentive frameworks for promoting retirement, and also a longer education period.

The analysis focused on the residential location shows that the number of inhabitants in all departments of the Paris region increased from 1976 to 2001, except in Paris where the population decreased by 5%. The most important increase occurred in the Seine-et-Marne Department (+58% between 1976 and 2001) in the east of the

Paris region and in the Val-d'Oise Department (+41% between 1976 and 2001) in the west/northwest of the Paris region. Even so, Paris remains the most populated place, with 1.97 million inhabitants, followed by the Hauts-de-Seine Department, close to the business area La Défense, with 1.31 million inhabitants.

These latter departments are those with the less important nonworking population. The share of nonworking individuals has significantly and continuously increased in the departments of Seine-Saint-Denis and Val-d'Oise, to the north of Paris.

The jobs are located mainly in the center and the west of the region, that is, in Paris and Hauts-de-Seine, and housing stock in the east. In recent years, firms have relocated their headquarters from inside Paris to the suburbs because of the high commercial rent levels in Paris.

Because of the high population density of the Paris region and the cluster location of business and administrative activities and housing, mobility is a key issue in this, the most important economic and labor area of France.

### Paris Mobility Survey

A large survey is regularly conducted on the transportation behavior of households in the Paris region. It contains various survey instruments to describe the means of transport owned by the household, commuting habits, daily mobility, and so on. Data collected in each of these instruments can be analyzed separately. The purpose of this survey is to describe the trips made by households and individuals who are living in Paris and the nearest departments, as well as their use of public and private transport means. The survey is conducted for a working weekday. The focus is on internal trips, that is, trips whose origin and destination are within the Paris region (the IDF).

Analysis of the trips and the mobility of inhabitants through the time and distance budgets of the most wealthy and densely populated region of France is based on the data collected by four household mobility surveys carried out in the Paris region in 1976–1977, 1983–1984, 1991–1992, and 2001–2002.

For each of the four surveys, the sample size is about 10,000 responding households. For example, from 18,182 households representative of the IDF population drawn in 2001–2002, there are 10,478 responses (i.e., a response rate of 57%). The questionnaire contains

1. Household data (address, class of income, motorization, number of persons, and so forth),
2. Surveyed individuals in the household older than 5 years (work, age, place of work, and so forth),
3. Characteristics of trips (origin, destination, mode, time, purpose, and so forth).

The origin and destination of trips are geocoded, which allows the analysis of Parisian mobility in different zones.

### Travel Patterns over the Years

The analysis favors the distinction between “constrained” and “nonconstrained” trips to identify travel behavior. The label is not coined in relation to the semantic meaning of “constrained” or “constraint” as relates to the feelings that an individual has in defining a trip as compulsory or not, but is based on the work of Jean-Pierre Orfeuill (2000). A constrained trip is designated as any trip whose destination is beforehand defined and chosen in relation to a daily activity involving a legal constraint or involvement (as a job contract or an activity under contract), the latter being mainly school or work.<sup>4</sup> The home destination trips whose share remained constant during the period of the four surveys (about 40%) are considered to be nonconstrained trips (Table 1).

If the focus is on the trips market at the global level, note the importance of nonconstrained trips over constrained trips, which increased during the period and was even more striking when focusing on the average time and distance traveled per trip in the Paris region.

During the period the average distance and duration of internal trips increased, but the rise was mainly the result of the growing importance of nonconstrained trips. The year 1991 should be identified as a turning point in travel patterns: the average trip duration went up by 6% in the late 1970s and 1980s and remained constant thereafter, and the average distance went up by 32% between the first survey and the last survey. The evolution of constrained and nonconstrained trips follows respectively contracting evolutions, with the increasing weight of the share of nonconstrained trips in overall mobility.

Although a surge by 20% of the traveled distance for constrained trips occurred between 1976 and 2001, the traveled distance for nonconstrained trips continuously

increased by 39%. The time dedicated to work destination trips diminished considerably (–26%) during the period as the length of nonconstrained trips increased by 5.6%. Travel time in the Paris region remained higher than in the other parts of France. The last National Household Travel Survey, conducted in 2008, showed that although travel times in the Paris region are still the highest in France, they diminished between 1993 and 2008 as they increased dramatically in the provinces (Hubert 2009), showing a convergence of travel time.

This brief overview of travel patterns in the overall Paris region shows that the increased number of trips is the result of the rise of nonconstrained trips, and this trend gains strength in regard to the duration and distance of trips. This analysis of past trends will now be investigated by decomposing them according to gender and age at the individual level.

### EVOLUTION OF MOBILITY PATTERNS OF WOMEN AND AGING PEOPLE IN THE PARIS REGION: A DISAGGREGATED POINT OF VIEW

The total travel time budget<sup>5</sup> for men stayed almost constant during the period between the surveys of 1976 and 2001; for women it increased by 15%. The breakdown is quite interesting because it appears that if the travel time budgets for constrained trips for men (35 min) are still higher than for women (20 min), they tend to converge with an increase for women by 14%. The increase in travel time budget is due to the rise in time dedicated to nonconstrained trips for women (Table 2).

This result has to be put into perspective with the evolution of travel distance budgets,<sup>6</sup> which had increased during the period at the global level. The growth by 26% of the travel distance budget for the internal trips during the period is the result mainly of increasing traveled distances for nonconstrained trips. The men's travel distance budget (19.5 km in 2001) is higher than the women's (13.5 km in 2001). The interesting point is that the

<sup>4</sup> The following trips have been defined as constrained trips: trips whose purpose at destination is “usual and fixed working place,” “business,” “elementary school,” “secondary and technical school,” or “higher/university education.”

<sup>5</sup> The travel time budget represents the total daily time devoted to traveling, measured as average time budget per individual.

<sup>6</sup> Travel distance budget represents the total daily distances devoted to traveling, measured as average distance budget per individual.

TABLE 1 Share of Trips, by Destination Purpose

Year (1)	Trip Destination (%)				Constrained (6 [3 + 4])	Nonconstrained (7 [2 + 5])	Total (8 [6 + 7])
	Home (2)	Work (3)	Education (4)	Other (5)			
1976	40	22	7	32	29	71	100
1983	39	21	8	32	28	72	100
1991	39	19	8	34	27	73	100
2001	40	18	8	34	26	75	100

SOURCE: Authors' calculations based on the four Paris Mobility Surveys (1976–1977, 1983–1984, 1991–1992, and 2001–2002).

TABLE 2 Number of Trips, Travel Distance Budget, and Travel Time Budget, by Gender: 1976–2001

	1976–1977 Survey		1983–1984 Survey		1991–1992 Survey		2001–2002 Survey	
	Male	Female	Male	Female	Male	Female	Male	Female
Number of trips (ind./day)								
Total trips	3.6	3.3	3.6	3.3	3.5	3.4	3.5	3.5
Constrained trips	1.3	0.8	1.2	0.8	1.1	0.8	1.0	0.8
Nonconstrained trips	2.3	2.6	2.4	2.6	2.4	2.6	2.4	2.7
Distance budget (km/ind./day)								
Total trips	16.9	9.4	17.7	10.8	19.7	12.7	19.5	13.5
Constrained trips	7.4	3.0	7.6	3.4	8.3	4.0	7.7	4.2
Nonconstrained trips	9.5	6.4	10.1	7.4	11.4	8.8	11.8	9.3
Time budget (min/ind./day)								
Total trips	87.1	64.8	85.7	65.9	89.2	73.5	86.9	74.4
Constrained trips	35.4	17.7	34.0	18.2	34.3	20.4	35.3	20.2
Nonconstrained trips	51.7	47.1	51.7	47.7	54.9	53.1	51.6	54.1

NOTE: ind. = individual.

SOURCE: Authors' calculations based on the four Paris Mobility Surveys (1976–1977, 1983–1984, 1991–1992, and 2001–2002).

travel distance budget for constrained trips decreased for men during the period between the last two surveys. The women's travel distance budget has increased by 44% at the total level, with a slight increase in the constrained trips distance and an important increase in the nonconstrained trips.

A brief comparison with the results for the Lille area<sup>7</sup> (surveys in 1976, 1987, 1998, 2006) (Krakutovski and Armoogum 2007; Merle et al. 2009), which presents a more clustered demographic and geographic structure, shows a decrease in the number of trips in 2006 compared with 1998 after a continuous increase. It seems to confirm, as in Paris, an increase during the period of travel time budgets and distance budgets, especially for women, and the development of car use for women even if they use mainly public transportation.

The results of the Lille region for 2006 are quite close in regard to number of trips, with a daily average per individual of 3.76. The average traveled distance in this very clustered urban and industrial area is 15.8 km per individual per day. It can be observed that the average traveled distances in Lille are shorter than in Paris. This difference is the result of the segmented organization of the activities in the Paris region covering the sectors for housing in the east and the sectors for business in the center and the west in a territory of 12,000 km<sup>2</sup>, compared with the cluster organization of the activities in a territory of 612 km<sup>2</sup> in the Lille region.

The gender issue is also at stake in that region, with 17.5 km per individual per day for men and 14.4 km per individual per day for women. The difference in traveled distance is also explained by the shorter distances for commuting for women. Indeed, occupation matters a great deal in explaining the traveled distance.

<sup>7</sup> An area of about 1 million inhabitants in the north of France at the border with Belgium, Lille has been historically industrialized by heavy industry (coal mining) and textiles.

When the Paris region results are compared with national results,<sup>8</sup> the gender issue is confirmed for France in 1994, with a larger number of trips, shorter traveled distance, and larger time budgets for women. In 2008, the first results indicate that the average number of trips is decreasing in the urban area, with 3.6 trips per individual per day in 2008 compared with 3.8 in 1994. The average traveled distance per day per individual increased by 6 km/individual/day between 1994 and 2008 in urban areas. The average total traveled time is quite stable with 56 min in 2006 (55 min per individual per day in 1994).

Nobis and Lenz showed that in Germany in 2002, gender issues in transport behavior are still at stake (2006). The number of trips for men is 3.26/individual/day against 3.52 for women (for full-time jobs), with respective average traveled distance of 14.5 km/individual/day for men and 13.8 km/individual/day for women.

During the period, male travel distance budgets remained higher than those of women, but they converge with a striking rise in the weight of nonconstrained trips. The female travel distance budget is 55% of the male travel distance budget in 1976 and 69% in 2001.

Nobis and Lenz noticed an increasing resemblance in behavioral patterns, however, especially when the household status is single (2006). They also showed that family life—the presence of children in the household—is an important determinant of travel patterns.

Gordon et al. (1989) showed that for a large U.S. sample, once having standardized the different categories of

<sup>8</sup> The results of the French National Household Travel Survey of 2009 are not yet published, but the first results are presented in Hubert 2009, "Dans les grandes agglomérations, la mobilité quotidienne des habitants diminue, et elle augmente ailleurs," (INSEE Première, No. 1252, July). INSEE-INRETS is still working on the questionnaires, and average distance and average time in rural areas versus urban areas have been obtained. More detailed results, especially on gender issues, will be published in 2010.

population by level of income, occupation, structure of household, location, and traveled modes, women still always show shorter traveled distances for work trips than men and undertake a greater number of trips for nonworking purposes.

As shown by Prédali (2001), although the travel patterns of men and women seem to be similar again in the Paris region, especially at the turning point of the 2000s, they are not overlapping and are far from being identical.<sup>9</sup> This divergence can be explained by sociological habits and representations. This research shows that women have different mobility practices as a result of the structure of the family core, a variable that has a weak influence on men's behavior. For equivalent professional and family patterns, men and women show different mobility behaviors measured through distance budget. The explanation has to be sought in regard to social identity and representations. Prédali shows that (a) even if the number of trips made by women is higher than in the case of men, the distance budgets are always much smaller, and (b) even when a woman is single with no children in her charge, she always chooses her home location to be close to her working location.<sup>10</sup>

<sup>9</sup> The research is supported by face-to-face interviews conducted in the Paris region.

<sup>10</sup> The authors would like to investigate whether or not the following sentence quoted in the full text just before the callout for this footnote ("even when a woman is single with no children in her charge, she always chooses her home location to be close to her working location") is still valid according to the results of the updated survey.

Results show, however, that women are ready to travel longer distances than in the past to secure an occupation and to travel to their occupation place. The gender issue is more striking when investigating the difference between the working and the nonworking population.

### Time and Distance Budgets Related to Labor Force and Types of Jobs

The gender tendencies and differences observed at the general level are confirmed when focusing on the labor force.<sup>11</sup> The travel time budget of working men is higher than that of working women, but during the period they converge [103 min/individual/day (with a peak point at 108 min/individual/day in 1991) versus 81 min/individual/day in 1976, but 103 min/individual/day versus 89 min per individual per day in 2001]. The travel time budget for constrained trips declined for men from 51 min/individual/day in 1991 (peak point) to 45 min/individual/day in 2001 and increased for women from 31 min/individual/day in 1976 up to 33 min/individual/day in 2001. For both categories, the daily time dedicated to nonconstrained trips went up (Figure 2).

The number of trips of working women is now considered by types of jobs to identify the category facing this increase in mobility. For all categories of jobs, the number of trips increased during the period. During the

<sup>11</sup> In France, the labor force or working population is composed of (a) people with jobs and (b) unemployed people looking for a job and ready to work within a month.

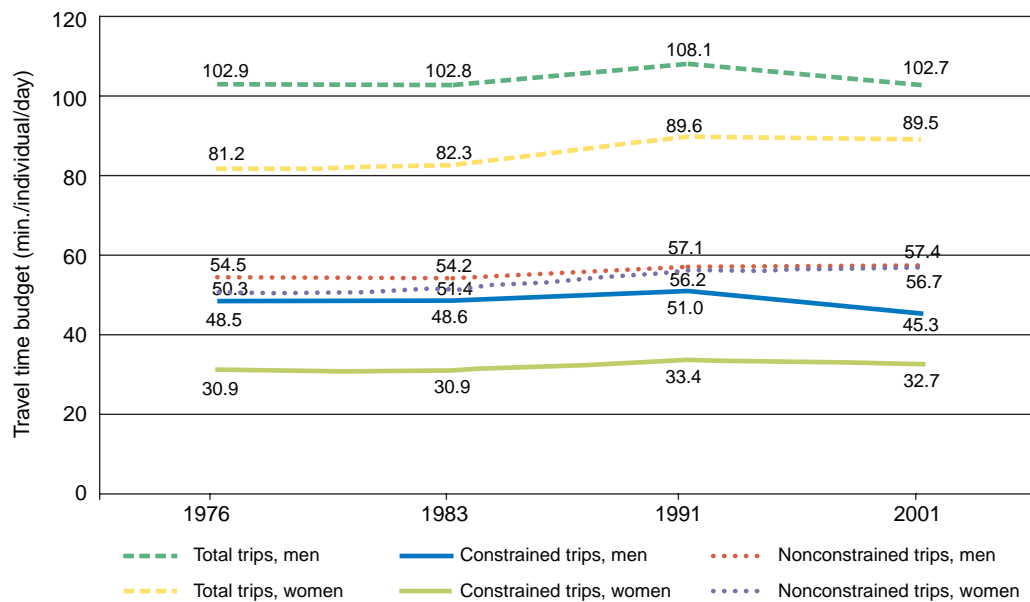


FIGURE 2 Evolution of time budget according to gender patterns in the working population: 1976–2001.

period, the number of constrained trips was almost stable, but for the number of nonconstrained trips, the rise concerns craftsmen and merchants and workers (labor) and pensioners. In 1976 the number of trips for women belonging to the category “staff and upper middle class” was at its highest peak and declined thereafter. The peak occurred at an important moment in the emancipation of women (Figure 3).

In comparing these results with working men's categories, the same trends are observed for men except for the decrease in constrained trips. The curves are flattened and the staff, upper middle class category did not face such an increase in the case of men compared with women. Also observed is that the mobility of pensioners and “other inactives” was higher for men than for women.

When crossing age, gender, and occupation, it is interesting to draw a comparison with the evolution in similar urban community, for example, the San Francisco Bay Area. Gossen and Purvis (2004) obtained interesting results for the 1990–2000 decade. They confirmed the fact that occupation matters in explaining longer traveled distance and time per day per individual. That is, in 2000, working women younger than 60 years of age spent more time on travel than unemployed men did.

But they found that “differences in travel time expenditures between working women and men in 2000 equal-

ized from 1900 to 2000” (Gossen and Purvis 2004, p. 4). Although in 1990 women between 18 and 22 years of age and between 40 and 64 spent less time in travel than working men, the difference disappeared in 2000 except for women in their 50s. During the decade, as in the Paris region, the nonworking population increased its travel time expenditures in 2000 compared with 1990.

### Travel Time and Distance Budgets for Women Related to Housing Location

Measuring mobility in regard to number of trips with a Paris region destination at the total level yields mixed results: although the frequency of trips whose destination is Paris decreases in some of the nearest areas (Val-de-Marne, Hauts-de-Seine), the fringes of the Paris region faced a huge increase in the number of trips. This increase is confirmed when looking at both travel distance and time budgets (see Figure 4).

The travel time budgets of the different parts of the region converged to reach an average of 80 min/individual/day between 1976 and 2001. The most important increase (14%) in travel time budget and travel distance budget (50%) occurred for residents living in the Seine-et-Marne Department, where the housing density has risen as a result of this department's low real estate prices (purchasing and renting). The latter is a semirural area

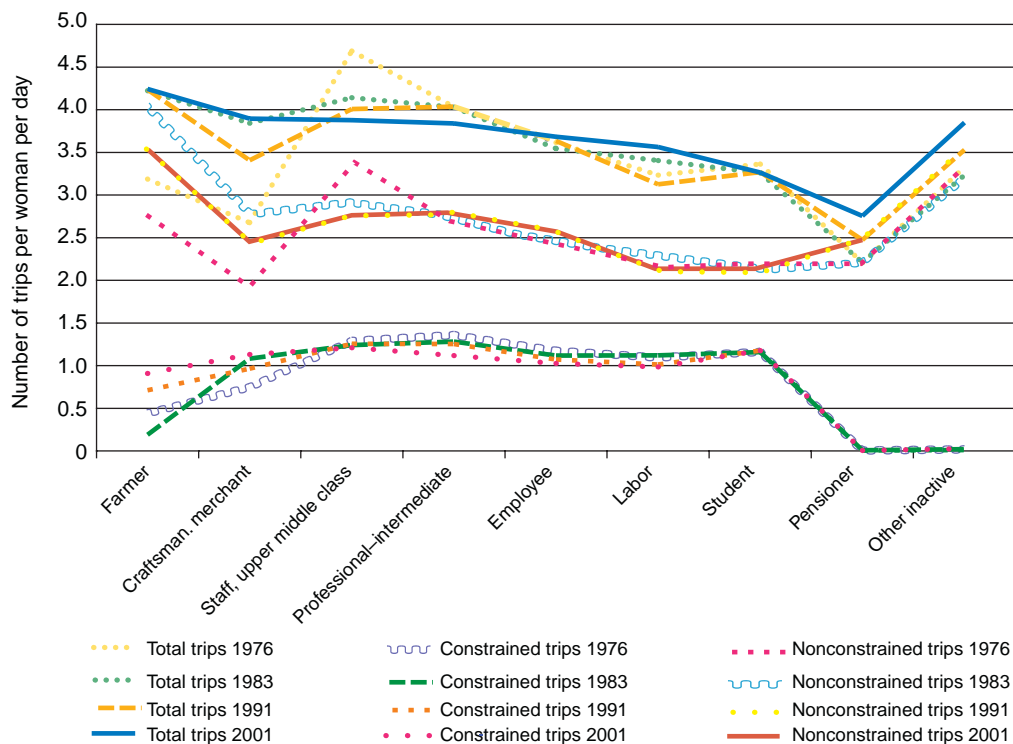


FIGURE 3 Evolution of number of trips for women by social categories: 1976–2001.

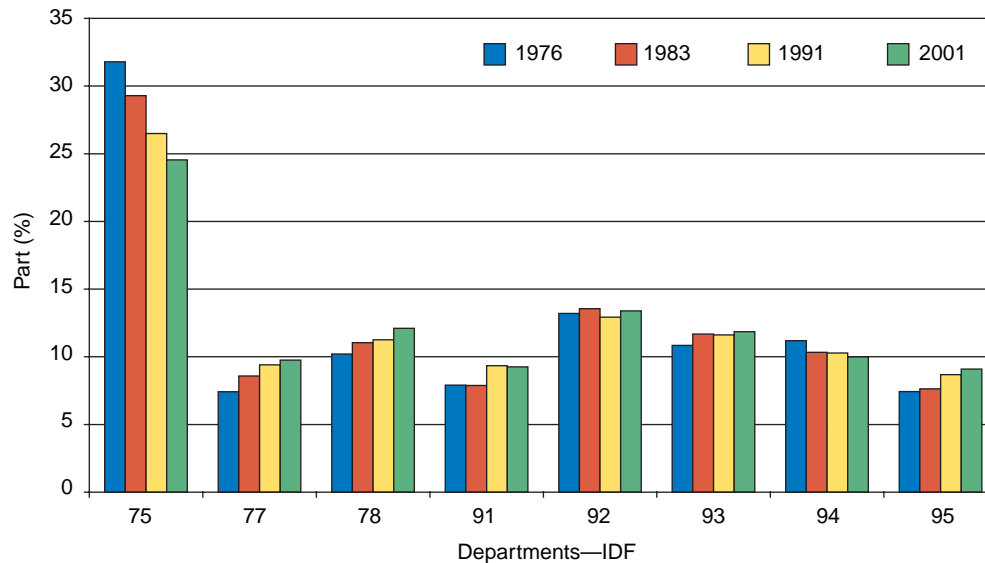


FIGURE 4 Share of number of trips in the IDF with Paris as the destination, by department: 1976–2001. See Figure 1 for departments corresponding to numbers given, e.g., Paris = 75.

with little access to public transportation except in the so-called “new cities” of Melun and Marne la Vallée. The travel time budget of inhabitants in Paris increased by 3% and the travel distance budget by 18% during the overall period.

In regard to distance, it is easy to identify three zones: (a) inner Paris with an average travel distance budget of 11.0 km/individual/day; (b) the inner belt with an average of 13.5 km/individual/day, and (c) the outer belt (semirural areas) with an average of 21.7 km/individual/day.

The gender differences are still at stake in each area with lower travel time and distance budgets for women and converging trends. But both men's and women's travel behavior seem to be ruled by the following “law”: the farther you live from Paris, the greater is your daily traveled distance and time budget for transportation. The converging trends are more striking in the fringes of the Paris region than in the center and areas close to Paris.

Schwanen et al. (2001) find similar results for the Netherlands, showing that the type of urbanization (monocentric versus polycentric) has a clear impact on travel patterns: there is more use of public transport in the core of the cities and less in the suburbs, and shopping distances and exchange commuting distances are longer in the suburbs than in the centers. They show that the urban structure affects the traveled distances only for commuting trips. Concerning the issue of the type and level of urbanization, personal attributes such as gender and the structure of the household matter a great deal: in any case, women travel shorter distances, confirming the results of Johnston-Anumonwo (1992) and Turner and Niemeier (1997).

## Modal Choice

Housing location explains not only increasing time and distance budgets but also modal choice, at the global level. The weight of the modal share of cars is overwhelming, from 31.2% of trips in 1976 up to 43.6% in 2001. The share of public transportation increased slightly from 18.6% to 19.5%. The share of soft modes (walking and cycling) decreased from 41.9% to 34.5% in 2001 as a result of the new urban framework and the room dedicated to cars, especially in the suburbs.

Results are mixed between the different areas: individuals walk more in the center of Paris than in the other areas and, not surprisingly, the car is the main mode of transportation in the outer belt areas.

Looking closer at the gender issue in modal choice, it can be seen that women are using public transport and walking more than men as modes of transportation. This result is not surprising, even common. Dupont-Kerlan and Fontaine (2002) show that women have a higher propensity and willingness to use public transport, especially in the Paris region (see Figure 5).

In Lille (Merle et al. 2009), 61% of the total daily distance traveled by men is by car, whereas for women it is only 51%. In the last survey of 2006, however, men traveled by public transportation more than women compared with 1998. Of the average traveled distance of 17.5 km/individual/day for men, 12.7 km are by car—10.7 km as driver and 2.0 km as passenger—and 3 km are by public transportation. In the case of women, of the average traveled distance of 14.4 km/individual/day, 10.4 km are by car—7.4 km as driver and 3.0 km as passenger—but only 2.7 km are by public transporta-

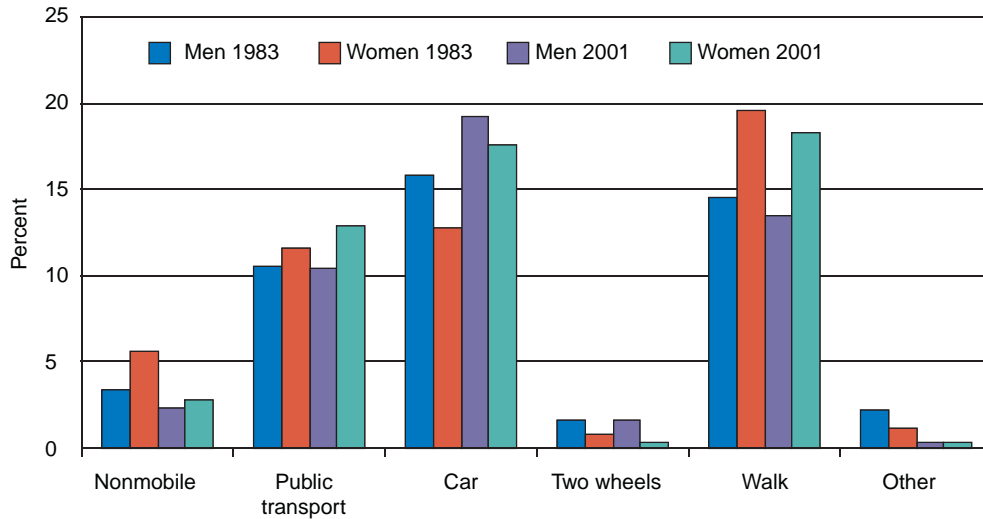


FIGURE 5 Modal shares for men and women in 1983 and 2001.

tion. Men and women walk and bike almost equally, with 1.2 km for men and 1.3 km for women.

The interesting point for the Paris region is the increase in car use among women during the period. This evolution of modal choice and travel patterns toward more car dependency may be related to the improvement in women's access to driver's licences in the past 20 years (see Figure 6).

Nobis and Lenz also showed an increasing share of women with a driver's licence in Germany in 2002 compared with the past decades and also increasing car availability, especially for women having part-time jobs (2006).<sup>12</sup>

<sup>12</sup> Most employed women in Germany are turning to part-time jobs because school ends at 1:00 p.m. and they have to pick up their children at school, most of the time by car.

### Travel Time and Distance Budgets Related to Age Class

The analysis of travel time budget by age class shows stability in the mobility of the 5- to 9-year-old age class and the 10- to 14-year-old and 15- to 19-year-old classes. In the past two surveys, the travel time budget had increased mainly for the age classes between 20 and 24 and 40 and 44 years. During the period the increase in the mobility of seniors is noticeable.

For all classes beyond the 20- to 24-year-olds, the time dedicated to nonconstrained trips rose during the period, especially in the last two surveys. The curve of travel time budget for nonconstrained trips has two maximums: the 25- to 29-year-olds and the 65- to 69-year-olds, which can be explained by life cycle and job activities. The most important travel time budgets for constrained trips

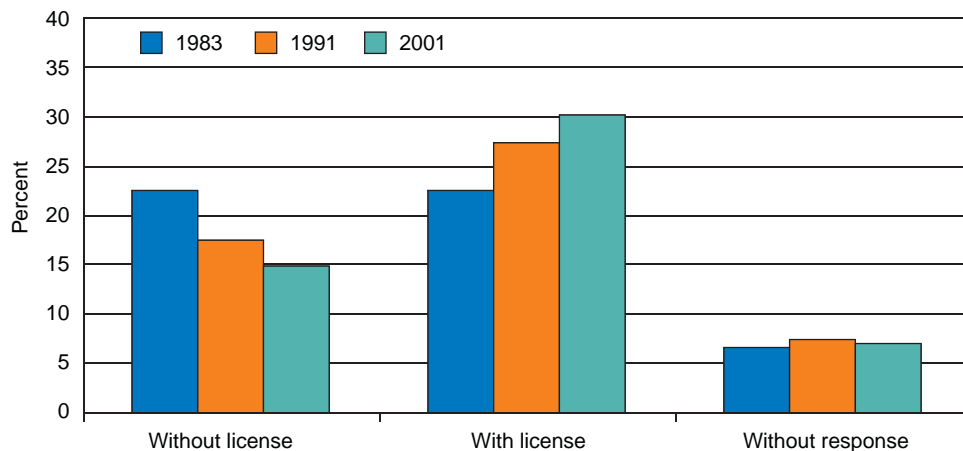


FIGURE 6 Share of women having a driver's license in 1983, 1991, and 2001.



are identified for the age classes of the middle of the life cycle until the 55- to 59-year-old class. In 1976, the 60- to 64-year-old and 65- to 69-year-old age classes had a more important travel time budget for constrained trips than later because of the higher legal age of retirement at that time (the legal age was then 65 years but was changed to 60 in 1981; the law applied from 1982 to 2008).

## FORECASTS SUPPORTING CONVERGING MOBILITY PATTERNS

In this concluding section, results are presented briefly on the basis of past trends and demographic patterns and also on future mobility trends in the Paris region. The travel time budget and the travel distance budget are identified and forecast with the help of an age cohort model.<sup>13</sup>

<sup>13</sup> These are the results obtained by the age cohort model

$$M_{i,p} = \alpha_{ik_0} \cdot A_i + \gamma_k \cdot C_k + \varepsilon_{i,k,p}$$

where

$M_{i,p}$  = mobility expressed either as a travel time budget (min/individual/day), or travel distance budget (km/individual/day). The index  $i$  designates the age class of individuals during period  $p$ .

$\alpha_{ik_0}$  = parameters measuring the influence of the age of the individual on mobility. The fundamental assumption is that the behavior generated by the age of the individual is stable over time. These parameters define a curve of profile-type for the life cycle for the generation of reference  $k_0$ .

$A_i$  = age indicators of individuals (age classes are in 5-year increments from 5 to 9 years old up to 80 years and over).

$\gamma_k$  = parameters measuring the lags between each cohort and the profile type of the reference generation  $\gamma_{k_0} = 0$ .

$C_k$  = indicators of 5-year cohorts (before 1911, from 1911 to 1915, ..., 1991 to 1995).

$\beta_p$  = parameters measuring the distortion of profile type along the life cycle due to period effects.

$\varepsilon_{i,k,p}$  = error term.

The modeling is supported by demographic forecasts provided by INSEE until 2030. The latter underlines an aging population even in the Paris region, especially in the Seine-et-Marne Department. The number of people over 80 years of age will double; however, the share of people under 20 years will be more important in the Paris region than in the other parts of France. The labor force between 20 and 59 years old will be stable.

The forecasts determined show a slight decrease in travel time budget from 79.7 min per individual per day down to 78.9 min per individual per day, this trend being a consequence of a decreasing travel time budget for men and for motorized households.

Forecasts show a decrease in total travel time budgets for the age classes of 25 to 29, 30 to 34, and 35 to 39 and an increase in travel time budgets for the age classes beyond 55 to 59. The increased trend of travel time budgets for nonconstrained trips is confirmed in the forecasts; especially for the age classes over 40 to 44.

The travel time budget for constrained trips should decrease for males between 2010 and 2030, and such trips will be stable for women (even when broken down into constrained and nonconstrained trips). The travel time budget for nonconstrained trips should increase for all parts of the population according to either gender or age patterns, even though gender differences are still at stake: the rise will be by 7% for men and only by 1% for women for the period between 2010 and 2030.

The important change in travel patterns is forecast to occur in the travel distance budget for women. Indeed, at the total level, the travel distance budget is stable, but it

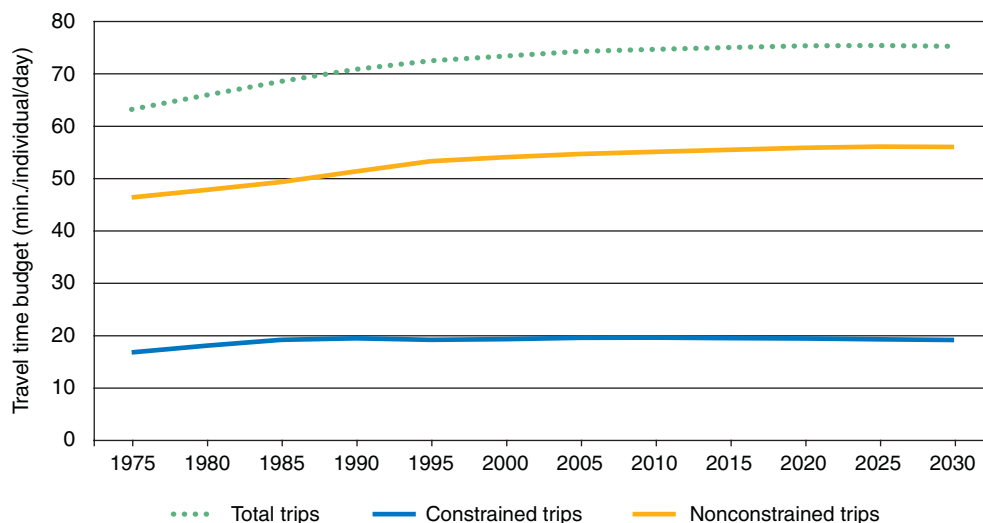


FIGURE 7 Forecasts of travel time budgets for women in the Paris region until 2030.

Forecasts are done from 1975 to 2030 in 5-year steps. The generation of reference is that of 1966–1970. The database is a pseudo-panel made up of the four Parisian mobility surveys and the demographic forecasts made by INSEE.

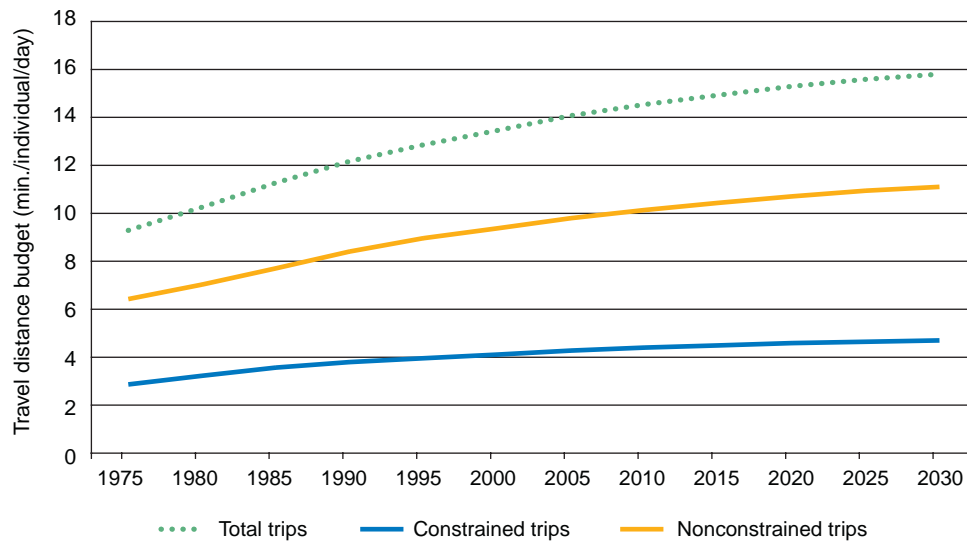


FIGURE 8 Forecasts of travel distance budgets for women in the Paris region until 2030.

increases continuously during the period for women (see Figures 7 and 8).

The travel distance budget of the population should stabilize from 17.5 km/individual/day in 2010 to 18.5 km/individual/day in 2030, the distance of constrained trips being stable at about 5.0 km/individual/day and the distance for nonconstrained trips increasing from 12 km/individual/day up to 13.3 km/individual/day. The travel distance budget for total trips for women is forecast to increase by 2030 by 9%, the distance traveled for constrained trips by 6.8%, and the distance traveled for nonconstrained trips by 14.8%. For the same period, the distance budget for men should rise by 4% for total trips, with a decrease of 12% for constrained trips and an increase of 11.4% for nonconstrained trips.

## CONCLUSION

The forecasts based on a demographic model confirm past trends with an increase in travel distance budget for women, for both purposes. Although men's nonconstrained trips are increasing, it seems that they are not a substitute for those usually made by women (driving children, shopping for groceries). These additional trips made by men are not partly replacing those traditionally done by women. They are done for their own purposes and activities (sport, shopping).

This analysis of Parisian individuals' time used for transport activities should be completed by deeper sociological investigation, the analysis of the impact of the evolution of working hours (from 40 h to 35 h per week), and the impact of the geomorphologic evolution of the area, with a new cluster of housing and working activities.

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*All errors remain the authors'.*

# Gender Differences in Adolescent Travel to School

## Exploring the Links with Physical Activity and Health

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This paper investigates gender differences in the associations between adolescent mode choices and travel patterns for the trip to school and levels of physical activity. Analysis relies on cross-sectional data collected from adolescents ( $N = 269$ ) in Baltimore City for a school-based recruitment study of physical activity and the built environment. Participants were recruited from two magnet high schools, comprising a predominantly African-American sample (67%) with geographically disperse home locations. Data analyzed here for each individual include (a) a web-based survey that collects background information, attitudes, perceptions, and recall behavior, (b) week-long physical activity data collected by accelerometers, (c) a week-long travel diary, (d) archived spatial data about the built environment around each student's primary home address, and (e) height and weight measurements, used to calculate body mass index (BMI). Multinomial logit models of the primary mode to school were estimated separately for males and females. Results show key differences in the factors associated with their travel choices. Aggregate levels of physical activity during the weekday for transit commuters and auto commuters were compared for males and females. Results show significantly higher levels of physical activity for both male and female students who commute by transit, although male physical activity levels were higher on average. There were no significant differences in BMI between transit and auto commuters by gender, however.

With rising rates of childhood obesity, researchers are increasingly alerted to potential ways to increase physical activity for youth through changes in their transportation patterns, including increasing walking to and from school (1, 2). Most of the research in this area focuses on elementary school-age children, and policies have been implemented to encourage more walking, such as Safe Routes to School and similar programs (3, 4). Considerably less attention has been given to adolescents, their travel choices, and health outcomes. Likewise, the role that gender plays in the behavior of this group is also ripe for investigation because efforts to encourage changes in transportation and physical activity behaviors may need to target the sexes differently.

Teenagers are a compelling group to study. On the cusp of adulthood, teenagers have increasing autonomy and responsibility. The teenage years mark a rite of passage for many Americans—obtaining a driver's license—that has the potential to alter activity and travel patterns. Although increasingly independent, adolescents are still subject to parental control and consent. In turn, parental consent and permissiveness may be influenced by the adolescent's gender, having impacts on travel choices, including the decision to drive, walk, or take transit. These travel patterns may be associated with different levels of physical activity in that nonmotorized modes of travel are a direct source of physical activity and travel is often needed to access opportunities to be physically active.

This paper investigates gender differences in the factors associated with adolescent mode choices for the trip

to school and levels of physical activity. Analysis relies on cross-sectional data collected from adolescents in Baltimore City for a school-based recruitment study of physical activity and the built environment. Participants were recruited from two magnet high schools made up of a predominantly African-American sample (67%) with geographically disperse home locations.

## BACKGROUND

This paper brings together the growing literature on adolescent travel behavior and the established work on gender differences in transportation. There is a long thread of literature on gender differences in travel behavior (5, 6). Most studies focus on adult men and women, and many fewer studies center on the travel of children and teenagers in particular [see Weston for a review (7)]. Given that adolescents are nearing adulthood, one might assume that some of the patterns observed among adults would also be present in teens, including the differences between the sexes.

As it is for adults, the automobile is the dominant mode for most children's travel. Weston found that children ages 13 to 15 are driven by their parents for a majority of their trips (7). The increasing number of children who are driven to school and elsewhere illustrates their dependence on others for much of their mobility, which many hypothesize contributes to the increasing rates of obesity among children. Thus, many programs are targeted at increasing the number of children who walk to school by making physical improvements to the transportation environment, organizing walking school buses, and introducing programs that encourage walking to school.

Despite the dependence on others for much of their travel, many children also travel independently to activities. Clifton found that nearly 40% of teenagers travel alone on their trip directly after school (8). This independence in travel is dependent on the age and gender of children. Not surprisingly, the proportion of trips made alone increases with age (3, 8–10) because older children are more mature. But parents often have concerns about allowing female children to travel alone.

Parent permission and constraint play an important part in children's activities. Although teenagers have more independence than younger children, parental control plays a part in their activities and travel choices. Research has documented differences in the way parents treat their teenage children. Adolescent boys tend to be subject to fewer constraints and are often granted more autonomy than are adolescent girls (11–13). Parents tend to monitor their female children more closely than their male children (13, 14). This tighter rein on female children may help to explain differences in observed travel patterns, including travel alone, mode choices, and time of day.

Research has shown gender differences in overall activity participation and time use among teens (15). Girls are more likely than boys to be involved in a wider array of extracurricular activities. Research has documented differences with respect to activities that affect physical activity. Since 1991, the Youth Risk Behavior Survey found lower levels of physical activity among young people in the United States and a significant decline in reported physical activity during the high school years (16). These marked trends are particularly striking for minority adolescents (17–19). Participation rates and time spent in physical activities are higher for boys than for girls (15, 20–23).

This brief review highlights the complexity of adolescent travel choices. Travel to school is dependent largely on parent permissions, physical environment, activity participation, and gender. The mode to school among high school students is examined here to try to understand some of the factors associated with this decision in males and females and how this might be related to levels of physical activity.

## DATA AND METHODS

This section describes the data used in the analysis and the multinomial logit models (MNL) used to examine the factors associated with mode choice to school for males and females.

### Location

This research takes place in the Baltimore, Maryland, metropolitan area and focuses on two schools in Baltimore City, located adjacent to one another and having a student body that resides in neighborhoods throughout Baltimore City and County. These schools can be accessed by light rail and bus transit, and students are required to find their own means of transportation to and from school. Students from both sample schools are predominantly African-American (70%–85%) and white (20%–25%) with total enrollments between 920 and 1,200 for Grades 9 to 12.

### Data

Cross-sectional data were collected from adolescents ( $N = 269$ ) residing in the Baltimore City area for a 2006 study of physical activity and the built environment. Participants (ages 14 to 18) were recruited from two area magnet high schools located adjacent to one another. Magnet schools were chosen as the study sites because students are drawn from across the city and county, thus ensuring variation

in the student participants' home environments, which was an important consideration in the study design. Data analyzed here for each individual include (a) a web-based survey that collects background information, attitudes, perceptions and recall activity, and travel behavior, (b) objectively measured physical activity data collected by accelerometers for 1 week, (c) a week-long travel diary, (d) archived spatial data about the built environment around each students' primary home address, and (e) height and weight measurements, used to calculate body mass index (BMI). The resulting sample was composed predominantly of African-Americans (67%), which reflected the demographics of the school and of Baltimore as a whole. None of the students in the sample live within walking distance of the schools. The descriptive statistics of these data are shown in Table 1 and described in more detail below.

The web survey asked students nearly 100 questions in an effort to gather information about the students, their households, attitudes, and behaviors. Relevant information useful to the examination of mode choices includes information about demographics, auto availability, driver's license status, primary mode of transportation to and from school, and participation in in-school and out-of-school activities, including employment. In addition, a measure of how well students know their way around Baltimore City was constructed from self-reported assessments. A measure of parental permissiveness to allow their teenager to travel independently by walking, cycling, or transit was constructed from a set of four questions about these modes with respect to parents' views on teens traveling alone, with adults, and with friends and their knowledge of where and when they are going.

Students were asked to wear accelerometers to capture levels of physical activity. Following a standardized protocol, each monitor was initialized before placing it on a belt to be worn around each participant's waist above the participant's right hip. Students were asked to wear it all the time, except at night while sleeping and while bathing or swimming during the seven consecutive monitoring days. Activity counts were stored in 30-s time intervals. Students who failed to comply with minimal wear, had a monitor malfunction, or left fewer than 7 days of data (or nonusable data) were asked to wear the monitor again until usable data were collected.

Accelerometry counts were summarized by quantifying the time (minutes) spent at different intensity levels. The thresholds for the activity intensities were less than 50.99 counts for sedentary activity, 51 to 578.99 counts for light activity, and 579 or more counts for moderate to vigorous physical activity. This threshold of 579 or more counts corresponds approximately to the lower bound for a 2.5-mph walk, representing an activity intensity level of three metabolic equivalents (METs). A 3-MET cut point to define the moderate to

vigorous physical activities (MVPA) was used because of its use as the threshold for MVPA in previous studies of youth. Accelerometer data reduction methods incorporated the following data processing issues suggested by the literature.

Participants were also asked to record all of their trips made during the week in a travel diary. Information about the trips collected include day of week, departure and arrival time, mode, and destination (home, school, neighborhood, other). Unlike the survey question, the diary allowed students to record not only their primary mode to school but also the secondary and tertiary modes used for these trips.

Several measures of the built environment were computed around the students' home address. Key measures relevant to this paper include pedestrian connectivity, population density, and mixed land use. These measures have been documented in the literature as correlated with transportation choices (24–27). Pedestrian connectivity is measured as a ratio of the number of intersections (two- to six-way intersections) to total intersections (two- to six-way intersections plus cul-de-sacs) on the road network. Population density is computed from the U.S. census as the number of people per square mile living in the census block of the student's home address. The mix of residential and commercial uses is measured by using the Herfindahl–Hirschmann index (HHI), which is computed as the sum of the squares of the percentages of each type of land use within a half-mile buffer of the student's home. The values range from 0 to 10,000, with the latter value representing a buffer area with only one use (i.e., the higher the value, the lower the level of land use mix).

Finally, BMI is a commonly used measure of obesity. Height and weight measures were taken from the students at the beginning of the study and measures were computed relative to their age and gender.

### Multinomial Logit

Discrete choice models are developed to examine the various factors associated with adolescent's mode choice to school. Discrete choice models are based on the random utility theory, which assumes that the decision maker's preference for an alternative can be captured by the value of an index, called utility. It is assumed that the decision maker chooses the alternative that yields the highest utility. The probability of any alternative  $i$  being selected from a choice set  $C_n$  is given by the following:

$$P(i \setminus C_n) = \Pr(U_{in} \geq U_{jn}) \quad \forall j \in C_n \quad (1)$$

where  $U$  is the utility of the given alternative. Because the analyst will have imperfect information about an indi-

TABLE 1 Descriptive Statistics

	N	Mean	Min.	Max.	SD
Personal and household characteristics					
Age					
Male	107	15.7	14	18	1.25
14		15.0%			
15		41.1%			
16		10.3%			
17		24.3%			
18		9.3%			
Female	162	15.7	14	18	1.19
14		19.1%			
15		26.5%			
16		19.8%			
17		30.9%			
18		3.7%			
Non-White					
Male	107	79.4%			
Female	162	84.0%			
Number of Cars					
Male	107	2.3	0	9	1.37
Female	161	2.2	0	10	1.36
Driver's license					
Male	107	37.4%			
Female	162	34.6			
Know Baltimore					
Male	107	3.9	1	5	1.07
Female	162	3.7	1	5	1.16
Parent permissiveness					
Male	107	14.0	0	16	2.48
Activities					
Employed					
Male	107	41.1%			
Female	162	44.4%			
Number of outside school activities					
Male	106	3.2	0	15	
Female	162	2.0	0	17	
Built environment					
Connectivity ratio					
Male	105	0.81	0.52	0.94	
Female	162	0.82	0.46	0.95	
Mixed use (HHI)					
Male	105	4497	561	9428	
Female	162	4253	150	9370	
Population density					
Male	105	14874	0	48353	
Female	162	19491	0	179965	
Transportation					
Mode to school					
Male	107				
Drive		9.3%			
Get ride		43.0%			
Transit		43.0%			
Female	162				
Drive		11.7%			
Get ride		37.7%			
Transit		50.6%			

NOTE: N = number; min. = minimum; max. = maximum; SD = standard deviation.

vidual's utility level, uncertainty is introduced into the utility equation (28, 29). Equation 2 represents the utility ( $U_{in}$ ) of alternative  $i$  in the choice set  $C_n$  for decision maker  $n$ .  $V_{in}$  is the systematic (or representative) component;  $\epsilon_{in}$  is the random component.

$$U_{in} = V_{in} + \epsilon_{in} \quad (2)$$

In this study, the choice alternatives consist of three travel modes: (a) car driver, (b) car passenger, and (c) taking transit. The being a car driver alternative is available only when the respondent's household owns at least one car and the respondent has a driver's license.

To model this decision, MNL models are specified. The logit model arises from the assumption that the

difference of the error terms is logistically distributed. Under this assumption the choice probability for alternative  $i$  is given by

$$U_{in} = V_{in} + \epsilon_{in} \tag{3}$$

**Model Specification**

The choice set in this model is expressed as  $C_j = \{\text{car driver, car passenger, transit}\}$ . The variables included in the utility functions can be summarized as

- Individual age;
- Number of autos available at the household;
- Whether the respondent has a job (dummy; 1, has a job; 0, otherwise);
- Race (dummy; 1, nonwhite; 0, white);
- Whether the person knows her or his way around Baltimore City (dummy; 1, yes; 0, otherwise);
- Summary measure of parent permissiveness concerning walking, bicycling, and taking transit (variable range 0–16, with higher scores indicating more permissive);
- Number of out-of-school activities respondent participates in;

- Population density;
- Connectivity ratio; and
- HHI.

On the basis of this specification, two models are estimated for males and females separately to better understand the factors associated with mode choice and the gender differences.

**RESULTS AND DISCUSSION**

This section provides the results of the analysis and discusses the implications of these results for the male and female students.

**Mode Choice to School**

Results of the MNL models for primary mode to school for females and males are shown in Table 2. The primary modes modeled include auto drive, transit, and auto passenger (base case). Both models are statistically significant at the 99% confidence level,  $p < 0.001$  for the  $\chi^2$  test. The log-likelihood ratio test clearly rejects the null

**TABLE 2 Primary Mode to High School**

Mode: Drive, Transit, Auto Passenger (base case)	Female		Male	
	Coefficient	t-Ratio	Coefficient	t-Ratio
<b>Drive</b>				
Alternative specific constant	11.174	0.80	-77.083	-1.64
Age	-0.544	-0.71	4.714	1.67
Race (1 = nonwhite)	-0.719	-0.59	6.861	1.63
Number of cars in household	0.809	1.77	3.012	1.78
Knowledge of city	2.321	2.09	-5.311	-0.69
Have a job	0.340	0.34	11.074	1.24
Out of school activities	0.382	1.70	-0.532	-1.36
Parent permission	-0.264	-1.25	-0.140	-0.48
Herfindahl–Hirshmann index	0.001	1.71	0.000	-0.82
Population density	0.000	1.48	0.000	0.31
Connectivity ratio	-6.870	-1.46	-23.152	-1.52
<b>Transit</b>				
Alternative specific constant	-2.722	-0.79	0.157	0.03
Age	-0.337	-1.74	-0.357	-1.48
Race (1 = nonwhite)	2.241	3.39	2.372	2.87
Number of cars in household	-0.366	-2.41	-0.262	-1.46
Knowledge of city	-0.396	-0.87	-0.457	-0.72
Have a job	0.628	1.40	1.203	2.03
Out of school activities	-0.139	-1.76	-0.056	-0.60
Parent permission	0.312	3.09	0.256	2.00
Herfindahl–Hirshmann index	0.000	-2.57	0.000	-0.86
Population density	0.000	-0.40	0.000	0.26
Connectivity ratio	5.248	2.07	1.071	0.34
<b>Summary statistics:</b>				
	<i>Female</i>		<i>Male</i>	
Number of observations	160		97	
Log likelihood at optimate	-98.50		-54.55	
Log likelihood at no coefficient	-175.77		-106.56	
Pseudo R <sup>2</sup>	0.44		0.47	
Adjusted R <sup>2</sup>	0.38		0.36	



hypothesis that all independent variable coefficients are zero for both models. The segmented models show some key differences between the travel choices of boys and girls in their trip to school.

Age is significant and positively correlated with driving in the male model but insignificant and negatively correlated in the female model. The ability to drive is correlated with age (and why possession of a driver's license was not included in the models), and thus the results for males make sense. Why the results are not similar for female students is less clear.

Age is also significant and negatively correlated with taking transit for girls. As girls become older they are less likely to take transit relative to being a passenger in an automobile.

Being nonwhite is significant in both models. The coefficient is positively associated with taking transit to school and has a similar magnitude for both males and females. This is consistent with other studies that demonstrate that African Americans and other ethnic minorities are more likely to use public transportation. In this case, explanations for this choice could be associated with lower household incomes relative to that of whites, leading to less access to automobiles. However, race was not significantly correlated with the number of autos in the household. In addition, the higher propensity for nonwhites to take transit to school may also reflect the spatial distributions of home locations that have better access to transit than do white students. However, the variables related to transit access (distance to rail and bus stops) were not significant in the models and were not included in the final versions.

Access to automobiles was reflected in the models by the number of automobiles in the home. This variable was significant in both the male and the female models, albeit with different effects. The more automobiles in the home, the more likely students are to drive to school. However the effect appears to be greater for male students than for females, as the coefficient for males is more than three times that for females. Likewise, the number of vehicles is negatively associated with taking transit, but the variable is significant only for female students.

An interesting result is the significance of the variable reflecting students' knowledge of the city of Baltimore. This variable is significant, and the coefficient is positive in the female model for the choice of driving to school. Although this indicates that female students that drive to school feel that they have a better knowledge of the city, the direction of that association is unclear. Students who drive may develop a better, or at least different, knowledge of the city than those who take transit. The freedom to drive may allow for more exploration of the city than is possible for those limited to transit routes. However, it may be that students who know more about Baltimore

City are given parental consent to drive or may feel more comfortable driving than those with less knowledge of the urban area. The fact that the variable is significant only for females raises questions about spatial knowledge and comfort level in traveling in places that may be unfamiliar.

Having a job might influence the mode to school as a result of temporal or spatial constraints placed on a trip before or after school. Students who have jobs may also rely more on automobiles because of these constraints or because the job affords the resources to purchase a vehicle. Thus, one would expect this to be significant in these models. However, the variable was significant in the male model and only for taking transit to school. Surprisingly, it is positively correlated with the choice of transit.

Participation in organized activities out of school may place scheduling constraints similar to holding a job. In addition, playing sports, taking music lessons, or other activity may necessitate carrying additional equipment, clothing, and other items. Therefore, travel to school by automobile may be more attractive, in that it provides higher levels of mobility and facilitates hauling gear. The results show a negative association between the number of out-of-school activities and taking transit to school among females. The coefficient was not significant for driving among females or among males.

Although teens can have a great deal of autonomy in their activities and travel relative to younger children, parent permission remains an important determinant of children's travel. Here the variable measures the level of parent permission for independent travel by walking, bicycling, or transit. As expected, the variable was significant for taking transit to school in both the male and the female models.

Several built environment variables were included in the model because the literature has shown correlations between land use and urban form characteristics and mode choice, as discussed above. The mix of residential and commercial uses near the student's home as measured by the HHI was significant in the female model only for driving and taking transit, although the magnitude of the coefficient is small. Population density was not significant in either model. Connectivity ratio, a measure of pedestrian networks, was positive and significant in the female model for taking transit to school. This suggests that the pedestrian network is an important facilitator of transit mode share for girls. Neighborhoods with higher connectivity may have better pedestrian access to transit or may be correlated with better transit service as a result of their location in the city.

Why these built environment variables are significant only for the female models is puzzling and points to areas for more research. Some research shows differences in how men and women respond to, perceive, or hold attitudes about environmental characteristics in ways that

may affect behavior. Clifton and Dill (30) show that differences in the built environment correlate with the walking behavior of women and men. Studies show women appear to be more sensitive to safety and aesthetics than men (31, 32)

### Transit Use, Physical Activity, and Obesity

There have been numerous calls for increasing children's physical activity by facilitating walking to school. However, the relationship between walking to school and measures of physical activity remains somewhat unclear. In this study, none of the students live within walking distance to the school; however, many walk as part of their transit commute trip. Here the relationship between measures of mode to school, physical activity, obesity, and gender is examined.

The differences between male and female students in the factors associated with mode choice would suggest that there may be differences in their levels of physical activity. Figure 1 reveals these differences, significant to the 99% confidence level, between those who take transit and those who take automobiles (passenger and driver), in aggregate measures of physical activity during the weekday.

The average weekday total (across 5 weekdays) minutes spent in MVPA for males was 210 for those traveling by auto and 275 for those traveling by transit. For females, the comparable statistics are 168 min and 211 min, respectively. A significantly greater amount of time is spent in engaging in physical activity among those who take transit, for both genders, although males show greater amounts of physical activity overall than females. This trend holds for the average minutes spent per 1 weekday engaged in moderate physical activity. Students taking transit have higher levels of engagement in physical activity (54 min for males; 47 min for

females) than those who take automobiles to school (43 min and 37 min, respectively). The measures of sedentary behavior are consistent with these findings, although the magnitude of the differences is smaller. Students who take transit to school spend fewer minutes in sedentary behaviors during weekdays than those who take automobiles. Females spend more time in sedentary activity than males, however, across all categories of mode.

Some have speculated that transit users will exhibit higher levels of physical activity because of walking to access and egress transit (33). To examine the walking trips associated with transit users (although not necessarily transit trips), the total number of walking trips made during weekdays (Monday through Friday) for all purposes, not just school travel, was calculated from the travel diary data. In Figure 1 the differences exhibited in mean total walking trips are significant to the 99% confidence level. Students who take transit to school undertake significantly more walking trips per week than those who travel by car. Although the total number of walking trips for males and females is nearly the same (3.5 and 3.4, respectively) (Figure 2), there are clear gender differences in the number of trips by mode of transport to school. Females, who travel to school by automobile make only 1.4 trips on average during school days, compared with 2.7 by their male counterparts. Conversely, the most walking trips during the school week are made by females who take transit to school—amounting to 5.1 walking trips on average compared with 4.6 for males.

The differences in walking rates between automobile and transit commuters are more straightforward to explain, albeit just speculation, than the gender differences in walking. In addition to the hypothesis that transit users walk more as part of their transit trips, neighborhoods with good transit access may also be communities with characteristics that support walking. Finally, students who use alternative modes may lack access to automobiles and thus use these modes more readily.

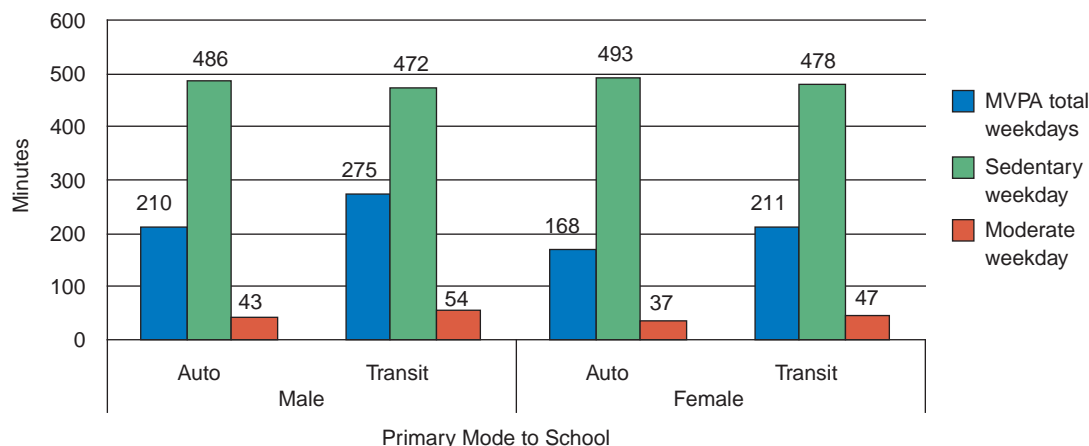


FIGURE 1 Measures of weekday physical activity, by gender and mode to school.

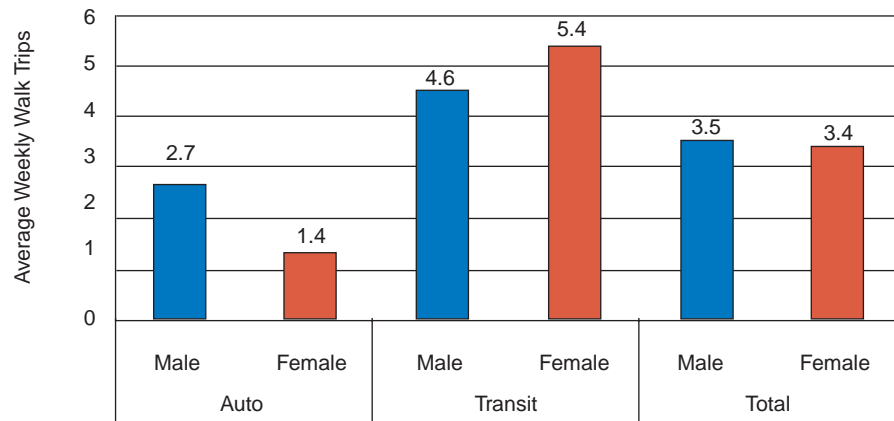


FIGURE 2 Average total weekday walk trips by commute mode to school and gender.

One must be careful not to attribute causality to these correlations and must interpret them with caution. It is unlikely that the physical activity associated with taking transit—walking to and from stops—is responsible for all of these observed differences. What it does suggest is that transit may provide important mobility for youth in accessing opportunities to be physically active. Transit may allow independent travel that may facilitate participation in activities, such as organized sports, informal recreation, or employment, that increase physical activity levels. Although travel by automobile is normally associated with greater mobility, transit may provide greater levels of independent mobility for adolescents without access to a car, who cannot drive, or who cannot arrange for a ride because of adult scheduling constraints. The number of outside activities that female students participate in, however, is negatively correlated with choosing transit, which confounds this logic.

Comparing BMI for transit and automobile commuters does not yield significant results. BMI for males is 24.5 for those that commute to school by automobile and 24.7 for transit users; these results are not statistically significant. For females, BMI is 24.0 for automobile users and 25.0 for transit users. These differences are also statistically insignificant. Obviously, body weight and obesity are more complex than just the level of physical activity. Diet, genetics, and physical activity all play a role. Similar to levels of physical activity, it is unlikely that differences in BMI could be attributed solely to transit use.

## CONCLUSIONS

The analysis presented here shows some important gender differences in the variables associated with mode choice in travel to school. These range from personal and household characteristics, activity participation, parent permission, and the built environment. Race, age,

the number of vehicles available, and parent permission affected both males and females, although at different magnitudes and often for different modes. Female students' choices were associated with their knowledge of the city, number of out-of-school activities, and the built environment. Having a job was an important determinant of males' transit use. The primary mode to school was also correlated with differences in physical activity levels and number of walking trips made during the week but not with measures of obesity.

These findings suggest that students who take transit to school exhibit greater levels of overall physical activity although why this is the case cannot be discerned from these data. Consistent with other research, girls show lower levels of physical activity than boys, across all mode categories. Although males and females have similar rates of walking, on average, females who take transit to school walk nearly four times as often as females who take an automobile to school. Although females who take transit tend to be making more walking trips than males, they are engaging in fewer minutes of physical activity, suggesting that the walking trips may be short or at a leisurely pace. Although the actual relationship to transit is unclear, these differences by mode are notable and should be examined more closely.

Adolescents remain an interesting group for study because they have formative experiences and form preferences and individual and group identities that may hold as they enter into adulthood. The results of this paper raise more questions than they answer, suggesting that gender differences in adolescent travel can be a fruitful area for future investigation.

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# What Do Existing Household Surveys Tell Us About Gender and Transportation in Developing Countries?

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Access to affordable, reliable, and safe transportation is critical in improving the welfare of individuals in developing countries. Yet, transport data are limited overall, and data that address the different patterns of use by women and men are even scarcer. A few studies have shown, however, that women and men have different transport needs and constraints. Typically, analysis of these topics has been hampered largely by the costs involved in carrying out the large-scale transportation surveys needed to provide such data. There are household surveys, however, that can provide further insights into how women and men use transportation in the developing world. Four common household surveys—income and expenditure surveys, living standards measurement study surveys, demographic and health surveys, and multiple indicator cluster surveys—are reviewed to identify the extent to which they can provide transportation planners and researchers with relevant data. The results are mixed. Substantial data on one or two aspects of transportation, such as cost and mode used to visit education and health facilities, are available across countries; however, the surveys contain little information on other important factors, such as mode choice, security, and travel patterns. A marginal influence on surveys to expand the data collected on gender and transportation may be possible. Stand-alone transport surveys, however, will continue to be needed to foster the production of gender statistics in transportation in developing countries and the incorporation of gender differences into transport decisions.

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Access to affordable, reliable, and safe transportation can be critical in improving the welfare of individuals and households in developing countries. Transportation opens up earnings opportunities, facilitates schooling and health care, and allows households to take advantage of other services and infrastructure. To maximize the effect of transportation spending on development, policy makers need to understand the constraints that all individuals and households face in using transportation. Traditionally, transport planning models have not considered women's specific travel patterns. This failure to address the different travel and transport needs of men and women resulting from their social and economic roles reduces the effectiveness of transportation spending and policy and can have a negative effect on economic growth and poverty reduction.

Dedicated transport surveys, carried out at the household and individual levels, provide much of the information needed for policy in the sector, and transport planners and policy makers rely heavily on them. However, few such surveys are conducted in developing countries. Surveys that allow disaggregation of access and use patterns by gender are costly in terms of time and other resources and therefore are done infrequently.<sup>1</sup> Most countries cannot afford to implement such surveys at any given time and are even less able to carry out the

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<sup>1</sup> The 2003 National Household Travel Survey by the Department of Transport of South Africa was a nationwide effort to provide strategic insight into the travel patterns and transport problems of households; it provided a unique example of what can be done to survey the demand for transport of women. The technical report highlighting the survey results can be found at <http://www.transport.gov.za/projects/nts/TechnicalReport.html>.

multiple rounds of a survey that are needed for trend analysis. Other sources of data need to be found if policy makers in developing countries are to incorporate gender considerations into transport policy.

The purpose of this paper is to explore other household and individual data sources that exist in developing countries to determine whether they can provide insights into transport and gender issues. Most countries carry out household surveys that, although not designed to provide specific transport sector data, may contain useable information for policy makers. Exploiting such household surveys could be a way to improve transport policy for women without massive expenditures. Additionally, unlike dedicated transport surveys, which are done as stand-alone efforts, the surveys that form part of a country's national statistical system are more likely to be repeated, thus ensuring the availability of future data. Finally, the methodology of these surveys is often fairly standardized, which facilitates cross-country comparisons.

To determine what type of gender data are available to policy makers in the transportation field, four common household surveys are reviewed here: household budget or income and expenditure surveys (HBS-IES), living standard measurement study (LSMS) surveys, demographic and health surveys (DHS), and multiple indicator cluster surveys (MICS). Examples of each type of survey are used to illustrate the extent to which they provide data on transportation. The paper concludes with recommendations for changes that could be made to allow greater analysis of how transportation and gender interact to affect an individual's welfare.

## GENDER DIFFERENCES IN TRANSPORT

The literature on gender and transport in developing countries is not extensive. However, the work that has been done identifies some important areas for transportation and development policy. Dissimilarities between men and women exist in relation to trip purpose, frequency and distance of travel, mode of transport used, mobility constraints to access other sector services such as health, and complexity of trip making.

### Accessibility and Transport Choice

Understanding and measuring accessibility is essential to assess the transport constraints that individuals may face in reaching work and nonwork opportunities (Srinivasan 2005). Women tend to have access to fewer transport choices, thereby constraining their ability to travel. Men are often given priority in terms of household transport decisions. A survey in Lagos, Nigeria, showed that the decision to acquire a private automobile was made

solely by the husband in almost three-fifths (59%) of households (Odufuwa 2007). In particular, women tend to have less access to cars; studies have shown that in households where there is a private car, men usually get priority for its use. This lack of access to private vehicles is reflected in women's less frequent travel and shorter distances traveled than men's (Anand and Tiwari 2006; Hanson and Hanson 1980). The greatest disparity in access to cars has been observed in rural areas, where three times more men than women use this mode of travel (Venter et al. 2007).

### Affordability of Transport Modes

Transportation costs can represent a significant share of households' budgets in most developing countries. Goddard and Diaz (2000) found transport to account for between 8% and 16% of households' budgets in a number of developing countries in Africa. Women have been found to spend a greater share of their income on public transport than men. A study in Kampala, Uganda, revealed that women spend as much as 29% of their income on public transport (Kamuhanda and Schmidt 2009). High costs of public transportation can make services particularly prohibitive for women when it comes to reaching their workplaces. As a result, women appear to work closer to home beyond a fixed cost threshold (Srinivasan 2005). Also, women tend to walk, and they rely on public transportation primarily for longer journeys.

### Travel Patterns and Trip Purposes of Women

Studies to determine women's travel needs in urban and rural areas of developing countries have found that women's travel patterns typically derive from the multiple tasks they must perform in the household and the community (Hanson and Hanson 1980; Rosenbloom 2005). Women have multiple roles—as earners, child care providers, household managers, and, often, maintainers of community and social networks (Moser 1993). Owing in part to these multiple roles, women's travel patterns are more likely to be characterized by more frequent and shorter trips than those of men (Hanson and Hanson 1980; Odufuwa 2005). The complexity of the trips made by women often is greater than by men, as women combine trips for shopping and household errands with their journey to work to save time. Minimizing travel time and choosing work opportunities shorter distances from home allows women to minimize their travel time and balance the overlapping schedules of work and household responsibilities (Anand and Tiwari 2006).

## Quality and Security Concerns

Studies have revealed that women are more willing than men to use public transport, independent of their car access, particularly if public transport can be provided in a clean, comfortable, and regular fashion with city-wide coverage (Okoko 2007). Women, however, can be particularly concerned with issues of trust in the role of public transport conductors and security.

## DATA AND METHODOLOGY

The selection of surveys for reviewing data on gender and transportation was based on three criteria. First, surveys were chosen for their frequency likelihood, as the more often specific data are collected across countries and across time, the greater is the potential usefulness of the data. Second, to be useful, surveys needed to collect data at the individual level. Finally, surveys were chosen based on a judgment, a priori, of each survey's potential usefulness.<sup>2</sup> A general description of the four types of surveys reviewed is presented.

### Living Standard Measurement Study Surveys

LSMS surveys were developed by the World Bank in the 1980s to provide new and better quality data on household behavior and on the interaction of households and policy. To meet these goals, LSMS surveys were developed as multitopic household surveys gathering information on a wide range of household and individual characteristics that affect welfare. Samples, while small to ensure quality control, are almost always nationally representative.<sup>3</sup> Data are collected at the individual, household, and community levels.<sup>4</sup> Previous work has shown that the LSMS surveys have the potential to contribute to knowledge on transportation in general even though it is not a specific topic area (Baker and Denning 2005). LSMS surveys have an additional advantage in that, for the majority of surveys, governments have made the data sets publicly available.<sup>5</sup>

<sup>2</sup> For example, while many countries carry out labor force surveys with great frequency, they were not included as their focus is narrow and of little relevance to the gender and transport linkages discussed here.

<sup>3</sup> The few exceptions are in countries where conflict, violence, and social unrest can make it impossible to visit certain areas.

<sup>4</sup> Further information on LSMS surveys is available at <http://www.worldbank.org/lsm/>.

<sup>5</sup> Not all governments have allowed open access. For information on how to obtain the survey data sets or to download many of them, see the LSMS website at <http://www.worldbank.org/lsm/>.

## Household Budget–Income and Expenditure Surveys

HBS–IES are designed to collect information on household expenditures, produce or update the weights for consumer price indices, and provide inputs for national accounts. Countries often add modules on income to their HBS to facilitate the measurement of national income as well. Most HBS–IES also collect a restricted set of basic questions on household members related to demographics, education, and employment status. With the exception of agricultural modules (included for income purposes), no other specific topics are traditionally collected in HBS–IES. Data are always collected at the household level, but some surveys also contain individual expenditure diaries. The advantage of HBS–IES as a data source is that these surveys are done in most countries and are done fairly systematically—annually in some parts of the world (Eastern Europe) and every 5 years in other areas (Latin America). Thus, one can compare transport patterns across countries and, more relevantly perhaps, over time within countries. The drawback of these surveys is that they are often difficult to obtain at the unit level. Permission is usually on a case-by-case basis.

### Demographic and Health Surveys

DHS are designed to collect data on health—primarily maternal and infant health—but they may also contain data on household demographics and assets. The surveys, started in 1984, usually include basic characteristics of the household and the respondents, child health, education, family planning, fertility and fertility preferences, HIV/AIDS knowledge, attitudes and behavior, infant and child mortality, maternal health, nutrition, and socioeconomic indicators based on asset ownership.<sup>6</sup> In specific countries, additional modules are applied. Data are collected at the individual and the household levels. The fact that the DHS are implemented systematically in many developing countries makes them a potentially valuable data source if they contain any relevant information on transport. Additionally, the DHS are publicly available and can be accessed on the DHS website upon registration.<sup>7</sup>

### Multiple Indicator Cluster Surveys

MICS were first carried out in 1995 to provide the data needed to monitor progress on the goals adopted at

<sup>6</sup> Information on the DHS comes from Vaessen et al. (2005) and the DHS website at <http://www.measuredhs.com>.

<sup>7</sup> For more information on DHS or for registering to obtain data sets go to <http://www.measuredhs.com>.



the 1990 World Summit for Children.<sup>8</sup> A second round was done in 2000 and a third was done in 2005–2006. More than 100 countries implemented MICS in the third round. The fourth round is planned for 2009–2010, and the frequency is expected to increase from every 5 years to every 3 years, given the importance of many of the indicators that are monitored with these surveys. The main topics covered by MICS are nutrition, child health and mortality, water and sanitation, housing, reproductive health and contraceptive use, literacy, child protection, labor, domestic violence, and other issues related to children and their welfare. A core questionnaire exists for each round of the survey, with each country doing some degree of customization given its circumstances and health issues.<sup>9</sup>

Twelve data sets or questionnaires were reviewed to determine the surveys' ability to inform transport policy from a gender perspective. From the pool of LSMS surveys, Bosnia and Herzegovina (2001), Guatemala (2000), Malawi (2004), and Panama (2003) were included. Guatemala was picked for the extra transportation questions that had been added for a specific policy concern. Only one HBS–IES survey was included: Brazil's household expenditure survey [*Pesquisa de Orcamentos Familiares* (POF) 2002–2003].<sup>10</sup> Ethiopia (2000) and Haiti (2000) were the two surveys included from DHS, and for MICS the core questionnaire was reviewed as well as those of Thailand (2005), Bosnia and Herzegovina (2006), and Kazakhstan (2006).

## WHAT THE SURVEYS CAN TELL US

Addressing all the issues relevant for understanding gender-specific transportation behavior requires a substantial amount of data. Four areas were identified where better data on how gender and transport interact could be of use for transportation planners: (a) access to transport by women, (b) affordability, (c) journey length and reasons for travel, and (d) quality of transport. The reviewed surveys show several limitations for the analysis of transport access and gender, as these different types of surveys do not address the full range of questions of interest. Useful information is being collected, however; the most common type of data available relate to transport use for accessing health and education facilities.

<sup>8</sup> Information describing the MICS is available at [http://www.unicef.org/statistics/index\\_24302.html](http://www.unicef.org/statistics/index_24302.html). MICS data sets and documentation are available at [http://www.childinfo.org/mics3\\_surveys.html](http://www.childinfo.org/mics3_surveys.html).

<sup>9</sup> Most MICS data sets are available from <http://www.childinfo.org>.

<sup>10</sup> A second data set with individual diary information from Belize, the Household Expense Survey 2008–2009, was not available in time to be included in this paper.

## Transport Access

No overall measure of transport access can be constructed from any of the surveys. The LSMS surveys provide the most detailed data, with trip and use information collected for some specific activities such as health, education, and labor (see section on journey length and reasons for travel), but the overall use or demand for individual transport needs cannot be determined. In addition, while LSMS surveys do collect community-level information on transportation (e.g., community access to paved and unpaved roads, existence of bus service), there is a lack of information on the choices an individual has in terms of transportation for specific activities. This situation limits the assessment of preferences in transportation and access.

HBS–IES can provide individual expenditures on mode of transport, by urban and rural areas, allowing more analysis of transport access and gender differences. Brazil's household expenditure survey (POF) reports the number of individuals with expenditures on modes of transportation the week before the survey. The survey results for 2002–2003 appear to indicate that women tend to rely on public buses, informal private modes (vans, minivans, and moto-taxis), and intermediate modes of transport such as taxis more than men (see Figure 1). This finding appears to confirm results from existing transport surveys. In particular, the results showed that 65% of all women used public buses in the week before the survey, while only 42% of men did.<sup>11</sup> Men were more likely to use private modes of transport such as cars, with more than a third of all men paying for gas (categorized as gas, ethanol, diesel, kerosene, or liquid gas) while only 11% of women did so.

When distinguishing between urban and rural areas, the Brazil POF shows that men who lived in rural areas had almost twice the average expenditure on interstate buses compared with men in urban areas, while women from rural areas averaged less spending on interstate buses than did urban women (see Figure 2). This finding may be explained by the fact that men from rural areas are more likely commute to work by interstate bus, whereas rural women are more likely to travel closer to home—and most likely on foot—to accomplish their household and domestic work.

Although the Brazil POF uses individual diaries, data are collected in an aggregated form. Specifically, this practice means that while data are collected for a wide range of transport-related expenditures (see Appendix A for complete list) they are not collected for each trip but instead are aggregated by type of expenditure over the entire reference period (7 days). As a result, the data

<sup>11</sup> Public buses refer to the following categories: bus, intercity bus, and interstate bus.

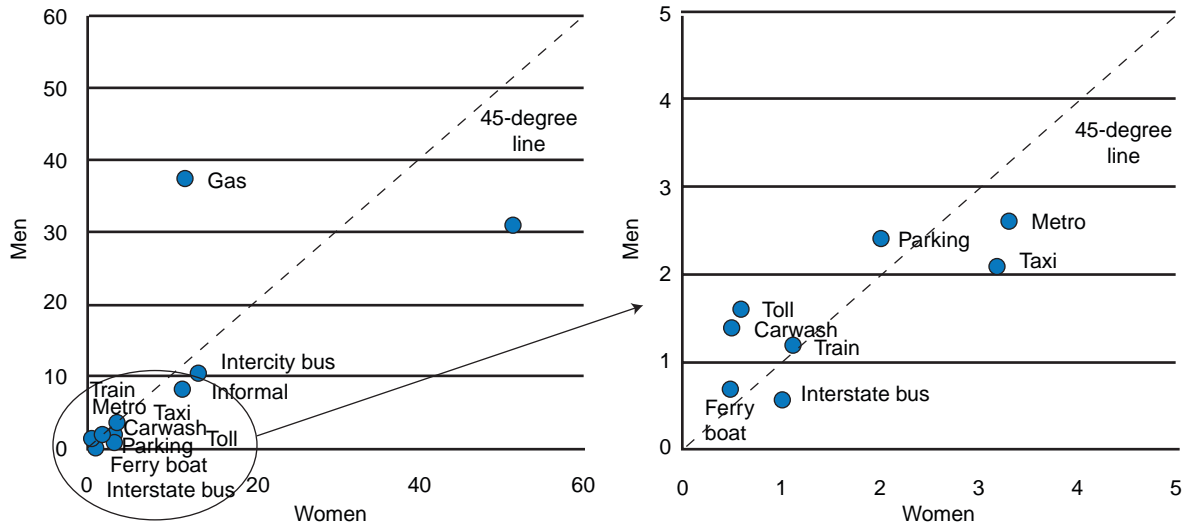


FIGURE 1 Type of transport expenditure made by women and men in Brazil (percentage of men and women who made each type of expenditure per week): 2002–2003. (SOURCE: POF 2002–2003; authors' calculations.)

can show how much a person spent on local bus trips during the week but not how many trips were taken. Other HBS–IES with individual diaries may not have this limitation.

Using HBS–IES surveys for analyzing gender and transport access has limitations. The surveys typically present no disaggregation per trip type or number of trips taken, making it difficult to assess mode shares and individual demand

for transportation. Also, as HBS–IES are expenditure surveys, any movements that do not require an expenditure are not recorded, which includes any travel by foot. Likewise, trips by private transport that do not incur an immediate cost, such as using one's own bicycle, do not appear, nor do trips that are subsidized in their entirety, such as school buses and employer-provided transport. Finally, HBS–IES do not permit an assessment of what share of movements

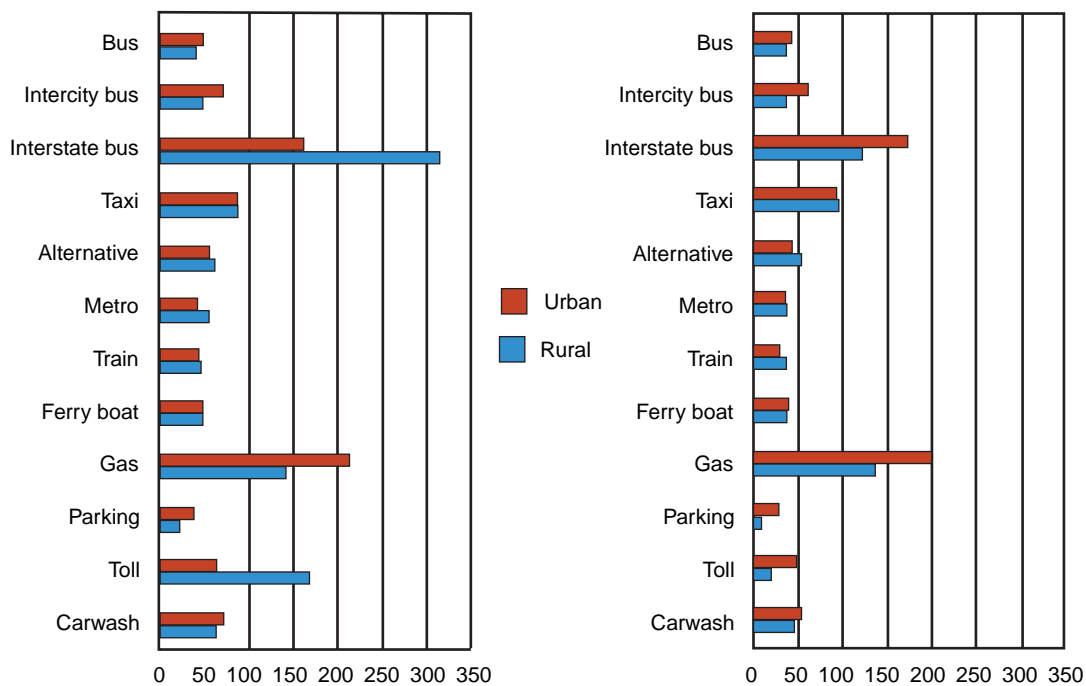


FIGURE 2 Average expenditures (reais per week), by mode of transport used by (a) men and (b) women in Brazil: 2002–2003. (SOURCE: POF 2002–2003; authors' calculations.)

(school, work, market, social engagements) are done by using different forms of transportation.

A second limitation in using HBS–IES data for assessing gender differences in accessibility is that costs related to mode use in such surveys are aggregated, posing difficulty for estimating private transport use. For trips by private vehicle, it is not possible to directly link cost with use. One person in the household may drive the car but not pay for gas, leaving that to another household user. Items such as daily parking and tolls provide indications of use patterns but, in their absence, the actual use of a household-owned private vehicle cannot be determined.

### Transport Affordability

HBS–IES appear to be the most relevant surveys for collecting information about expenditures on transport, but such surveys are often done at the household level only. However, more HBS–IES are including individual diaries of expenditures in addition to the overall household diary. This information allows an examination of spending by males and females on transportation. In some cases, the surveys may also provide information on the types of transportation being used. The usefulness of HBS–IES depends on the level at which expenditures are recorded and entered into the data set.

Results from Brazil's POF showed that men's expenditures on all items related to private vehicles (tolls, parking, gas, car washes) are higher than those for women (see Table 1). However, no conclusions can be drawn on whether one form of transport is more or less expensive for men or women as there are no data on the number of trips. Looking at the incidence of transportation expenditures by welfare quintile (based on consumption) shows that, as expected, as welfare levels rise the incidence of public transportation expenditures falls and private transport expenditures increase. The decline is less for women than for men in most areas. For both men and women, informal transport expenditures are the most common among the poorest, with the amount dropping dramatically as welfare levels rise, indicating, perhaps, the lower quality of this good.

Other HBS–IES, unlike the POF reviewed here, use more open-ended questions to collect transport-related expenditure data. Surveys, such as the Belize 2008–2009 Household Expenditure Survey, collect data on each specific expenditure for transportation. These data provide a more comprehensive look at transportation spending by men and women, the modes of public transport used by gender, and the associated expenditures. One can relate expenditures on transport to total expenditures of individuals and households and how they vary geographically and by the welfare status of households.<sup>12</sup>

<sup>12</sup> The Belize data were not available at the time of writing this paper.

**TABLE 1 Incidence of Expenditures in Brazil, by Consumption Quintile and Type of Transport**

Consumption Quintile	Female (%)	Male (%)	Total (%)
Municipal bus	( <i>n</i> = 10,720)	( <i>n</i> = 7,906)	( <i>n</i> = 18,626)
1	24.4	27.2	25.6
2	23.7	24.5	24
3	21.3	20.7	21.1
4	18.3	16.6	17.6
5	12.3	11	11.7
Alternative	( <i>n</i> = 3,138)	( <i>n</i> = 3,061)	( <i>n</i> = 6,199)
1	43.7	48.6	46.1
2	23.7	22.7	23.2
3	17.1	14.7	15.9
4	9.9	8.5	9.2
5	5.7	5.5	5.6
Intercity bus	( <i>n</i> = 2,630)	( <i>n</i> = 2,642)	( <i>n</i> = 5,272)
1	30.7	35.2	32.9
2	22.1	25.4	23.7
3	19.5	17.4	18.5
4	16.2	13.4	14.8
5	11.5	8.6	10.1
Taxi	( <i>n</i> = 832)	( <i>n</i> = 669)	( <i>n</i> = 1,501)
1	13.2	18.7	15.7
2	15.4	17.5	16.3
3	16.1	17.9	16.9
4	21	16.3	18.9
5	34.3	29.6	32.2
Gas	( <i>n</i> = 2,617)	( <i>n</i> = 10,474)	( <i>n</i> = 13,091)
1	3.8	14	11.9
2	7.9	16.7	15
3	13.8	20.5	19.1
4	24.8	22.4	22.8
5	49.7	26.5	31.1

SOURCE: Brazil, POF 2002–2003. Individual expenditures on transportation.

### Journey Length and Reasons for Travel

LSMS surveys can provide evidence of whether there are different uses of transportation by males and females for two important areas of transportation use: health and education. Data also exist on transportation related to labor but only in a small fraction of countries (see Appendix A). While the core questionnaire of the MICS does not contain related questions, some of the countries have customized their survey to incorporate such variables. The DHS has limited information and the HBS–IES has none.

### Education

No information on the reasons for travel, existing transportation options, or why an individual—male or female—chooses one form of transport over another can be found in the HBS–IES, as they focus on expenditures only. LSMS surveys, on the other hand, while collecting data on transportation expenditures and vehicle ownership at the household level, also collect data for individuals. In almost 60% of the countries with LSMS surveys reviewed

within the context of the World Bank's website on LSMS surveys,<sup>13</sup> all individuals attending school were asked questions about the type of transportation used to get to school and, in many cases, the amount of money spent on school-related transportation. Questions on education-related transportation are typically asked of individuals of primary-school age and older and are conditioned on whether the individual attends school. If so, the child (or the child's parent or guardian) is asked to provide information on the mode of transport used and how much was spent on education-related transport. Also, data are collected on reasons for not attending school: distance and transport issues are usually included in the list of possible answers. (Appendix A provides examples of these types of questions from different LSMS surveys.)

These types of questions, while limited to education-related travel, address many of the key gender-transport questions raised in the literature: reasons for transport, types of transport used, cost, and average time needed. An overview of the data available from four LSMS surveys—Bosnia and Herzegovina, Guatemala, Malawi, and Panama<sup>14</sup>—shows the type of information available and provides quick insights into how much transportation can vary across countries and the extent to which gender matters.

In Malawi, as shown below, practically all children who attend school walk to their school:<sup>15</sup>

<i>Mode of Transport</i>	<i>Percent</i>
Foot	98.5
Bicycle	0.6
Bus/Minibus	0.5
Private Vehicle	0.4
All	100.0

The situation is different for children in Panama, where almost half use buses as their primary mode of transportation—some are specifically designated as school buses and others are regular buses (Table 2). As most children walk to school in Malawi, there are no significant differences between boys and girls:<sup>16</sup>

<sup>13</sup> Data are from <http://iresearch.worldbank.org/lsmssurveyfinder.htm>. This website contains information only on LSMS surveys done with the support or involvement of the World Bank; many other LSMS surveys have been done in recent years, but reviewing their content is outside the scope of this paper. The number of surveys with transport by gender information is probably greater.

<sup>14</sup> The surveys in Bosnia and Herzegovina, Panama, and Malawi are fairly standard in terms of the transportation questions asked. The Guatemala survey, however, had significantly more questions related to transport as it was a topic of interest at the time.

<sup>15</sup> Source: Second Integrated Household Survey, Malawi, 2004. Authors' calculations.

<sup>16</sup> Source: Second Integrated Household Survey, Malawi, 2004. Authors' calculations.

	<i>Time to School (min)</i>	<i>Standard Error</i>
All	25.2	-0.162
Boys	25.2	-0.231
Girls	25.1	-0.237

In Panama, however, girls are more likely than boys to travel to school by bus (Table 2). While the difference is statistically significant (at the .001 level), it is not large, which helps to explain why there are no differences in terms of transportation spending and in terms of time spent traveling to school (Table 3). In contrast, females in Bosnia and Herzegovina pay almost a third more for transport than boys do (Table 4). Time traveling to school, however, does not vary and since the Bosnia and Herzegovina survey does not ask about mode of transportation, it is not clear what is driving the greater expenditures for girls.

Using the Guatemala survey as an example of the importance of being able to link community level data with the household or individual data, the characteristics of the community and its location vis-à-vis schools can be used to assess the impact of distance on use of services. Enrollment is higher in communities with paved roads. As one would expect, the percentage of children enrolled in school declines the farther away the schools are (Table 5).

## *Health*

As is the case with education, LSMS surveys provide some information on transport for access and use of health services. The surveys often ask individuals how long it took them to get to a health facility, the mode of transport used, and the associated costs. As data are collected at the individual level, it is possible to determine how men and women vary in their use of transportation to access health services. (A list of the questions related to transportation and health in several LSMS surveys is provided in Appendix A.) In addition, for health care

**TABLE 2 Mode of Transport Used to Attend School in Panama: 2003**

Mode of Transport	Males	Females	All
Bus or taxi	34.4	39.9	37.2
School bus	9.4	9.4	9.4
Private car	6.4	6.9	6.7
Bicycle	1.4	0.6	1
Boat	0.9	0.6	0.8
Horse	0.3	0.3	0.3
Walking	47.1	42.3	44.6
Other	0.1	0.1	0.1

SOURCE: Encuesta de Niveles de Vida, Panama 2003, authors' calculations.

**TABLE 3** Schooling and Transport in Panama: 2003

	Annual Transport Costs for Preschool for Children Under Age 6	Children Age 6 and Older	
		Time to School (min)	Annual Transport Costs for Schooling
All	141.5 (-10.617)	25.3 (-0.355)	151 (-3.047)
Males	137.3 (-14.483)	24.8 (-0.504)	149.1 (-4.753)
Females	145.9 (-16.371)	25.8 (-0.51)	152.6 (-3.987)

NOTE: Standard error in parentheses.

SOURCE: Encuesta de Niveles de Vida, Panama, 2003; calculations by authors.

**TABLE 4** Transportation to Schooling Among School Attendees Age 7 or Older in Bosnia and Herzegovina: 2000

	Time to School (min)	Distance (km)	Amount Spent Weekly (KM)
All	35.34 (-1.557)	9.25 (-1.412)	7.79 (-0.847)
Males	33.45 (-1.748)	7.7 (-1.368)	6.31 (-0.684)
Female	37.12 (-2.538)	10.71 (-2.439)	9.2* (-1.516)

NOTE: Standard error in parentheses. Authors' calculations. KM = konvertibilna marka.

\*Difference significant at .1 level.

SOURCE: Living Standards Measurement Study, Bosnia and Herzegovina, 2000.

**TABLE 5** Enrollment of Girls and Boys in Primary School in Guatemala, by Distance to Nearest Primary School and Type of Road Access: 2000

Distance to Nearest Primary School (km)	Girls (%)	Boys (%)	Total (%)
Paved communities			
<1	79.2	80.4	79.8
1-10	62.2	78.3	71.3
>10	51.3	65.8	59.0
All other communities			
<1	67.5	87.1	75.8
1-10	67.3	65.4	66.3
>10	50.1	56.2	53.2

use, individuals who self-report illness or injury in the time before the survey but who did not seek health care are asked why they did not do so: transport difficulties are options to this question.

The Bosnia and Herzegovina LSMS survey<sup>17</sup> shows that women pay significantly more than men for transport to health care, while in Panama the differences between genders are insignificant (Table 6).<sup>18</sup> No data were collected for Malawi. The Panama data show that there are also no significant differences in men's and

<sup>17</sup> The Bosnia and Herzegovina survey of 2001 collected data on health transport expenditures for all types of services, some for the 4 weeks before the survey and some annually. In other surveys, only transport expenditures for the prior 4 weeks are collected, and typically they are for a specific provider.

<sup>18</sup> This survey does not control for the amount of health care used.

women's transport to health facilities in terms of the average time spent and the type of transport used.

As with LSMS surveys, the DHS ask reasons for nonuse of health care, with distance and lack of transport as options. In the case of the DHS, however, the question refers only to why a woman did not use a health facility for giving birth. A question also lists eight factors that limit the use of health care. Among the eight factors are distance and lack of transport and whether any of these factors is a constraint to health care access. As other factors that inhibit access to health care are also questioned, the surveys allow the issues that affect health care access to be ranked, thus showing the importance of transport. For very specific purposes related to health access, the DHS provide key data on transport but are not an important source of other transport-related information.

The reviews of the core MICS questionnaire show that transport questions are included at the household level with a focus on the types of transport modes owned by the household. However, because each country can customize the core questionnaire, there can be additional questions related to transport in some cases. (The text of example questions used in several countries is shown in Appendix A.) For example, in Thailand in 2005, reasons for not attending school were questioned as well as reasons for not registering children's birth. For both questions, distance and time of travel were options.

### *Domestic and Household Work*

The review of the core MICS questionnaire also shows that the only quasi-individual-level question included relates to who is mainly responsible for fetching water (adult female, adult male, female child, or male child). However, because each country can customize the core questionnaire, there can be additional questions related to transport. Some, but not many, LSMS surveys gather information on who collects water and fuel; the Malawi survey does.

A further area of investigation concerning the MICS is the ability to link household data sets to other data sets in individual countries. The MICS data sets do not include any community-level data that could provide information on access to roads as well as distance to health, education, and other facilities. However, the survey developers recommend that Global Positioning System data be collected as part of the MICS to allow household survey data to be linked to other administrative data sources. It is not clear from the available information how many countries have collected these data, let alone matched them to administrative data sets that would allow more analysis of transportation. Some LSMS surveys are georeferenced and similar analyses could be possible.

TABLE 6 Transport Costs Related to Health in Bosnia and Herzegovina (2001) and Panama (2003)

	Transport Costs		Time to Health Provider, 0- to 5-year-olds (Panama)	Transport to Health Provider (Panama)	
	BH (mean KM)	Panama (balboas)		Walking (%)	Private vehicle (%)
Total		4.63 (0.420)			
Males	5.23*** (0.485)	4.91 (0.692)	32.9 (2.36)	30.9 (2.36)	10.9 (1.68)
Females	7.89*** (0.655)	4.46 (0.531)	30.2 (2.03)	30.8 (2.55)	13.5 (2.07)

NOTE: Bosnia and Herzegovina (BH) collects information on all health related transport spending by type of provider using different reference. For both questions, distance and time of travel were considered as options. Where feasible, MICS are coordinated with the DHS or LSMS surveys. To the extent that this coordination is really an integration of the surveys, there may well be further data on transport available periods. Panama data are for past 30 days. KM = konvertibilna marka. Standard error in parentheses.

\*\*\*Significant at the .01 level.

SOURCE: BH Living Standards Measurement Study, 2001; Panama Encuesta de Niveles de Vida, 2003.

### Quality of Transport

None of the surveys reviewed provided information on the quality or safety of various transportation options, which tend to play an important role in a woman's decision to travel and in her overall mobility.

### CONCLUSIONS AND RECOMMENDATIONS

In-depth transportation surveys cannot be replaced by alternative data sources: data needs for assessing how gender and transport interact to affect access and mobility are too great to be covered in multitopic surveys or in those with a specific focus on another topic. None of the surveys reviewed provided information on the quality or safety of various transportation options, which can be important for women's overall mobility. Also, each type of survey serves specific purposes, which are not aimed at transportation planning in particular: the purpose of MICS is to provide indicators that track the Millennium Development Goals and the goals of the World Summit for Children; DHS aim to shed light on fertility decisions and maternal-child health; HBS-IES seek to measure expenditures, and LSMS surveys assess welfare and the factors that affect it. However, much remains to be learned from these surveys and exploiting existing data sets can be useful and cost-effective. In particular, the LSMS surveys reviewed confirmed differences in health and education-related travel: girls are more likely than boys to use public transportation to travel to school; girls and women are more likely to pay significantly more than boys and men for transport to access education and health facilities.

The most relevant data for assessing gender needs and differences in relation to transport access and use are the HBS-IES expenditures on transportation, with some of these surveys collecting data at the individual level. MICS typically include questions at the household level related to modes of transport owned by the household and, in any given country, may collect data on transport use for

accessing education and social and economic activities. Potential linkages with community-level data sets might provide more relevant data but they will still be limited. However, adapting this type of survey for monitoring transport and gender data could have a substantial impact, considering the number of countries in which they are implemented. The LSMS surveys can provide data relevant for the transportation sector in relation to community access to paved and unpaved roads, existence of bus service, and all-weather road access.

Some data on transport affordability can be found in those HBS-IES that include individual diaries of expenditures in addition to the overall household diary. This information can allow an examination of spending by men and women on transportation. In some cases, the surveys may also provide information on the types of transportation being used. The usefulness of the HBS-IES will depend on the level at which expenditures are recorded and entered into the data sets. LSMS surveys also provide expenditure data for some types of trips; however, they are usually limited to education and health facilities.

In terms of household data on travel patterns and trip purposes, MICS can provide occasional information but LSMS surveys provide the most substantive information on transportation and gender that relates to health and education. However, the same questions across surveys do not always exist, thus creating some limitations to cross-country analysis. When individual countries maintain the same questions over time, the surveys can help assess tendencies and linkages between changes in transportation policy and actual use over time. Additional information exists in some surveys on labor-related transportation, what is used, and, in at least one survey, the provision of employer-subsidized transport as well and in others on firewood and water collection, but they are rarer.

DHS questionnaires also provide information on transport use for accessing health care. To the extent that DHS link to other data sources (other surveys or through georeferencing), there may be country-specific opportu-

nities to analyze gender and transport. National statistical systems are increasingly likely to have georeferenced road networks and many countries have administrative data on public transportation, such as routes and costs, that could be linked to the household survey data based on geography.

Four recommendations can be made for improving the surveys reviewed in relation to transport data that focus on gender issues. First, adding more questions could ensure a focus on transport and gender issues. This recommendation is probably most feasible in the LSMS surveys as they are designed to look at the factors that affect welfare and is less feasible in the MICS as they are focused on indicators and not the linkages among the indicators or cause and effect. DHS already include some questions that are relevant for understanding the effect of transport on health care; it appears unlikely that questions related to more general transport use would fit. The IES-HBS provide the most potential for new analysis but only on expenditures.

Second, survey questions could be systematized as much as possible. Among LSMS surveys, the questions vary because of the heavy customization of these surveys to meet country demands for data. Some attention to ensure that questions are similar over time within each country should be simple to implement and comparability

across countries may also be possible. DHS are already quite harmonized in terms of the few transport questions, which facilitates comparisons across time and space.

Third, data on expenditures collected through IES-HBS would be more useful if disaggregated by expenditure, which would increase the costs of data collection, entry, and processing and may not be feasible. However, in some surveys data are collected at the expenditure level but are then aggregated to the category level when the data are entered; providing guidance to countries on the benefits of maintaining the expenditure-level data may be effective in increasing the availability of good expenditure data for men and women.

Finally, before designing a full transportation survey for collecting gender data in a given country, transportation planners and analysts should investigate existing data sources; depending on the country, there may be substantial information that can be gleaned from existing surveys. If a country is planning to implement a survey in the near future, it is worth exploring the possibility of adding critical transport questions to that survey. Statistical offices are often willing to add specific questions to an ongoing survey for a cost that would be well below that of carrying out a dedicated transport survey. Only after these options have been exhausted would it appear to make sense to invest in an in-depth transport survey.

## APPENDIX A

Examples of questions from household surveys are shown in Table A-1.

TABLE A-1 Household Survey Questions

LSMS Survey		MICS
<p><b>Education</b></p> <p>What is the distance to the kindergarten where [CHILD's NAME] is taken care of?</p> <p>What is the distance between your home and school?</p> <p>How much time does it take to travel to the school where you were attending?</p> <p>How much do you spend for transportation to school each week?</p> <p>What means of transportation did you mainly use from your house to the school or educational center?</p> <p>Bus or taxi..... 1 School bus..... 2 Private car (own or friend's).... 3 Bicycle..... 4 Boat..... 5 Horseback..... 6 On foot..... 7 Other, specify..... 8</p>	<p><b>Health</b></p> <p>How much did you pay in money or in kind for transport costs associated with these visits to [HEALTH PROVIDER/FACILITY]? (<i>question repeated for each provider</i>)</p> <p>During the previous four weeks did you need medical services but did not obtain them?</p> <p>What was the main reason you did not obtain them:</p> <p>Minor disorder, self-treated... 1 Minor disorder, did not treat . 2 No health insurance ..... 3 Too far..... 4 Institution closed..... 5 Poor service..... 6 Too expensive ..... 7 Other..... 8</p> <p>In total, how much time did it take to go from your house to the (health provider) location where you were seen?</p> <p>What means of transportation did you use most of the time to go to the (health provider) location where you were seen?</p> <p>On foot..... 1 By horse or other animal..... 2 Boat or motor boat..... 3 Bicycle or motorcycle..... 4 Bus or taxi..... 5 Private or own means..... 6 Ambulance..... 7 Plane, helicopter..... 8 Other, which?..... 9</p>	<p><b>Water, Health, Registration</b></p> <p>WS3. How long does it take to go there, get water, and come back?</p> <p>WS4. Who usually goes to this source to fetch the water for your household?</p> <p>Adult woman ..... 1 Adult man..... 2 Female child (under 15)..... 3 Male child (under 15)..... 4 Don't know..... 8</p> <p>C10. Does any member of your household own...?</p> <p>Watch Bicycle Motorcycle or scooter Animal-drawn cart Car or truck Boat with motor</p> <p>BR2. If child's birth not registered with civil authorities: Why is ... birth not registered?</p> <p>Costs too much ..... 1 Must travel too far..... 2 Didn't know it should be registered ..... 3 Don't want to pay fine..... 4 Don't know where to register..... 5 Other..... 6 Don't know ..... 8</p>
<p><b>Labor and Time Use</b></p> <p>In this job did you receive free transportation or money for transport to your work?</p> <p>How much did you receive last month?</p> <p>If you had to pay for the transport, how much would you spend a month?</p> <p>What means of transport do [YOU] mainly use to go to your job?</p> <p>Public services (bus, taxi) ..... 1 Own or friend's car..... 2 Transport from business..... 3 Bicycle or motorcycle..... 4 Boat..... 5 Horse or other animal..... 6 Other private..... 7 Don't use (walk)..... 8</p>		<p><b>HBS</b></p> <p><b>Expenditures for</b></p> <p>Bus (local, long distance) Alternative transport (unlicensed motorcycle, van, and car taxis) Taxi Subway, train Boat Airboat Ferry boat Gasoline, alcohol fuel, diesel Parking Tolls Transfers (bus-subway-train)</p>

SOURCE: LSMS questions from Bosnia and Herzegovina 2001 and Panama 2003 questionnaires; MICS questions from Thailand 2006 questionnaire; HBS questions from POF, Brazilian Institute of Geography and Statistics 2003.



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*Any errors in the paper are those of the authors. The findings, interpretations, and conclusions expressed here are also entirely those of the authors. They do not necessarily represent the views of the World Bank and its affiliated organizations or of the executive directors of the World Bank or the governments they represent.*

# Gender Equality as a Subsidiary Objective of Swedish Transport Policy

## What Has Happened Since 2004?

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Åsa Vagland, *The Swedish Governmental Agency for Innovation Systems VINNOVA*

At the 3rd International Conference on Women's Issues in Transportation in Chicago 2004, the author presented a paper on the background and reasons why Sweden has a gender-equality objective in the transport sector. This paper describes what has happened since then in the political arena and in the implementation process in government agencies and other stakeholders and on the effect in planning and building new infrastructure and maintaining the existing infrastructure. The author analyzed government bills on transport policy, how proposals in the bills were formulated in the annual government guidelines for transport agencies, and how the transport agencies—especially the National Rail Administration (Banverket) and the Swedish Road Administration (Vägverket)—responded to the proposals and reported to the government in the annual sectoral report. There has been progress in the National Rail Administration and the Swedish Road Administration throughout the period from 2004 to 2009. Awareness has increased, and the discussion about gender equality in planning infrastructure is more mature, even if the results in the transport system are not evident. On the other hand, there is concern about how the decision on new transport policy objectives in spring 2009 will influence progress toward a gender-equal transport system. Also important is the change in how annual government guidelines are formulated and how it will affect transport agencies' work toward gender equality. Another issue is the ongoing reorganization in Sweden, where transport agencies are divided and reassembled. How this change will influence gender equality in the transport system is not clear.

At the 3rd International Conference on Women's Issues in Transportation in Chicago 2004, the author presented a paper on the background and reasons why Sweden has a gender-equality objective in the transport sector. That paper described the background, results until 2004, and some conclusions. This paper describes what has happened since then in the political arena and in the implementation process in government agencies and other stakeholders and on the effect in planning and building new infrastructure and maintaining the existing infrastructure.

### RESEARCH QUESTIONS

- What has happened since 2004 in the political arena?
- What has happened since 2004 concerning implementation in government agencies?
- What impact has the objective had in planning and building new infrastructure and maintaining the existing infrastructure?
- What is the gender-equality situation in the transport sector in Sweden in 2005–2009 and how will today's decisions affect gender equality in the transport system in the future?

### SOURCES

The author has analyzed government bills on transport policy, how proposals in the bills have been formulated

in annual government guidelines for transport agencies, and how the transport agencies—especially the National Rail Administration (Banverket) and the Swedish Road Administration [SRA (Vägverket)]—have responded to the proposals and reported back to the government in the annual sectoral report.

## BACKGROUND

### Transport Policy Objectives and Subsidiary Objectives in Sweden

For a number of years, Swedish transport policy has been guided by one overall objective and six subsidiary objectives in different areas. The subsidiary objectives apply to more precise goals, specifying the objective for different parts of transport policy. They are meant to help attain the overall objective. In the hierarchy of objectives there are also intermediate objectives to help attain the subsidiary objectives. These objectives were set by the Swedish Parliament, Riksdagen, during the period 1998–2001.

In December 2001, the Swedish Parliament established a sixth subsidiary objective for achieving the transport policy objective of ensuring an economically efficient, sustainable transport system for citizens and businesses throughout the country (Swedish Parliament 2001).

It is formulated as follows:

The transport system shall be designed so that it meets the conditions and travel needs of both women and men. Women and men are to have the same opportunities to influence the initiation, design, and administration of the transport system and their values are to be given the same weight.

The overall objective for transport policy is to ensure long-term sustainable transport resources that are socially and economically efficient for the public and industry throughout Sweden. The other subsidiary objectives are an accessible transport system, positive regional development, high-quality transport, safe traffic, and a good environment.

The long-term objectives will remain in effect for an extended period. They are to stand for continuity and a long-term perspective in transport policy. There is no internal order of priority among the long-term objectives. Ultimately, all subsidiary objectives are to be achieved.

In the short-term, it will sometimes be necessary to prioritize among the subsidiary objectives. This prioritizing should be accomplished primarily by means of realistic intermediate objectives, taking into consideration available resources, technical possibilities, and international commitments; the intermediate objectives are to be coordinated.

### Organization of Swedish Transport Sector

Sweden is a parliamentary democracy. At the national level, the people are represented by the Swedish Parliament, Riksdag, which has legislative power. The government implements the Parliament's decisions and draws up proposals for new laws and law amendments.

The Swedish government is assisted in its work by government offices comprising a number of ministries, central government agencies, and public administrations. The Ministry of Enterprise, Energy and Communications is responsible for transport issues. The Swedish ministries, compared with those in many other European countries, are rather small. Instead of large ministries, there are many Swedish expert agencies that provide the government with material for decision making. For a long time, Sweden has had four transport agencies: the National Rail Administration (Banverket), SRA (Vägverket), the Swedish Maritime Administration (Sjöfartsverket), and the Civil Aviation Administration (Luftfartstyrelsen).

A new transport agency called Swedish Transport Agency (Transportstyrelsen) was launched on January 1, 2009. It has overall responsibility for drawing up regulations and ensuring that authorities, companies, organizations, and citizens abide by them. The agency is composed of the former inspection agencies for road, rail, air, and sea.

There is also a proposal to merge the remaining parts of the transport agencies into one intermodal agency responsible for all four transport modes. A decision by the government is foreseen in early autumn.

### Government Briefs and Annual Government Guidelines

The agencies in Sweden are governed by a government brief (*instruktioner*) and annual government guidelines included in the agency's budget document (*regleringsbrev*). The government brief regulates an agency's purpose and includes its main tasks in a long-term perspective. The government brief is not changed often.

In December every year, agencies receive an annual budget document, including the government guidelines, for the coming year. The guidelines consist of main tasks in the short term and sometimes include special commissions for the agency to carry out.

### What Has Happened Since 2004?

The analysis of what has happened in the field of gender equality in Sweden with regard to the transport sector is divided into three parts:

- Political arena,
- Government briefs and guidelines, and
- Reports from government agencies.

### *Political Arena*

**Government Bill on Transport Policy** In March 2006, the Swedish government presented a new government bill on modern transport policy (Swedish Parliament 2005a), and on May 30 the Swedish Parliament adopted the new transport policy decision. The bill takes into consideration the recommendations put forward through the work of different parliamentary committees and reports from the transport agencies and other bodies in the transport sector. The most important issues in the bill for the objective on gender equality are as follows:

- The decision on gender mainstreaming in which all subsidiary objectives should be analyzed through a gender perspective, and
- The intermediate objective on representation—in 2010, the transport agencies' steering committees should consist of at least 40% women (or men).

The government also proposes that a systematic review of the documentation, working methods, and procedures should be undertaken and that more research should be initiated on typical female and male perspectives and evaluation of transport-related issues.

**Government Bill on Gender Equality** In May 2006, the Swedish Parliament adopted national gender-equality objectives proposed by the government in a bill concerned with gender-equality policy objectives (Swedish Parliament 2005b). The overall objective for gender equality is that women and men have equal power to shape society and their own lives. In the bill, the government also stipulates that gender mainstreaming is the strategy to be used to achieve the national gender-equality objectives.

**New Government** After the election in autumn 2006, a new government was established. It is a coalition, the Alliance for Sweden, consisting of Moderaterna, Folkpartiet, Centre Party, and Christian Democrats. The new government took over power from the Social Democrats, who have ruled Sweden for 65 of the past 74 years.

**Government Bill on Transport Policy** In March 2009, the Swedish government presented a new bill on transport policy (Swedish Parliament 2008) and in June the Swedish parliament adopted the new transport policy decision.

The structure of objectives in the new transport policy differs from the former transport policy decision, but the overall objective remains the same: to ensure the economically efficient and sustainable provision of transport services for people and businesses throughout the country. This objective is defined by two new subsidiary objectives: one functional objective called accessibility and one impact objective on health, safety, and the environment.

The accessibility objective is formulated as follows:

The design, function, and use of the transport system will contribute to provide everyone with basic accessibility of good quality and functionality and to development capacity throughout the country. The transport system will be gender equal, meeting the transport needs of both women and men equally.

To achieve the functional objective the following is proposed:

- Travel for people will be improved through increased reliability, security, and convenience.
- Transport quality for the business sector will be improved and will strengthen international competitiveness.
- Accessibility will be improved within and among regions as well as between Sweden and other countries.
- The working methods, implementation, and outcomes of transport policy will contribute to a gender-equal society.
- The transport system will be designed to be accessible for people with disabilities.
- Opportunities for children to travel independently and safely on the transport system, and be present in traffic environments, will be enhanced.
- Public transport, pedestrian, and cycling options will be easier to choose.

The impact objective on health, safety, and the environment is formulated as follows:

The design, function and use of the transport system will be adapted to eliminate fatal and serious accidents. It will also contribute to the achievement of the environmental quality objectives and better health conditions.

In the text, the government states that men and women still have different travel behaviors and that more knowledge about the underlying causes is desired. The government also states that women's and men's conditions and interests are not equally represented in construction, design, and management of the transport system and that the current conditions concern-

ing women's and men's transport needs, values, and representation motivate further development toward a gender-equal transport system. The former subsidiary objective is mentioned in the text and the government states that the objective remains relevant and the work needs to continue in the long term and on a wider scale. The government states that gender equality in the transport system is a main aspect of the new functional objective of accessibility and that a systematic overview of the working methods in the transport sector is needed to ensure that values and needs in different groups of women and men are treated equally.

Finally, the government announces that women's representation on steering boards and elsewhere is important but not sufficient. A further step is needed to develop working methods for gender equality by focusing on accomplishments and results in the transport sector toward gender equality in the transport system. The means to obtain this objective is gender mainstreaming.

### *Government Briefs and Guidelines*

The author has analyzed government briefs and annual government guidelines for the SRA and the National Rail Administration in depth for 2005–2009.

**Government Briefs** The first paragraph in the government briefs for the SRA and the National Rail Administration (exemplified by SRA) is as follows:

#### Instructions

1§ The SRA has a common responsibility, a sector responsibility, for the whole road transport sector. The SRA shall work to attain the transport policy objectives. The SRA shall, within their responsibility for the road transport sector, work together with, support, and be the driving force toward the other parts of the sector.

The second paragraph presents a long list of assignments and objectives. The first two sentences are connected to transport policy objectives:

The SRA shall especially work for an accessible and efficient road transport system while keeping a regional balance, and the construction of the road transport system shall meet the requirements for a safe and environmental road transport sector.

The only subsidiary objectives not mentioned specifically in the government briefs are gender equality and transport quality.

These paragraphs are the same in the government briefs from 2007 and 2008 as in the old government

briefs from 1997. The difference is that some annual assignments have been moved from the annual government guidelines into the government briefs.

**Annual Government Guidelines for 2005 and 2006** The overall transport policy objective and the six subsidiary objectives are set as objectives for the SRA and National Rail Administration in the annual government guidelines. The text below is exemplified with assignments for the SRA, but the same assignments are given to the National Rail Administration.

The Swedish Road Administration shall report and comment how the Swedish Road Administration and the road transport sector have worked toward the overall transport policy objective and each of the subsidiary objectives throughout the year. The Swedish Road Administration shall also analyze and report how the road transport system meets women's and men's different transport requirements.

When it comes to specifically following up the year's progress toward the subsidiary objective for gender equality in the transport sector, the assignment for the SRA is as follows:

Analyze women's and men's usage of the road transport system and their opportunities to influence the construction, design, and management when it comes to travel patterns, travel times, transport modes, travel costs, accessibility to traffic information, number of fatalities and serious injuries, and women's and men's mobility in different parts of the country.

The percentage for men and women who participate in working groups or other cooperation committees that are part of the SRA's external activities shall be reported.

The SRA shall also aim for an equal distribution of power and influence between women and men within the organization. Therefore, a key figure the SRA has to report to the government is the percentage of women and men working on the executive board, the steering committee, and other levels (Figures 1 and 2).

**Annual Government Guidelines for 2007 and 2008 (Exemplified by SRA)** The annual guidelines for 2007 and 2008 have the same assignments for the SRA and the National Rail Administration when it comes to transport policy objectives as in the guidelines for 2005 and 2006, except for two amendments. According to the decision of the Swedish Parliament in June 2006, the wording in

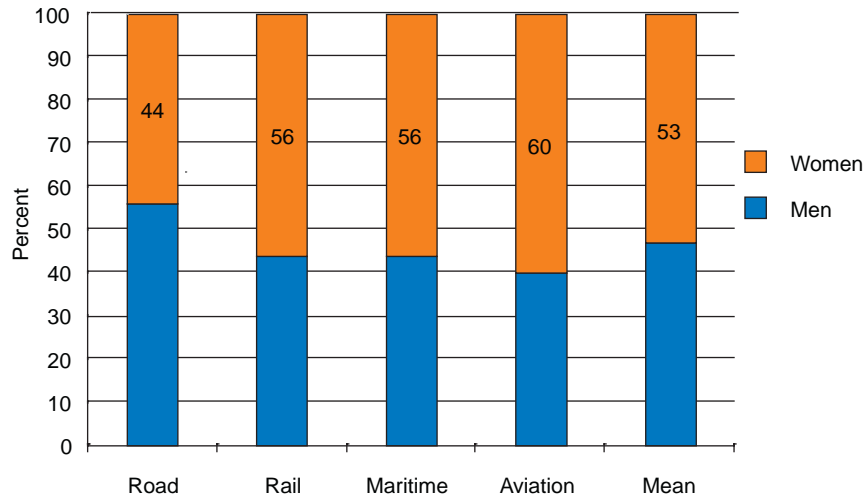


FIGURE 1 Representation of men and women on executive boards in transport agencies in Sweden: 2008. (SOURCE: Swedish Institute for Transport and Communications Analysis 2008.)

the annual guidelines was reformulated: “All other subsidiary objectives should be analyzed through a gender perspective.”

A new intermediate objective has been added to the guidelines: “In 2010, SRA’s steering committees should have at least 40 percent women (or men).”

**Annual Government Guidelines for 2009** In general, the annual government guidelines for 2009 are shorter and less detailed than earlier guidelines. In the guidelines for 2009 for the SRA and the National Rail Administration, the paragraph stating the overall transport policy objective and the six subsidiary objectives has been omitted. The special assignment to follow up

and report how the objectives are attained has also been omitted.

The only criterion left is the intermediate objective: “In 2010, SRA’s steering committees should have at least 40 percent women (or men).”

*Reports from Government Agencies*

During the period 2004 to 2009, the transport agencies and the Swedish Institute for Transport and Communications Analysis, SIKa, reported their commissions to the government, including the follow-up reports on progress toward the transport policy objectives.

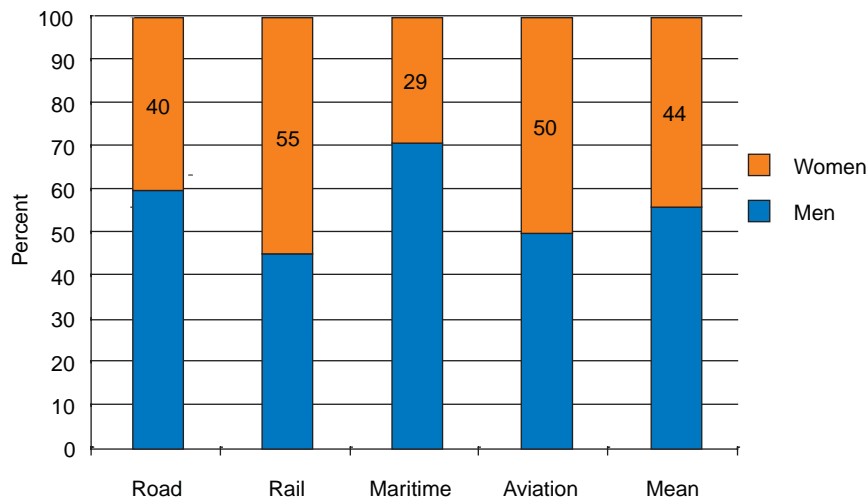


FIGURE 2 Representation of men and women on steering committees in transport agencies in Sweden: 2008. (SOURCE: Swedish Institute for Transport and Communications Analysis 2008.)

**Follow-Up of Swedish Transport Policy Objectives 2005** In the follow-up report for the year 2004, SIKA observed that all transport agencies report on women's and men's travel patterns in their yearly reports (Swedish Institute for Transport and Communications Analysis 2005).

The SRA reports in the road sectoral and annual reports how access to cars, the proportion of women and men with a driver's licence, and the fact that more women than men work part time explains some of the differences in travel patterns and mobility between women and men (Swedish Road Administration 2005). The SRA also reports the number of fatalities and injuries by gender. For example, about 85% of drivers killed in the past 5 years were men, while fatalities among car passengers were generally distributed evenly among men and women.

SIKA, together with the transport agencies, presented a survey of women's and men's representation in leading positions in the transport sector (Markör 2004). Men dominated on executive boards and on steering committees, especially in the interest and sector organizations but also in transport agencies.

SIKA's assessment in the follow-up report was that women's perspectives and values continue to be poorly represented in planning, decisions, and administration throughout the transport sector. They have poorer opportunities to influence the design of the transport system.

**Follow-Up of Swedish Transport Policy Objectives 2006** In the introductory chapter of the road transport sectoral report for 2005, the SRA states that the sectoral report emphasizes presenting a goal analysis of the transport policy objectives (Swedish Road Administration 2006). The intention is to provide an exhaustive description in this year's report that could be used as a basis for future sectoral reports. In the text, the SRA describes how far different subsidiary objectives have come in the process of achieving a complete goal analysis. For gender equality and regional development, the first step requires analyzing the objective and the purposes and intentions behind it. For accessibility, the next step is to translate the objective into comprehensive parameters; for transport quality, it is necessary to find measurement methods, instruments, and measuring of parameters. For environment and safety, parameters are linked to time. The last step of the objective analysis concerns casual relationships.

Consequently, the chapter on gender equality focuses on intentions behind the objective. The chapter starts by describing the government's general gender-equality policy by describing policy decisions, theory, and strategy followed by a description of why Sweden has a gender-equality objective in the transport sector. Parameters for

determining the degree of achievements are discussed—both the current parameters and new parameters. Current parameters are travel patterns, usage of different transport modes, access to cars, and participation in working groups. The SRA proposes two types of new parameters: parameters describing the degree of integration and parameters describing the current degree of gender equality with regard to the design and function of the transport system. Examples of parameters describing the degree of integration are percentages of women and men who state that they are able to influence decision making, research, construction, design, and management of the transport system. Examples of parameters describing the current degree of gender equality with regard to the design and function of the road transport system are percentages of women and men who feel safe and believe the road transport system meets existing transport needs as well as the degree of attention paid to female and male physical characteristics when developing and designing roads and safe vehicles. Finally, the SRA reports on travel patterns, access to cars, drivers' licences, and representation in working groups. The SRA states that the currently used parameters are not sufficient for a comprehensive assessment and, consequently, the degree of goal achievement cannot be measured.

In the follow-up report for 2005, SIKA concluded there was a lack of analysis of the basic cause for women's and men's particular travel patterns. In-depth studies are required for knowing how the resources should be distributed to meet the interests of both sexes. SIKA also noted that transport agencies allocated very small resources to work with the gender-equality objective, which means that work to achieve equality in the transport system moves very slowly.

SIKA stated that the situation remained the same: women's perspectives and values continue to be poorly represented in planning, decisions, and administration throughout the transport sector, which means they have poorer opportunities to influence the design of the transport system.

**Follow-Up of Swedish Transport Policy Objectives 2007** For the reports declaring the circumstances in 2006, the new assignment to analyze all other subsidiary objectives through a gender perspective is in force.

In the road transport sectoral report for 2006, the SRA analyzed the road safety objective through a gender perspective (Swedish Road Administration 2006). The SRA has carried out and presented an analysis of risk of injuries in the road transport system, stating that the risk for men being killed as car drivers is twice as high as that for women. Men expose themselves to greater risk more frequently by violating speed limits, not using seatbelts, and driving when intoxicated. Men's and women's attitudes toward traffic safety also differ. The subsidiary

objective on the environment has, at least partly, been analyzed through a gender perspective. The SRA states that there are a number of differences between how women's and men's travel behaviors affect the climate. One difference concerns purchasing cars, with men on average giving priority to performance and engine power whereas women give priority to more practical things.

In the chapter on gender equality, the SRA continues the discussion about the intentions of the subsidiary objective. For example, the SRA states that there is a need to make gender patterns visible (including information about quantitative and qualitative parameters distributed on gender) and letting the information be reflected in financial control, planning processes, goals, resource allocations, and monitoring of work done. Citizens' needs are to be captured in these processes, identified as women's and men's respective experiences, and built into the transport system on equal terms. The SRA also refers to Jämstöd's<sup>1</sup> strategy and model for gender-equality integration, called the "staircase." The staircase method shows how to integrate gender equality into an organization. New, improved parameters measuring gender equality in the road transport system and measuring the degree of gender equality in the organization are proposed by the SRA. Finally, the SRA also reports about women's and men's use of the system and some background facts that explain why there are differences (i.e., part-time work, household chores). Representation in working groups, on boards, and so forth is also presented. The chapter ends with some reflections on why the figures are the way they are concerning gender patterns in the organization and in the transport system.

In the follow-up report for 2006, SIKÄ, on the other hand, does not refer to the annual and sectoral reports from the different transport agencies (Swedish Road Administration 2007). Instead, SIKÄ states that the differences between women's and men's travel patterns are significant and that there is still a lack of analysis of the basic cause of women's and men's travel patterns.

The new intermediate objective about the percentage of women and men on steering committees is reported. SIKÄ concludes that it is unlikely that the intermediate objective of a gender-equal representation (about 40% women or men) on steering committees in 2010 will be attained.

**Follow-Up of Swedish Transport Policy Objectives 2008** In the road transport sectoral report for 2007, the SRA made an effort to analyze the overall transport policy objective and all six subsidiary objectives through a gender perspective (Swedish Road Administration 2008). A gender-equality heading is connected to each

objective and even to the intermediate objectives for accessibility and the environment, but usually the text below states only that there are no assessment methods for measuring gender equality (yet). If possible, statistics are reported for women and men. For example, girls travel more by car and use school transport more than boys, while boys cycle to a greater extent.

The objective that has the most thorough gender-equality analysis is traffic safety, in which seatbelt and helmet use are reported by women and men and there is also a discussion about injury risks and women's and men's attitudes to road safety.

When reporting about air pollution, a study showing that it was twice as common for women, compared with men, to feel disturbed by air pollution is mentioned.

In the gender-equality chapter, the SRA states that gender equality is created where ordinary decisions are made, resources are distributed, and standards are established and a gender perspective must therefore be included in everyday work. The result is that the services offered to citizens are equally accessible, have the same high quality, and are equally adapted to all, regardless of gender. It is also stated that the most important part of the subsidiary objective is to be responsive to women's and men's values and needs. When these values and needs have been dealt with fairly, continuously, and self-evidently, a gender-equal transport system has been achieved.

The SRA presents five strategies to achieve its objective:

- Women and men should have representation in all groups.
- Women and men should be offered equal opportunities to use the road transport system.
- All statistics should be divided into women and men.
- SRA employees must have knowledge, competence, and understanding of gender mainstreaming.
- SRA management systems should be designed to take a gender perspective into account.

The SRA considers that the long-term work to achieve gender mainstreaming in the administration has developed during the year. The increase in basic understanding mainly is a result of more employees attending gender mainstreaming courses during the year. The SRA has also created a detailed document for gender equality for the period 2008 to 2017, stating that each area of activity should be responsible for gender mainstreaming.

The discussion on how to measure gender equality and proposed indicators is continued from the sectoral report from earlier years.

Finally, the SRA summarizes:

There still is a male dominance in forums that influence the construction, design, and management of

<sup>1</sup> Jämstöd was an inquiry into support for gender-equality integration within the state.



the road transport system and that travel patterns for women and men are a reflection of gender patterns in society.

In the follow-up report for 2007, SIKA reports on how transport agencies have dealt with analysis of all other subsidiary objectives through a gender perspective, on representation of women and men on boards and committees, on gender mainstreaming efforts, and on how women's and men's transport patterns and needs are fulfilled.

When analyzing the sectoral reports from transport agencies, SIKA concludes that a lot of work remains before all other subsidiary objectives can be analyzed through a gender perspective. Statistics are often divided into women and men, but analysis of why they differ is rare. SIKA refers to some examples from the civil aviation report and the SRA report.

SIKA presents the percentages of women on executive boards and steering committees in transport agencies. This year, SIKA's assessment is that it is possible for transport agencies to have at least 40% women and men on executive boards and steering committees in 2010.

Gender mainstreaming is the means to attain a gender-equal transport system. SIKA reports from the discussion in the SRA sectoral report, mentioned above, and also about an e-learning course with basic knowledge about gender equality, financed by the SRA, the National Rail Administration, and Stiftelsen Minerva. The aim is for all employees at the SRA and the National Rail Administration to attend the course. SIKA also reports from the sectoral reports by the Civil Aviation Administration and the Swedish Maritime Administration.

SIKA finally states that differences remain between women's and men's travel patterns, and it is difficult to judge to what extent their transport needs are fulfilled in the transport system.

**Follow-Up of Swedish Transport Policy Objectives 2009** In the road transport sectoral report for 2008, the SRA continued to analyze the overall transport policy objective and all six subsidiary objectives through a gender perspective (Swedish Road Administration 2009). In some cases, the same facts and reports as in the 2008 report are used again. For most objectives, the changes are long term and cannot be observed over 2 years.

In the accessibility chapter, the SRA reports from a commuter route project in the southern part of Sweden, where the project members prioritized routes that can contribute to strengthening and developing local labor market regions for women, as these regions are geographically smaller, ahead of routes that expand the wider geographic labor market regions for men. Another gender analysis was carried out in a commuter project in the southwestern part of Sweden where the result

showed that planned measures to improve commuting in some cases benefit women and men differently. In Gothenburg, similar analyses were carried out during the year.

In the gender-equality chapter, the SRA is continuing the discussion on how to measure gender equality and how the SRA should work toward achieving a gender-equal road transport system (i.e., the strategies). The SRA is also reporting on how gender equal the road transport system is, on measures the SRA carried out during 2008, and on other factors that contribute to attaining the objective. The structure and some of the text are the same as in earlier sectoral reports, but the discussion is slightly more mature every year.

In the follow-up report for 2008, SIKA reports about analysis of all other subsidiary objectives through a gender perspective, representation of women and men on boards and committees, gender mainstreaming efforts, and how women's and men's transport patterns and needs are fulfilled.

When analyzing sectoral reports from transport agencies, SIKA concludes that there has been an improvement in the way the agencies analyze the other subsidiary objectives through a gender perspective.

SIKA presents the percentage on executive boards and steering committees in transport agencies. For executive boards, all transport agencies are gender equal. For aviation, the percentage is 60% women and 40% men, which is the limit for gender equality. In 2004, only road and aviation had gender-equal executive boards.

The difference is even greater when comparing the steering committees between 2004 and 2008. In 2008, only maritime had a steering committee without at least 40% women (or men). In 2004, the share of men on steering committees was around 80% in all the transport agencies.

When analyzing the percentage of women and men managers in the transport agencies, a large majority of managers are still men in the SRA (81%), the National Rail Administration (76%), and the Swedish Maritime Administration (85%), while the Civil Aviation Administration has nearly as many women managers (43%) as men managers.

SIKA's assessment in the follow-up report is that it is possible for the transport agencies to attain a share of at least 40% for both women and men on executive boards and steering committees in 2010.

Gender mainstreaming is the means to attain a gender-equal transport system. SIKA reports from the sectoral reports about the actions the National Rail Administration has carried out during the year: the compulsory e-learning course, counting women and men attending consultation meetings among other things. SIKA also reports from the Civil Aviation Administration, the Swedish Maritime Administration, and the SRA.

Also this year, SIKA states that there are still differences between women's and men's travel patterns, and it is difficult to judge to what extent women's and men's transport needs are fulfilled in the transport system. In the report, SIKA refers to research reports analyzing the basic causes behind travel patterns for women and men. SIKA also reports from surveys carried out during the year on how women and men value different parts of the transport system differently.

## ANALYSIS AND CONCLUSIONS

### The Decision in 2001

The political decision, taken in 2001, to add a sixth subsidiary objective on gender equality in the transport sector was essential to start the gender mainstreaming process in the transport sector in Sweden. Without the new subsidiary objective, transport agencies would never have started working toward gender equality in the transport system in this systematic way.

This fact was also stated by the director general<sup>2</sup> for the SRA at the postdisputation seminar on Wittbom's thesis (2009). He stated that the SRA would never have come this far without the subsidiary objective and the commissions in the annual government guidelines to follow up the overall objective and the subsidiary objectives.

### Transport Agencies' Sectoral Reports

After the decision was made, the new subsidiary objective was put into the annual government guidelines, together with the other objectives, with the assignment for the transport agencies to follow up the progress toward attaining the objectives. With the commission to follow up the new subsidiary objective, the transport agencies had to report on the progress toward gender equality.

When analyzing the period 2005 to 2009, the author's impression is that the transport agencies, especially the National Rail Administration and the SRA, have matured in the way they think about the subsidiary objective on gender equality, compared with the earlier period 2002 to 2004 (Vagland 2004). The text referring to the sectoral reports has attempted to describe this process by providing examples of issues discussed in the sectoral reports.

There is a change in how different transport agencies report about the gender equality objective. This paper analyzed the National Rail Administration and the SRA, the largest agencies with the most resources put into the sectoral reports. Examples have also been presented from

the SRA sectoral reports together with the follow-up reports made by SIKA. The SRA has covered the greatest distance toward the objective on gender equality in the transport sector.

The SRA started in the sectoral report for 2005 and forward to emphasize goal analyses in the sectoral reports and the whole structure of the sectoral report changes in 2005 compared with earlier years. Consequently, the chapter on gender equality also had another structure. In 2005, a more mature discussion started about the gender-equality objective: the background, what gender equality means, and ways to attain the objective. The SRA has decided on strategies for working toward the objective and has worked through measures for both the process and the state of the road transport system.

The effects of the subsidiary objective in the transport system are difficult to measure on a more long-term perspective. The present transport system is the result of investments over several hundred years even if the investments of the past 75 years are the most important. Today's transport system is explained by the values and needs of those who planned, decided, and constructed it throughout the entire period. The transport agencies, and especially the SRA, are now aware that it makes changes involved in the processes of planning, designing, constructing, and maintaining the transport system.

The SRA has also decided on a program for gender mainstreaming within the SRA and, together with the National Rail Administration, financed an e-learning course that is compulsory for all employees. The SRA has realized that knowledge and competence are needed to be able to work toward gender equality.

### New Government, New Transport Policy Objectives

The current government, elected in 2006, stands for a number of changes in trends by reformulating the structure for the transport policy objectives, by rephrasing the annual government guidelines, and by reorganizing the transport sector.

With the new transport policy structure, the subsidiary objective on gender equality in the transport system is no longer valid. The following questions are raised: What effect will it have on gender equality in the transport sector? How much will the gender-equality perspective influence future infrastructure plans, construction, and maintenance in the transport sector when there is no specific objective? Will transport agencies continue to work toward a gender-equal transport system? Are they mature enough to keep working toward a gender-equal transport system even if there is no longer a subsidiary objective and the objectives no longer are explicitly expressed in the annual government guidelines? The sec-

<sup>2</sup> Ingemar Skogö, June 17, 2009.

ond change is the way the government has decided to use the annual government guidelines. When taking out the objectives and the annual assignments to report to the government about the work toward transport policy objectives, the whole governing structure for government agencies is changed. The Swedish National Financial Management Authority (Ekonomistyrningsverket) has started analyzing the changes in how the annual government guidelines are written. A first report is presented with quantitative analysis comparing the annual government guidelines between 2008 and 2009, but the long-term effects of the changes will not be evident for a few years (Ekonomistyrningsverket 2009).

Third, reorganization of the transport agencies might change the way the SRA and the National Rail Administration have worked until now, depending on the new government briefs and the executive board for the new transport agency (or agencies) and also on how knowledge and competence in gender mainstreaming in the current transport agencies are taken on in the new organization.

### Representation on Executive Boards and Steering Committees

The intermediate objective on percentage of women (and men) on executive boards and steering committees for 2010 is the only gender-equality objective left in the annual government guidelines. The representation of women and men on executive boards and steering committees is one of the easiest ways to measure gender equality and development since the decision in 2001 was successful. On average, the intermediate objective is already attained even though the Swedish Maritime Administration has only 29% women on its steering committee. A new transport agency is one way to attain the intermediate objective and the author hopes and believes this part of the objective—"the same opportunities to influence the construction, design and management of the transport system" through representation on executive boards, steering groups, and other important decision-making groups—will still be valid even if the subsidiary objective is not valid as an objective.

As the government states in the government bill on transport policy, women's representation on steering committees is important but not sufficient (Swedish Parliament 2008). The government mentions working methods for gender equality, focusing on accomplishments and results in the transport sector as the means to achieve gender equality. The author is not convinced that this goal can be achieved without a subsidiary objective on gender equality and without special commissions for transport agencies in the annual government guidelines to report and follow up the work toward gender equality.

### What Will Happen in the Future?

What will future governments and future parliaments decide on concerning transport policy objectives? Would it be possible to reintroduce a gender-equality objective again or did a window of opportunity make it happen in 2001? Does Sweden still need a gender-equality objective in the transport sector?

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# Women and Men in Public Consultations of Road-Building Projects

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This paper discusses results of a research project designed to increase knowledge about women's and men's participation and their opportunities to take part in and influence the road planning process. The project was accomplished in an explorative case study, an advertisement study, and an implementation study that used questionnaires, observations, quantitative and qualitative analyses of conversations, content analysis of minutes, and advertisements. A basic principle of public participation argues that it should be inclusive and equitable to ensure that all interests and groups are respected. A literature study found that the subject of gender equality is basically nonexistent in the literature on environmental impact assessment. This project shows that about a quarter of participants at consultation meetings are women, but men talk longer and ask more questions. Those who attend meetings are generally older and have more education than the average person. Men and women bring up environmental and road safety issues during meetings, but men more often discuss economy, technical facts, alternative routings, and landownership. Some participants had more experience taking part in public meetings and talking in front of other people. Participants with less experience seem to need more guidance and take a more active part in the meeting when a moderator leads the discussion. It is tempting to say that men are more experienced and women are less experienced, but that would be an oversimplification. The aim of increasing gender equality through an intervention study did not completely succeed.

The basis for this paper is a research project aiming at increasing knowledge about women's and men's participation and their opportunities to take part in and influence—on equal terms—the road planning process. It draws background from gender mainstreaming in the consultation process and, more precisely, in Swedish road planning, which connects to ideas about democratic values of public participation and the rigor of road planners' dialogue with different groups on environmental issues (IAIA 2006). The project was based on empirical studies and was constructed in three parts. The first part consisted of an exploratory case study of consultations on road projects. Part two followed from the results of the first part and consisted of an analysis of the recruitment to the consultations—that is, newspaper advertising, which is the Swedish Road Administration's principal way to invite participants for public consultations. The third part, an intervention study, was designed from the first two parts with an emphasis on measurements to increase women's participation. The explorative study showed that 26% were women at the consultation meetings and the intervention study showed that 32% were women. These and other results are discussed.

The aim of the project was twofold: to increase knowledge about women's and men's participation and their opportunities to take part in and influence on equal terms and to intervene in the process and increase gender equality in the public consultation. The core questions for this paper are: How do women and men take part in the consultation and how do they judge it? What questions are discussed by women and men? How do the experts answer questions from women and men—

do they develop answers in the same way or do they discriminate in any specific way? What methods can be used to increase equal participation? Are other forms of consultation more appealing to women?

Theoretical perspectives on gender equality and transportation planning follow the introduction. Then, two sections describe study design and results, and finally there is a discussion of strengths and limitations and a concluding section with implications for further studies.

## GENDER EQUALITY AND TRANSPORTATION PLANNING

From previous research, it is known that men and women do not participate equally in public consultations.<sup>1</sup> Previous researchers have analyzed this inconsistency and pointed out historic asymmetries (Greed 1994; Scott 1988) and lack of political power on the female side of society (Burns et al. 2001). Earlier research about participation of women and men in public meetings has stated that their conversational styles differ; Maltz and Borker (1982) suggested that cultural factors could be an explanation. Research has shown that both women and men can experience barriers to participation because of power asymmetries (Kendall and Tannen 2001; Tannen 1993).

### Gender Mainstreaming

In Sweden, equality in the transport sector is part of a broader policy, and gender mainstreaming should be incorporated in all political and public domains (SOU 2001; Vagland 2004).

The overall objective of ensuring socially and economically efficient and sustainable transport resources for the public and industry is guided by six subsidiary objectives for different areas. One of them considers how to design the transport system to meet men's and women's transport needs and requirements. Vagland stated: "Women and men shall have the same opportunities to influence the construction, design and management of the transport system, and their values shall be given equal weight" (Vagland 2004, p. 3). The objectives are undergoing development. It also appears that the transportation sector has not grasped the full meaning of a gender

equality perspective. In general, the transport sector in Europe (and in Sweden) is a gendered workspace dominated by masculine values (Christensen et al. 2007).

The distribution of women in national governmental and municipal politics is rather high—often 40% to 50%. Women constitute 48% of the Swedish Parliament. Also, the proportion of women in employment is high: 81% of women 20 to 64 years old are employed (compared with 87% of men). However, Swedish women and men work in one of the most gendered labor markets in the world. For example, within the group of assistant nurses and nursery school teachers 90% to 100% are women and within the group of truck drivers and construction workers 0% to 10% are women. Women are paid less than men. In private companies, women are underrepresented in managerial positions (Statistics Sweden 2008).

Among the basic principles of public participation, it is argued that public participation should be inclusive and equitable, ensuring that all interests and groups are respected (IAIA 2006). However, a literature study connected to this project found that gender equality basically is nonexistent in the literature on environmental impact assessment (Yazar 2008). In transport planning, gender diversity has been nonexistent and thus planning is the story of man (Greed 1994). Greed (2006) suggested that, however legitimate they may appear from environmental and financial perspectives, road building and traffic measures should be scrutinized from a gender perspective. There is little point in increasing transport networks if potential travelers do not have access to them. It is not only public transport that is relevant in discussions about accessibility. Greed (2006) argued that accessibility is a complex factor related to travel experience; access and movements within the built environment are also restricted to spatial and psychological safety factors. From this position, gender equality is not just about physical representation that affects women's and men's positions (Law 1999).

### Understanding Gender

The intention of this paper is not to categorize gender theories and discuss interdisciplinary variations; instead, it follows a few steps on the theoretical map and introduces a perspective for understanding the current project. The study follows the ideas of a gender conception that includes thoughts about male and female factors in a societal context—that is, female versus male behavior does not have to be tied to biological factors but rather is concerned with social and sociopsychological aspects (Conell 2002). This study deals with a living, ongoing, and to some extent uncertain process, which means women and men cannot be placed in fixed categories. Adding more women (or men) in the spheres with

<sup>1</sup> A well-known fact is also that women's and men's travel behaviors differ. However, women's travel behavior has changed in the past three decades: they make more trips, travel more often as car drivers, and cover more miles than before (Rosenbloom 2004). There are also considerable differences in the travel patterns of subgroups of women, which are due to factors such as economic circumstances and age. Older women still do not drive as often as older men, and they stop driving earlier; it is assumed that this picture will change when today's younger and middle-aged cohorts grow old (Hjorthol et al. 2009).

unequal gender representations may increase equality but is not the only way to do so. There is no guarantee that having more women in transportation planning will result in a more equal and sustainable transportation system (Hjorthol 2003; Polk 1998).

The research conducted so far is about “doing gender” (Eveline and Bacchi 2005) in public participation and about the gender mainstreaming process (Christensen et al. 2007). This study goes beyond counting women and men, looks at the contexts and situations of road projects, and asks what is going on in the consultations. The study also uses the concept of gender consciousness (Friberg 2006) as a perspective in discussing the results. Gender consciousness means being aware of gender concepts in social life—for example, how the words “woman” and “man,” “female” and “male,” and “sex” and “gender” are used and how they influence common sense as well as scientific knowledge. Gender consciousness is also about how people adopt and understand concepts—for example, how gender equality is transformed into action. From a scientific viewpoint, it also means being aware of what is established scientific knowledge and what are more loosely formed ideas or norms about what somebody thinks should be the order of things. In transportation planning, gender consciousness means adopting a critical approach to figures of travel patterns and the underrepresentation of women in planning. From Polk's (2001) theoretical outlines it is found that gender is a much more complex source of power and symbolic representation than is acknowledged in the documents dealing with transportation policy in Sweden today.

### Public Participation and Gender Equality

From the gender policy point of view, it is considered important to use democratic tools to involve women's and men's interests, and measures in the transportation system should be developed and implemented through a dialogue with the population.

Societal change, particularly increased education among citizens, has been considered grounds for involvement and demand for access to information by the public. Citizen participation has been characterized as an inevitable outcome of a movement from elitist, isolated, and bureaucratic modes of governance to more open, transparent, and participatory approaches (Moynihan 2003). Democracy theorists, for example, propose that societal change, including distrust of formal institutions, and relations among individuals in liberal democracies make it more likely that citizens will involve themselves in public issues (Inglehart 1997; Putnam 1993).

Historic analysis with a feminist approach has indicated that women's adjustment of their time and space (to extend their control and resources for their home and

children) has resulted in increased interaction between the home community and the public sphere, which also affects the urban environment and infrastructure. It has altered the nature of home community, has resulted in creation of new spaces and networks, and has produced different relations between private and public environments (Mackenzie 1988). For example, many of the activities of childcare are performed in qualitatively different ways with public recognition of parenting. The need to coordinate childcare, work, and leisure activities has also increased people's travel needs. According to Mackenzie (1988), the implications of these changes for women's and men's impact on future urban environment and transportation systems depend on employment and domestic activities.

Burns and colleagues (2001) used statistical methods to analyze women's and men's participation in political activities in the United States and found that choice of profession and workplace were important. Their analyses showed how different factors appear to influence an individual's choice to participate in political assemblies. For both women and men, education influences who goes to work, what kind of jobs they have, and whether they develop civic skills that lead to political activity. However, those who are born to parents with limited educational attainment begin life with a participatory disadvantage. Burns and colleagues (2001) discussed the impact of different institutions and found that parents' education as an influence on children (to attain education) was an obvious factor for entering a specific job category. Financial resources in the family also appear to affect whether one or both parents play an active role in politics. They also found that democratic projects in work groups and conscientious activities at work reinforced the development of participatory skills, whereas domestic work did not foster political activity in the same noticeable way.

Friberg (2006) pointed out a dilemma in the use of the terms “public” and “private,” as the lives of women are often linked to the private (domestic) spheres, and men's lives are often linked to the public spheres (work and politics). The dilemma is that the terms private and public are often used in planning contexts to distinguish between privately owned land and land accessible to all inhabitants. There is a long tradition in which the public sphere (associated with men) is considered superior to the private sphere (associated with women), and thus the traditional order in planning contexts reconstructs patterns of women's subordination. To break these patterns, planning must recognize everyday life as a starting point, including home and workplaces equally, the point of intersection in everyday life (Friberg 2006, p. 283).

The perspective from Friberg (2006) will also make clear the heterogeneous groups of women and men. Women are not a homogeneous group with the same opportunities and disadvantages. Case studies in Great Britain (in Leicester, Sheffield, and Birmingham) identified, for example, that

financial barriers and lack of accessible transportation hindered some women from participating in consultations (Booth 1996). Hence, expenses to allow all women to attend the meetings were included in the planning projects (e.g., taxis for women with disabilities). The case studies provided examples of consultations in contrasting institutional, organizational, and political contexts. While the more traditional public consultation exercises in planning often have used reactive approaches, in which members of the public were asked to introduce their views of a proposal, this approach was nonhierarchical. Despite some differences in approach, the case studies have adopted similar participatory models of involvement and relied heavily on women officers, women consultants, and women themselves to act as facilitators. Also, education, training, and support were provided to build women's confidence. Women were asked to set their own agendas. Booth (1996) concluded that these measures enabled women to participate more effectively in the local consultation process and have given women more visibility in the planning process. Booth also pointed out that most initiatives were ad hoc and that more research is required.

### Gender and Interactional Resources

This paper does not have space for a thorough analysis of women's and men's talk and interaction in consultation meetings. Whereas the paper reports the essential results of the analysis, it also gives a short theoretical background. The cross-cultural miscommunication metaphor applied to adult female-male interaction by Maltz and Borker (1982) and further research (Kendall and Tannen 2001; Tannen 1993) formed the basis for discussions on how different meeting forms fit women versus men in workplaces and consultations. Later, critical voices by Cameron (2007) and Ford (2008) illuminated quite different interpretations. As Ford stated: "current research on gender and language have developed a productive scepticism regarding the dichotomous conception of gender" (Ford 2008, p. 7). Documentation of differences and similarities in language practices in relation to activities has led to more complex and expanded understanding of variation than in those who referred to a social categorization of gender. For example, conversation analysts in earlier research interpreted women's (over)use of questions as a tendency to hesitancy and lack of authority. However, these forms of questioning were later reinterpreted and found to be a successful way to pursue topics more frequently. Rather than expressing hesitancy or insecurity, questions were used as vehicles to strengthen the force of their turn and put their topic on the agenda (Ford 2008). Also, narrative research within social science has developed useful tools to understand the power of individuals and groups of individuals (also institutions

such as workplaces, family, and mass media can be analyzed with a narrative approach). Narrative in this study means accounts, storytelling, and talking in the interaction of one person with one or more others. Narratives can be expressed by one individual or by individuals together. Narratives linked to knowledge are intermediated through the continuity of identity and continuity of conscience in which people recognize themselves in time and society. Hence, it is fruitful to study narratives as a toolkit that people strategically use not merely to explain the past and present but also to transform it into a reliable source for the future (Miztal 2003; Riessman 1993).

### Gender in Research and Practice

Pointing out the representation perspective is risky: the more likely that women and men are represented in the same numbers, the better is the situation for equality mainstreaming. Gender mainstreaming is risky because women tend to be "the other" sex, the group involved in and taking responsibility for solving the inequality problem. Emphasis tends to be on women instead of on the process for which men and women should be equally responsible. Gender mainstreaming is also risky for research outcomes because it misses the theoretical perspectives, the complexity of people's interactions, and contextual understanding of the subjects.

From Burns and colleagues (2001), Friberg (2006), and West and Fenstermaker (1995), an intersectional approach is identified, which means women and men are heterogeneous groups divided along multiple axes of social cleavages and different ethnicity, class, generation, religion, and ideology. Instead of asking whether and how women and men differ, it is necessary to distinguish how gender differences vary according to domains and contextual processes. There is no evidence that one can generalize from activities in workplaces, classrooms, board rooms, and living rooms to committee meetings and consultations in transportation planning. Hence, understandings of gender in various domains need systematic, empirically grounded research.

The theoretical framework described in this section serves as a tool for interpreting the empirical findings described in the next sections.

### STUDY DESIGN

The project took its starting point in investigating the representation of women and men in consultations and with in-depth case studies from consultation meetings. The procedure followed three stages (Figure 1). During the research process, the findings were evaluated before the next stage was created.



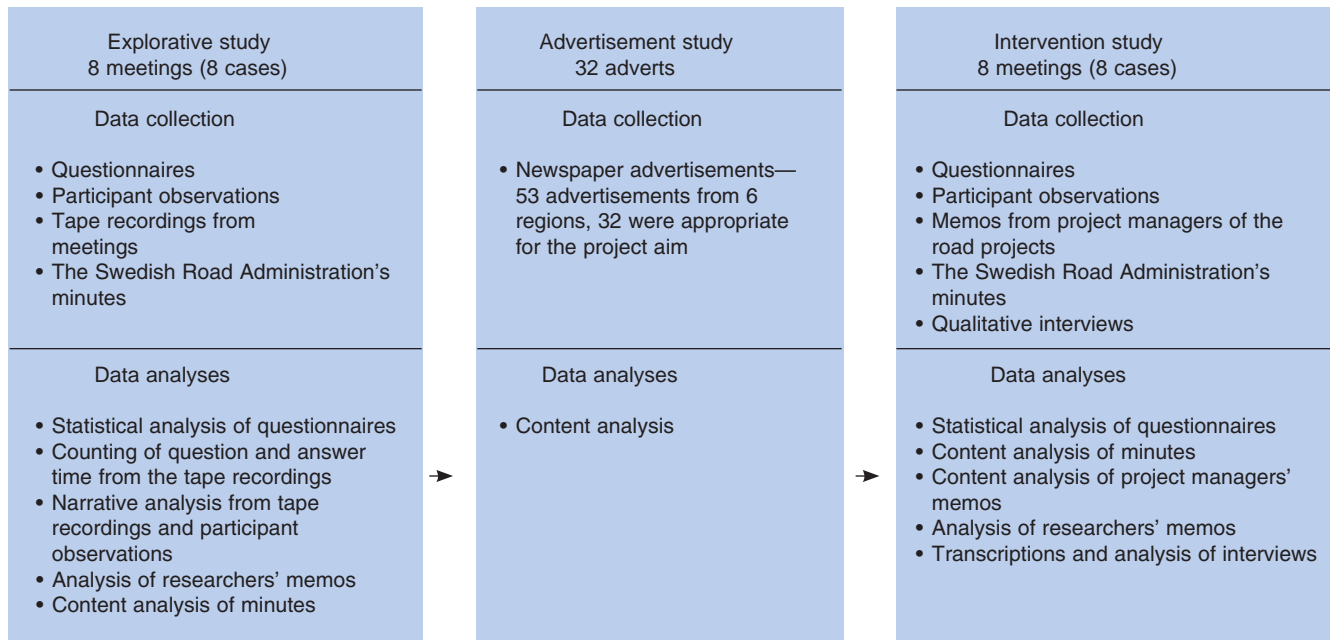


FIGURE 1 Outline of project.

No single research method is immune to presuppositions such as researchers taking for granted ways of seeing, interpreting, categorizing, coding, and representing findings (Goodwin 1994). This project used methodologic triangulation to ensure the results were not one-sided and to reduce biases from general assumptions. The research team worked with an interdisciplinary approach and the methods for data collection included questionnaires with participants at the consultation meetings, researchers' field notes from participant observations, tape recordings of conversations at meetings, the Swedish Road Administration's advertisements and minutes from the meetings, memos, and complementary interviews with project managers for the road projects.

The project team consisted of six researchers from two research institutes, with connections to the universities in Linköping and Stockholm. The researchers also worked together with students from advanced courses in public health and cultural studies.

Processing and analyses of data consisted of statistical analyses of questionnaires, content analyses of field notes and minutes from the meetings, counting of time for questions and answers, narrative analyses of tape-recorded meeting conversations, transcriptions, and thematic content analysis of interviews (Faith-Ell and Levin 2008a, 2008b; Faith-Ell et al. 2009).

All personal information such as names of individuals was omitted or changed in presentations and reports. Participants were asked for permission to tape record the meetings. The tape recordings are solely for the research team's use and detailed transcriptions with sensitive information will not be published.

The next section describes the results and how the three studies were connected to each other.

## RESULTS

The project started with the explorative study. After that, recruitments to the meetings were analyzed further, and it was found that invitations to the meetings always consisted of adverts for newspaper publishing and publishing on the Swedish Road Administration's homepage. The advertisements followed a fixed form. An intervention study could be designed from the outcomes of the other study phases of the project.

### The Meetings

The explorative study and the intervention study were based on eight cases each, for a total of 16 cases. One case consisted of one consultant meeting.

The following meetings were studied in the explorative study:

- Classic information meeting,
- Open house meeting,
- Dialogue meeting, and
- Landowners' meeting.

The dominating meeting form is the classic information meeting, in which road planning experts lecture on the project followed by a question-and-answer session.

The meeting is typically held in a meeting room or a school room. These meetings usually take 2 to 3 h, from 6 or 7 p.m. until 9 or 10 p.m. It is also common to have a coffee break in the middle of the meeting.

The next typical form is the open house, which is a much more freely formed meeting, in which the experts assemble and discuss with participants in small groups or give shorter informative lectures. Often there are maps and poster boards with images and written information.

Dialogue meetings are rare. They are characterized by small groups with individuals representing various groups such as associations and professionals (school teachers, social workers, administrators) from the local area.

Landowners' meetings are typically held at the end of a planning process, and personal invitations are sent to landowners in the area. The meeting form resembles the classic information meeting.

Sometimes the meetings are combined with excursions.

The case studies should be representative of the consultations. From 30 meetings held in four road administration's regions, eight meetings were chosen for the explorative study. Five classic meetings, two landowners' meetings, and one combination of dialogue and open house meeting were studied. It was decided to include narrative analysis of the talk at the consultation meetings in a part of the explorative study.

More women than men attended the open house meetings, especially one meeting with a walking tour to the section where the new road was supposed to be located. Consequently, in the intervention study it was decided to give priority to open house meetings and walking tours (excursions). However, it was found that specific forms of consultation meetings were decided early in the planning process before the intervention study began. This was also an organizational issue, and it was difficult to change perspective from the organizational strategies.

For example, it would have been interesting if some project managers had followed suggestions and arranged a walking tour along the road section. Instead, the meeting included a bus tour. The bus was hired by the regional road administration and drove along one part of the road that was being rebuilt. It stopped four times to pick up interested citizens, and at the 30- to 50-min stop at each place, the project manager and experts held lectures and answered questions. The other meetings studied in the intervention study were two open houses, four classic information meetings, and one landowners' meeting. The eight meetings for the intervention study were chosen in consultation with the road administration. From a record with 35 meetings, meetings were chosen that could be involved in the timetable. The project managers were encouraged to reshape the advertisements and the meetings. For organizational reasons, it was not possible to take part

in the early planning, and thus the intention to change meeting forms worked only to an extent.

### Advertisement Analysis

The project team tried to change the conditions, and recruitment was considered to be a crucial aspect for participation. All available advertisements before consultations, which were published in 2007 and 2008 within six road administration regions, were collected. Of 53 advertisements, 32 were deemed appropriate for the project and were analyzed (21 advertisements, invitations for exhibition, were left out).

Analysis of the advertisements revealed four forms: the technical advertisement, the practical advertisement, the encouraging advertisement, and the dialogical advertisement. The dialogical advertisement was judged to be the best, as it asked questions and had an open welcoming approach. For example: Do you want to discuss Road 282? Are you going by bus from Nyköping to Eskilstuna? It also often had illustrations. This advertisement was also the least used by the road administration. The most common advertisement was the technical one, followed by the practical. The research team started the intervention study with the advertisement design and altered the old-fashioned technical advertisements to more contemporary dialogical ones.

### The Participants

The number of adult participants was 305 in the explorative study and 426 in the intervention study. The figures from the explorative study showed that about a quarter of participants in the meetings were women (26%). In the intervention study, women represented a few more percent (32%) (Table 1).

The number of women and men varied between the meetings; in the explorative study women's participation varied from 60% to 0%, and in the intervention study it varied from 42% to 26%.

The people who attended meetings in the explorative study were generally older and had a higher level of education than the average population. Participants in the intervention study were also older than the average but held the same educational level as the majority of the

TABLE 1 Total Number of Women and Men at the Meetings in the Studies

	Women		Men	
	Number	Percent	Number	Percent
Explorative study	80	26	225	73
Intervention study	138	32	288	68

Swedish population. A majority had no children under 18 years old (71% in the explorative study and 68% in the intervention study). In both studies, the participants had higher incomes than the average citizen. The majority also went to the meetings by car. In the intervention study, no one came to the meetings by bus.

In the explorative study and the intervention study, most women came together with their partner (76% and 65%, respectively, of respondents), while men to a larger extent attended the meeting without their partner (69% and 62%, respectively). The respondents were also asked if they knew why their partner did not participate in the meeting. Most women not attending in the explorative study were at home with children or grandchildren (30%). In the intervention study, a large group of women were at work (25%). Not interested and busy with other things, are other common reasons for not attending (15% and 18%, respectively). In the explorative study, many women answered that their partner did not participate because he was not interested (28%).

### Issues Discussed

Environmental and road safety issues were brought up by both men and women during the meetings, but men more frequently discussed economy, technical facts, alternative routings, and landownership. Women more often asked questions about the consultation process and the opportunity to leave information after the meetings and on later stages of the planning process.

From the minutes and the narrative analyses, a complex of the topics discussed was identified. Four thematic topic areas were identified from the minutes: the project and the planning process, environmental issues, road sections and alternative routings, and other aspects with no direct connections to the road projects. Each thematic topic has subtopics identified in concepts. Some examples are as follows: how to interpret the maps (women and men asked); how the new and the old road can be used after rebuilding (women and men); cycling and walking (women and men asked and the questions often concerned children's mobility); noise (women and men); barriers (men, a few women, questioners were landowners); technical solutions about, for example, roundabouts, exit roads, and intersections (men and a few women); financing (men and a few women); timetable (women and men); local place (women and men); different needs for a new road (women and men); earlier investigations versus current planning process (women and men); how to get more information; and when and where is the next consultation (women and a few men). The more detailed the analyses are, the more complex is the image of how women and men interact.

### Interaction

The counting of questions and answers from the conversational interactions showed that men talked longer and asked more questions. Women and some men talked more together with other participants and with the road experts at the meetings. From the narrative analysis, two types of storytelling were identified. In the first, one person is telling a story by himself (in this study, it was always men who practiced this form of narrating). The people using this form introduced themselves as representatives of an association or a political organization. The second form is storytelling, with one person introducing a topic she or he evaluates together with other participants or with the experts. In the first type, the storyteller often holds the floor alone for several minutes. The other type of storytelling also takes more than 1 min, but it is always elaborated in short turns of just a few seconds each. At one meeting, a moderator organized the discussions and then he was also a co-narrator taking part with short comments and answers to participants.

Some participants had more extensive experience taking part in public meetings and talking in front of other people. Participants with less experience seem to need more guidance and take a more active part in the meeting when a moderator leads the discussion. It is tempting to say that men are more experienced and women are less experienced, but that is an oversimplification (Ford 2008; Kendall and Tannen 2001; Tannen 1993). It was observed that women and men who asked questions and talked in short turns instead of talking alone in extensive and argumentative turns also elaborated their arguments and took another strategy in making their topics known. It was also found that the road experts did not discriminate as they answered questions from women and men. Both women and men received the same attention for their questions.

The results show that not many more women attended the meetings in the intervention study. Comparable figures were 26% women in the explorative study and 32% in the intervention study, which was not the expected result. At the same time, most women and men said they were satisfied with the information at the meetings in both studies, and women tended to be more satisfied than men.

At the same time, in some meetings women were more active and asked more questions in comparison with their quantity at the meeting. A difference was recognized in the explorative study—for example, in a meeting with a walking tour in which 60% of attendees were women there was also more activity among the participating women. Also, in the intervention study, some meetings tended to increase women's activity. Open house meetings, meetings with excursions, and small group discussions seemed to attract more people from different groups than the classic open information meetings.

The questionnaires also asked for alternative consultations. Women said they would attend other meeting forms and some of them mentioned questionnaires, interviews, and study meetings. However, the attending women said they were more satisfied than the men with the information and the meetings, so it cannot be concluded that women need other meeting forms than men.

From the questions about the advertisements, the majority of participants who came to the meetings considered the advertisements interesting. Yet, many people were not informed by the advertisements and instead got information from neighbors and from newspaper articles. Women and men who attended the meetings seemed to be interested or curious about the road project before they came. A few were also well informed about the road administration and its activities. Younger persons (no differences between women and men) said they missed newspaper advertisements because they do not read daily newspapers regularly.

## DISCUSSION OF FINDINGS

The problem is not only a women's issue. When women attend meetings they are often satisfied and as active as men. The problem is that so few women still take part in the public participation process and there are many silent participants at the public meetings, both women and men. In addition, the invitations are considered too narrow to reach all presumptive participants and the meeting time and form are not appropriate for all inhabitants and road users who may be concerned. Another problem is the age of the participants; it is desirable to increase the participation of younger adults and youths without reducing the middle-aged people's and pensioners' access to the meetings.

Complexity of the planning process as well as the form of invitation to the meetings must be considered. Advertisements in local news papers should be completed with other recruitment methods. If new generations do not come to the Swedish Road Administration, other methods should be considered; rearrange the meetings, search for other locations, and find specific occasions to meet the public, such as sport and concert assemblies, colleges, and workplaces.

A challenge for gender research is that it runs the risk of becoming a circular and self-fulfilling process whereby presumptions taken for granted are already embedded in the research questions. Gender studies have shown a great deal of power asymmetries and inequality among women and men in general. However, not all areas are unequal in the same way and power relations do not play the same part for all women and all men.

Thus, gender and transportation research needs empirical evidence to compare with the findings from other fields.

What is unique about transport planning and how does gender equality come into that? Is transport planning just mirroring the situation and state of the art in other areas? Should transport planning be interpreted as an interactive area constructing and reconstructing gender inequality, or can it be interpreted apart from society in other respects? From the current project about consultations within Swedish road transport planning, one might consider the situation more unequal than in other areas, since Sweden is quite a gender-equal society according to representations in public areas such as local and national politics, government organizations, and public associations. However, when the road transport sector is compared with private areas such as technical and business companies there are no big differences. The public road transport administration is like many business companies with private ownership, dominated by men and by masculine values.

In these two case studies, male dominance among the attendees appears to be partly due to education. Previous research has pointed out the importance of education for participation in public issues. Disparities in educational attainment are often at the root of group differences in participation in public issues, and Burns and colleagues discussed the problem in terms of different experiences from working life, which play an important part in the differences between women's and men's choice to attend a public meeting (Burns et al. 2001). The average woman is less educated than the average man and has less experience in working outside the home. Even if she works full time, she is less likely to have the kind of job that generates opportunities to utilize her civic skills (Hernes 1987; Statistics Sweden 2008).

More women than men came together with their partner to the meetings and women often traveled as car passengers while men were usually car drivers. In both studies, a majority traveled by car to the consultation meetings. A few participants came by bicycle or by walking and very few came by bus. In the intervention study, no one traveled to the meeting by bus. Greed (2006) discussed whether one should plan for or against the car, but the question might as well be reformulated to ask whether the planning should be for male car drivers and against other travel modes and other groups of travelers. These patterns were not recognized in the intervention study in time to intervene and try to change them. Also, this project did not have the mandate to change more overarching patterns.

From the first parts of the project (the explorative study and advertisement study), it was acknowledged that recruitment of participants was a major problem, with too much technical information in the advertisements. Hence, it was decided to work with changes on the invitations—that is, the advertisements should be more interesting for noninformed citizens in the intervention study. It was also decided to work on the meeting forms

and encourage project managers to introduce more interactive meetings: open house meetings with discussions in smaller groups, walking tours in the environmental area for the road project, and addressing local groups.

From experience with the project, the authors have pointed out in a written "toolbox" for road project managers and, in the project report, also discuss further research that might focus more on the early planning of the consultation process and look beyond the obvious facts about road projects. This research project was so focused on the gender perspectives in the cases that it missed the more structural facts about the organization of road planning that influenced the consultation process (Lando 2003; Wittbom 2009).

## CONCLUSIONS

This research project adopted a skepticism about the dichotomous conception of gender that characterized much previous research on gender and transportation. Thus, the outcomes of the project suggest making the questions more detailed and more elaborate. The authors argue for putting more emphasis on contextual factors; diversity in communities of practice; and in forms of gender combined with various other categorizations and positions such as age, ethnicity, social and economic features, sexuality, and body characteristics and impairments in relation to the environment. At the least, environmental issues stemming from climate debates should be emphasized more. Why should the consultation about road planning be just for car drivers? In these two case studies, other road users appear to be neglected, as a few participants in only one case actually took a bus to the meeting (in the city of Stockholm) and few went by bicycle or by walking. The opportunity to go by public transport was very difficult to fulfill in most meetings because there were few or no buses at the time of the meetings (late afternoon or evening) and the meeting places were in suburban or rural areas.

A more thorough analysis of gender consciousness and an intersectional approach to the studies of public participation are recommended. There is a need for more research on planning the transportation system and especially on early stages of planning of the consultation process: What does gender mean for the planners and experts involved? How does gender influence specialist knowledge and how does specialist knowledge influence intentions of gender mainstreaming?

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# Appreciation of Gender Differences in Development of Qualitative Level of Service for Sidewalks

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Pedestrian level of service indicates the environmental qualities of a pedestrian space and serves as a guide in developing standards for pedestrian facilities. Pedestrian space needs to be designed in consideration of human convenience and must be qualitatively suitable to the needs of users. Additional environmental factors that contribute to the walking experience and consequently to the perceived level of service—such as comfort, security, and attractiveness—should also be considered. The central hypothesis in this paper is that gender difference plays an important role in the importance attached to different parameters of the walkability index. With this hypothesis, the difference in perception of male and female pedestrians for different parameters of pedestrian facilities has been analyzed. Five parameters were identified: sidewalk width, sidewalk surface, obstruction, security, and comfort. Equal numbers of male and female pedestrians in different land uses in Delhi, India, were interviewed with a view to understanding the variation in perception. They were asked to rate the importance of the five parameters according to their needs and requirements on a 5-point scale ranging from most important to immaterial and their response on a satisfaction rating regarding the sidewalk facility they were using on a 5-point scale ranging from excellent to poor. The importance ratings were called weights attached to the parameter. This study found that the responses of male and female pedestrians in terms of mean relative weights for all five parameters differed from one another.

The needs and requirements of pedestrians are seldom given importance in the planning and design of road infrastructure in metropolitan cities in developing countries. Proper guidelines and standards for sidewalks and crosswalks are yet to be established. Pedestrian facilities can be designed in a rational manner on the basis of detailed study of pedestrian flow. Level of service (LOS) of sidewalks has been discussed in detail in different highway capacity manuals including the U.S. *Highway Capacity Manual* (1). LOS for a sidewalk is expressed in terms of pedestrian volume alone; 15-min pedestrian volume for LOS A is 360 and for LOS E it is 1,700. Capacity values are available for different widths of sidewalk in India (2). Indian guidelines do not provide pedestrian volume figures for different LOSs.

Besides the quantitative analysis, the perception of users—the aspect of quality—should also be taken into account while estimating capacity for different pedestrian facilities. Khisty developed an evaluation methodology for assessment of the qualitative elements of facilities used by pedestrians by independent observers familiar with the situation (3). Sarkar advocated that qualitative evaluation of pedestrian precincts is important for providing adequate facilities for the elderly, the physically challenged, and children, who are most inclined to use this mode of travel (4). Gallin undertook a study of the main roads of Western Australia aimed at developing guidelines for assuming the LOS of pedestrian facilities (5). In all these studies, the difference in the subjective response of male and female pedestrians was not considered for the planning and design of sidewalks. Responses of female pedestrians toward certain elements of side-

walks likely differ from responses of their male counterparts. There is a need to understand these differential responses so that a methodology for sidewalks can be evolved that is sensitive to gender differences.

## BACKGROUND

Studies on women's and men's travel have resulted in a reasonable understanding of the relationship between gender differences and travel patterns. Rosenbloom analyzed work done on this topic and concluded that (a) women's and men's aggregate travel behaviors are still far from equal on a number of measures, whereas trends toward convergence may be slowing; (b) disaggregating behavior often reveals distinct differences between the sexes; and (c) so many potentially explanatory variables in society are tied to gender that it may not be relevant whether sex or other intensely gendered variables, such as household role or living alone in old age, explain differences between men and women (6).

Gender difference in travel is prominent in a study of older drivers in the United States. Older women make up the largest percentage of all nondrivers, and a high proportion have limited incomes and household support with which to address their travel needs. The study suggested that mobility losses do not fall evenly on men and women or among different groups of men and women (7).

Handy explored the role of community design as an influencing parameter for the travel behavior of women (8). In studies of the link between community design and travel behavior, gender has been just one more variable to control for rather than the focus of analysis, despite the fact that it has been a significant factor in many studies. Research on the relationship between community design and travel behavior points toward an understanding of causal relationships in building the evidence base for community design policies in general and those targeted to the needs of women in particular. Quantitative approaches can be used to explore not just travel behavior but also the travel needs, constraints, attributes, and preferences that shape behavior and can produce new insights into the role of community design as facilitator, constraint, or both. Qualitative studies focused on women can provide deeper insights into these questions than quantitative studies alone.

Security is a major concern of women compared with men when it comes to using transportation systems. Schulz and Gilbert presented transit security in relation to women in the United States (9). A transit system after 3 years of its initial opening was forced to organize a special police force to deal with the problem of crowding. Within 8 years of its opening, the transit system was being criticized for the sexual harassment of women and girls who, although they accounted for only about a quar-

ter of all peak-hour passengers were forced to endure jostling and unwelcome sexual contact. The cross-class nature of these incidents was viewed as "a violation of the laws of decency." In terms of security, gender difference is quite prominent with respect to transportation system operation. All these studies establish that travel patterns are linked to gender differences. They also point toward a gray area in the community design policies targeted to women.

Studies relating gender differences and travel behavior in the Indian context are limited. As part of a technology development and research program funded by the Overseas Development Administration, the Transport Research Laboratory undertook studies of urban travel behavior in Pune, India (10). This study emphasized understanding the travel behavior of women. It was observed that women perceived bus service in Pune to be inferior to the local train service in terms of convenience, comfort, and safety, largely due to the existence of female-only carriages on trains. Interestingly, however, women appeared disinterested in the idea of female-only buses (perhaps due to earlier unhappy experiences when sections of buses were caged for female security) and preferred that more buses be provided. More frequent service would create a less crowded and safer environment in which all, but especially females, can travel in comfort.

## CONTEXT OF DELHI STUDY AREA

Delhi, the national capital, is the center of attraction for people searching for better job opportunities and better living standards. The total area of Delhi is 1,486 km<sup>2</sup>. Its population has grown rapidly from 1.7 million in 1951 to 13.7 million in 2001. However, its vehicle population exceeds the total vehicle population of three mega cities in India: Mumbai, Calcutta, and Bangalore. The share of road transport infrastructure in land use is the highest in the country. The per capita road availability of roads in Delhi is 2.6 m. The vehicle ownership rate is also very high compared with other metropolitan cities in India. The road network in Delhi is based on a hierarchy of roads ranging from arterial roads designed to carry fast through traffic to collector roads. The existing road design does not cater to the needs of pedestrians. Footpaths are either not available or are poorly maintained; they are provided on the road space that is left after providing road space for motor vehicles. A mass rapid transit system has recently become operational. It has been useful in enhancing the share of the public transport system. The increase in public transport usage will also induce an increase in the share of walk trips. The cosmopolitan character of Delhi makes it a good choice for a case study.



## RESEARCH METHODOLOGY

Pedestrian LOS indicates the environmental qualities of a pedestrian space and serves as a guide for development of standards for pedestrian facilities. Pedestrian spaces need to be designed in consideration of human convenience and must be qualitatively suitable to the specific requirements of human beings. The planning and design methods for pedestrians suggested by many researchers are based primarily on vehicular traffic flow theory. Additional environmental factors that contribute to the walking experience and therefore to the perceived LOS—such as comfort, convenience, security, and attractiveness—should also be considered. The qualitative method of developing LOS models incorporates the perceptions and needs of the pedestrians implicitly. Pedestrians are asked to identify their requirements—for example, the importance of various attributes of sidewalks. Pedestrians of various age groups and both genders have different needs and they are neglected in conventional methods. In the qualitative approach of developing LOS, all these factors are considered.

In this study, a psychometric method was adopted to develop relative weights of five attributes of sidewalk facilities and satisfaction ratings of pedestrians. Twelve locations for qualitative assessment of the sidewalk facility were selected in Delhi. The locations were selected on the basis of sidewalk width and pedestrian volumes and were spatially distributed throughout the city of Delhi. For qualitative assessment of sidewalk facilities, a questionnaire-based survey was conducted. Pedestrians using the sidewalk facility were asked a set of questions, with a view to ascertain the LOS the pedestrians experience by using a particular sidewalk facility.

For qualitative evaluation of pedestrian facilities, a form was designed using a rating scale concept. The initial stage of this method involved identifying parameters for inclusion in a questionnaire, reflecting the important aspects of LOS experienced by pedestrians. Five parameters were included in the questionnaire. Three parameters pertained to the physical evaluation of the sidewalk facility, which included sidewalk width, sidewalk surface, and obstruction. The two user factors were security and comfort. An equal number of male and female pedestrians were asked to rate the importance (how important good performance is to them) and performance (indicating bad or good condition) on a 5-point scale. A detailed description of all the factors is given below.

### Physical Characteristics of Sidewalks

- **Footpath surface:** A smooth surface without any cracks or bumps, for comfortable walking;

- **Footpath width:** A measure, in meters, of the width of the sidewalk available to pedestrians; and
- **Obstructions:** Impediments such as an electric pole, a tree, a garbage bin, and hoardings. The number of obstructions per kilometer of sidewalk was assessed.

### User Characteristics of Sidewalks

- **Security:** The feeling of being safe is the most important governing factor. A pedestrian should feel safe during the day as well as at night while using a sidewalk. Characteristics of security include provision of adequate street lighting, police patrolling at night, and sufficient activities in surrounding areas to ensure security.
- **Comfort:** A pedestrian needs to be shielded from inclement weather such as harsh sun and rain. Trees protect pedestrians but if planted in an unplanned manner also act as an obstruction. The location and species of trees need to be carefully planned. Curbs must be mountable so that pedestrians can easily climb up and down them. Provision of chairs, benches, and restrooms add to the comfort of pedestrians.

Onsite assessment of 30 sidewalk facilities was carried out by the authors in various locations spatially distributed throughout the city of Delhi. On the basis of the weights achieved from primary surveys and the scores assigned by the onsite assessment, attitudinal scores were estimated for these locations.

### Survey Locations

The details of locations for the qualitative survey are presented in Table 1.

**TABLE 1** Details of Locations for Pedestrian Survey

Survey Number	Location	Land Use Type
1	CRR I Okhla Tank	Institutional and residential
2	AIIMS	Institutional
3	Azadpur	Commercial
4	Ashram	Residential
5	Janakpuri	Residential
6	ITO	Public-semipublic
7	Cannaught Place	Central business district
8	Hauz Khas	Institutional and residential
9	Vivek Vihar	Residential
10	Rohini	Residential
11	ISBT, Ajmeri Gate	Terminal
12	Shahdara	Residential and commercial

NOTE: CRR I = Central Road Research Institute, AIIMS = All India Institute of Medical Sciences, ITO = Indian Tourism Office, ISBT = interstate bus terminus.

**Survey Execution**

A simple random sampling strategy was used to select a respondent from the pedestrian stream. The survey was conducted on working days from 6:00 a.m. to 10:00 p.m. to capture people using the footpath with various purposes. The data were used to ascertain the importance and satisfaction rating of each attribute. The weights assigned to importance and satisfaction were used to develop a qualitative LOS of sidewalks.

**Characteristics of Male and Female Pedestrians**

The socioeconomic characteristics of male and female pedestrians were collected pertaining to age, profession, purpose of trip, frequency of trip, and response to the reason for nonuse of sidewalks if they were available. The comparative graphs are shown in Figures 1 to 6. An effort was made to include respondents from all age groups, but, because of their greater mobility, 63.4% of men and 50.3% of women surveyed were in the 21- to

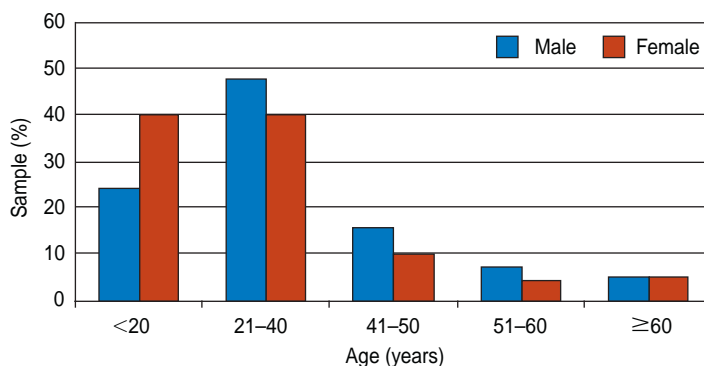


FIGURE 1 Distribution of male and female pedestrians, by age.

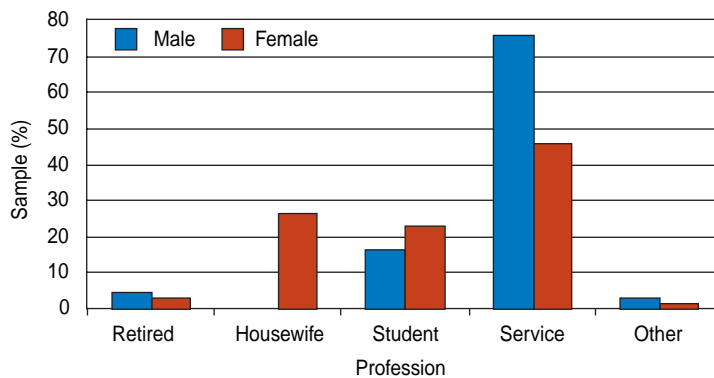


FIGURE 2 Distribution of male and female pedestrians, by profession.

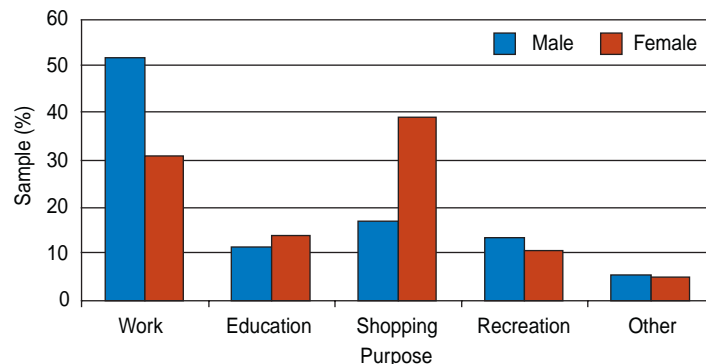


FIGURE 3 Distribution of male and female pedestrians, by purpose.

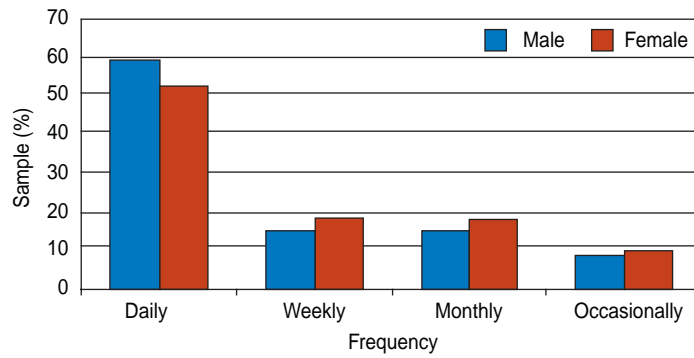


FIGURE 4 Distribution of male and female pedestrians, by frequency of trips.

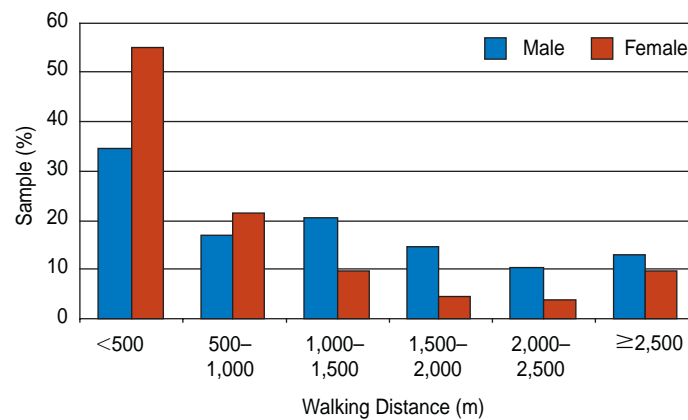


FIGURE 5 Distribution of male and female pedestrians, by walking distance.

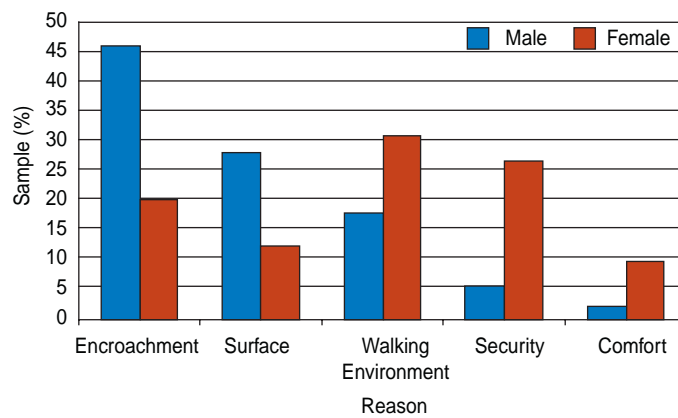


FIGURE 6 Response to reason for not using available sidewalk facility.

50-year age group. Among men, 75% were employed, while for women the share was 45.8%; 26.7% of females were housewives. For men, 52.2% of the total trips were undertaken for work; for women, most trips were in the category of shopping (39.3%). Male and female pedestrian characteristics are similar for the frequency of trips made. It was observed that women make smaller trips than men in terms of walking distance, as 76.44% of

women walk less than 1 km. This distance includes the entire tour from origin to destination. The response to the reason for not using the available sidewalk facility also varied, with 46.04% of males not using it because of encroachment on sidewalks followed by 28.06% because of sidewalk surface. The major reasons cited by women were the walk environment (31.01%) and security (26.56%). Encroachment is a common phenomenon

on the sidewalks in Delhi. Vending activities can be attributes of primary encroachment. The walk environment refers to factors such as shade of trees, absence of foul smell, and so forth.

### COMPARISON OF MALE AND FEMALE PEDESTRIAN RESPONSE

The responses of male and female pedestrians were analyzed separately to study the difference in mean relative weights and satisfaction rating for different parameters of sidewalks. It is possible to estimate the frequency of male and female respondents with respect to the different weights assigned for the sidewalk parameters and then compare the values. Similarly, for the five identified categories of satisfaction rating, the percentage responses of male and female respondents can be compared. Mean relative weight is a representation of aggregate value and it may undermine the effect of microscopic variation in responses of male and female pedestrians within subcategories. A detailed comparison of responses for relative weights and satisfaction rating is presented below.

### Response on Importance Levels by Male and Female Pedestrians

Responses of male and female pedestrians were compared on a 5-point scale from immaterial to extremely important. Percentage responses for all 5 points were compared and differences were estimated. Mean weights were calculated for male and female pedestrians separately. The attribute-wise comparison of responses toward the importance level of parameters is presented

in Table 2. The mean weights were almost similar for all attributes except security, to which females attach more importance than males. The mean weight for security for females is 3.5, while the corresponding figure for males is 2.9. As the sample size was small, no attempt was made to ensure that the difference is statistically significant. In India, women generally do not venture out alone at night or to places that are relatively unsafe; still, security plays a large role in their mind.

### Response to Satisfaction Rating by Male and Female Pedestrians

The responses of men and women pertaining to satisfaction ratings of five parameters were compared on a 5-point scale ranging from poor to excellent and are presented in Table 3. Women seemed to be more satisfied than men in terms of physical factors, but in terms of the user factor (security) they were more dissatisfied. It can be inferred from this response that women are ready to compromise with physical parameters but not with security and comfort. The mean weight for security by females is 2.4, as opposed to 2.9 by males.

### Gender Difference and Physical Design

Female pedestrians assign more weight to security and comfort. A comparison of relative weights for all five parameters indicates that male and female responses are quite different for security. Women avoid using transport services after evening hours, indicating that security issues are associated with this service. The mean weight for the satisfaction rating for security is less for female

TABLE 2 Relative Weights for Sidewalk Attributes

Attribute Score	Width		Surface		Obstruction		Security		Comfort	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Immaterial	19.8	27.1	22.4	18.2	13.6	19.1	29.3	9.3	17.1	15.1
Least important	25.1	19.1	26.4	34.2	23.3	22.2	17.1	16.9	20.9	16.4
Important	19.6	17.3	18.4	16.0	28.2	24.4	13.3	17.3	18.0	22.2
Very important	16.2	15.6	15.8	18.2	21.8	17.3	19.1	23.6	22.9	18.7
Extremely important	19.3	20.9	16.9	13.3	13.1	16.9	21.1	32.9	21.1	27.6
Mean weight	2.9	2.8	2.8	2.7	3.0	2.9	2.9	3.5	3.1	3.3

TABLE 3 Satisfaction Rating for Sidewalk Attributes

Attribute Score	Width		Surface		Obstruction		Security		Comfort	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Poor	10.7	8.0	17.6	10.7	30.4	22.7	28.7	36.9	26.4	30.2
Satisfactory	29.8	22.7	29.3	28.9	21.8	20.9	14.9	20.9	23.6	26.7
Good	25.6	23.1	16.2	24.0	17.8	16.0	21.3	18.7	28.0	16.0
Very good	16.9	20.9	18.4	20.4	13.6	16.0	11.1	15.1	13.8	16.0
Excellent	17.1	25.3	18.4	16.0	16.4	24.4	24.0	8.4	8.2	11.1
Mean weight	3.0	3.3	2.9	3.0	2.6	3.0	2.9	2.4	2.5	2.5

than for male pedestrians. Even if the different response for male and female pedestrians is not significant for width, surface, obstruction, and comfort, the difference is pronounced for security as a design element of sidewalks. Efforts need to be undertaken to further enhance the security of female users within the pedestrian infrastructure in addition to other qualitative parameters.

### LEVEL OF SERVICE OF SIDEWALKS

These LOS definitions describe the adequacy of pedestrian facilities and have evolved utilizing the five factors that affect pedestrian LOS. LOS A provides the best walking conditions for pedestrians in terms of a wide sidewalk, good surface quality, and separation from fast-moving vehicles. LOS E, on the opposite end of the scale, may depict narrow sidewalks, encroachment, an unpleasant walking environment, and potential conflict with motorized vehicles. With this understanding, five LOSs were worked out for this study. Normally, planners in Delhi do not use this LOS concept for designing sidewalks.

1. LOS A is a pedestrian environment where ideal pedestrian conditions exist and the factors that negatively affect pedestrian LOS are minimal.

2. LOS B indicates that reasonable pedestrian conditions exist, but a small number of factors affect pedestrian safety and comfort. LOS A is the ideal, and LOS B is an acceptable standard.

3. LOS C indicates that basic pedestrian conditions exist, but a significant number of factors affect pedestrian safety and comfort.

4. LOS D indicates that poor pedestrian conditions exist and the factors that negatively affect pedestrian LOS are wide-ranging or individually severe. Pedestrian comfort is minimal and safety concerns within the pedestrian environmental are evident.

5. LOS E indicates that the pedestrian environment is unsuitable. This situation occurs when all or almost all the factors affecting pedestrian LOS are below acceptable standards.

The satisfaction rating for all five attributes was multiplied by the relative weight assigned to each attribute. The total weighted scores were calculated for all 30 locations. The mean score was 48 with a standard deviation of 10.

The total weighted score grading of sidewalks was calculated to define five ranges representing five LOSs. Initially, grading was worked out taking the mean and standard deviation as reference figures. Mean plus one standard deviation (i.e., 58) has been defined as the upper limit and any score above it qualifies for LOS A.

The lower limit is the mean minus twice the standard deviation (i.e., 28). Any score less than 28 is designated as LOS E. For LOS B to LOS D, an interval with a range equal to one standard deviation was used. With this scheme, more than 50% of locations qualified for LOS A and LOS B for the 30 sidewalks selected for onsite assessment. It is desirable that locations in LOS A, LOS B, and 50% of LOS C lie within 50% to 60%. Thus, the intervals for cumulative scores were marginally modified. These grading schemes are indicated in Table 4.

The cumulative weights were calculated for males, females, and combined data sets. As the mean weights for male and female pedestrians were not distinctly different, a frequency distribution curve for cumulative weights (combined data set) was used. The distribution of 30 sidewalks on the basis of cumulative weights calculated using mean relative weights of male and female pedestrians did not exhibit dissimilarity. This similarity can be attributed to the fact that the physical design of sidewalks using an aggregate score is not very sensitive to the gender difference.

### CONCLUSIONS

The design of pedestrian facilities requires a different approach in view of the human factor. Different highway capacity manuals have resorted to an approach that is similar to vehicle-oriented design. In these approaches, the performance of sidewalk is not related to qualitative dimensions of walking such as footpath width, footpath surface, walking environment, comfort, and security. Qualitative approaches developed for sidewalk design do not implicitly take gender differences into account. The perception response of female pedestrians is often neglected during the process of physically designing sidewalks. Efforts were made in this study to incorporate the attributes that affect the walking experience in a holistic manner to evolve LOS indicators for sidewalks. LOSs of sidewalks have been worked out taking into account

TABLE 4 Allocation of LOS for Sidewalks

LOS	Cumulative Score	Modified Cumulative Score	Distribution of Sidewalks		
			Model 1 <sup>a</sup>	Model 2 <sup>b</sup>	Model 3 <sup>c</sup>
A	>58	> 60	3	3	3
B	48–58	50–60	7	6	7
C	38–48	40–50	15	16	15
D	28–38	30–40	3	3	3
E	<28	<30	2	2	2

<sup>a</sup> Model 1: Calculation of cumulative scores using mean relative weights of male pedestrians.

<sup>b</sup> Model 2: Calculation of cumulative scores using mean relative weights of female pedestrians.

<sup>c</sup> Model 3: Calculation of cumulative scores using combined mean relative weights.

both relative weight and satisfaction rating in terms of composite score. This method of evaluating and designing sidewalks provides a simplified approach to incorporate different qualitative elements into physical design. However, it is essential that both male and female pedestrians are adequately satisfied with all sidewalk parameters. There is a need for further study to define LOS in terms of satisfaction toward certain important individual parameters of sidewalks. In this study, female pedestrians did not rate the security element of sidewalks as satisfactory. Improvement of physical features alone may not be useful to enhance the patronage of sidewalks. Addressing genuine concerns of women in sidewalk design can contribute immensely to promote walk trip patronage within the urban transport system.

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# Gender Considerations in Performance Measures for Bicycle Infrastructure

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In the United States, men's total bicycle trips surpass women's by a ratio of at least 2:1. Gender differences in perceptions of bicycling safety, combined with the effect of bicycle facility type, could help explain the different cycling rates for men and women. The United Nations and the European Union (EU) have recognized that women and men have different transportation needs, and the EU requires explicit recognition of these differences in national transport policies and implementation. Currently, the indices or measures commonly used to evaluate American bicycle infrastructure do not account for gender differences. Bicycle facility design is often guided by design cyclist categories that define bicyclists by how well they ride in vehicular traffic. Female cyclists have been shown to prefer more separation from vehicular traffic than male cyclists, which can lead to women having to choose to travel on bicycle facilities that have been designed for safety rather than to provide a convenient route to community services. The imbalance of U.S. bicycle trip rates by gender is an indicator that American bicycle infrastructure does not serve the needs of all bicyclists. Two gender-neutral indices, the bicycle compatibility index and the bicycle level-of-service index, which are commonly used to assess U.S. bicycle infrastructure, are compared with the Netherlands' bicycle infrastructure survey in an effort to understand the association of gender-neutral versus gender-sensitive policies on bicycle infrastructure design and assessment.

**I**ncreasing bicycling ridership in the United States is now recognized as being beneficial in various ways, ranging from decreasing vehicle miles traveled to fighting obesity to strengthening community cohesion and social capital. Although people are told bicycling is good for them, Americans—especially American women—do not bicycle: fewer than 1% of trips in the United States are made by bicycle (1, 2), with men's total bicycle trips surpassing women's by at least 2:1 (1).

Low bicycle modal share is not a global phenomenon; in the Netherlands, for instance, national level bicycle policy first enacted in the 1970s has helped maintain bicycling levels where 27% of trips made are by bicycle and women make 55% of these trips (2, 3). This high level of bicycling can be partially attributed to an existing strong bicycle culture that allowed policy implementation to build on the existing infrastructure (4, 5). The high level of female bicyclists can perhaps be attributed to a national culture that accepts gender equality as a cultural norm (6, 7).

Member countries of the European Union (EU), which includes the Netherlands, have recognized that there are differences in men's and women's transport needs by integrating gender mainstreaming requirements into all EU policies including transportation by the late 1990s (8, 9).

The concept of gender mainstreaming was identified as a global objective in 1997 by the United Nations (UN) Development Council and was defined by the UN Economic and Social Council in 1997 as follows:

[T]he process of assessing the implications for women and men of any planned action, including

legislation, policies or programmes, in all areas and at all levels, as a strategy for making women's as well as men's concerns and experiences an integral dimension of the design, implementation, monitoring, and evaluation of policies and programmes in all political, economic and societal spheres so that women and men benefit equally and inequality is not perpetuated. (10)

The Swedish government made gender equality the sixth goal of transport policy in 2001. Three important focuses for gender mainstreaming and transport were recognized: "concrete differences between women's and men's travel differences, gendered attitudes and valuations of transportation facilities, and gendered distribution of power and influence over the sector" (11).

In contrast, the United States has not integrated gender mainstreaming into transportation policies, and although the FHWA does sponsor the Women's Travel Issues National Conferences and recommends that transportation policymakers and planners pay attention to conference findings of travel differences between men and women, there is no requirement to follow the recommendations (11).

Could the gender-neutral approach of U.S. transportation policies be contributing to the disparity between male and female bicycling rates? Currently, the studies used as a foundation for the evaluation of American bicycle infrastructure do not take gender travel differences into account (12–14). This has serious implications; the assumption in U.S. bicycle infrastructure design that all bicyclists have the same needs regardless of gender, or that male bicyclists are representative of all users, could be partially responsible for the imbalance between bicycle trips made by men and women in the United States. This paper examines performance measures used in planning bicycling facilities with respect to the treatment of gender differences and the implications with respect to the types of facilities provided.

## CONCEPTUAL BASIS AND LITERATURE REVIEW

Two conceptual frameworks are used in this paper: the first is to give insight into bicycling behavior from the viewpoint of bicycling as a physical activity and the second is to further understand differences in bicycling behavior by gender.

The first framework is based on the ecological model commonly used in physical activity research within the public health field to explain individual behavior (15). This model suggests that individual behavior is influenced by factors at multiple levels, including the individual, the social environment, and the physical environment. Individual factors include attitudes, preferences, and beliefs as

well as confidence in one's ability to engage in the behavior (a concept called "self-efficacy" in the field of public health). Social–environmental factors include the cultural norms of the community as evidenced by the collective behaviors of its residents. Interpersonal relationships, including those within households, are also considered social–environmental factors. Physical–environmental factors depend on the nature of land use patterns and transportation infrastructure. The ecological model was chosen over the more traditional model of travel behavior that focuses on utility maximization and does not readily account for attitudes or social–environmental factors.

In relation to the ecological model, use of the gender category in bicycle behavior research provides a structured framework to further analyze the relationship between gender and bicycling behavior. In her discussions of gendered transport geography, Law recommends analyzing the social and cultural dimensions of transportation research from a gendered viewpoint (16, 17). This viewpoint is important as gender not only deals with perceived differences between men and women but also influences other subgroups' (i.e., defined by age, disability, income, ethnicity) experiences of bicycling (9, 17–19). Analyzing the levels of the ecological model from a gendered perspective helps one to understand not only the factors but also the interrelations between factors that can be associated with different bicycle behaviors in men and women.

Hall (19) further suggested conceptualizing the social context of transport in terms of the dynamics created by the interactions "of three competing groups of actors ... each able to be subjected to a gendered evaluation: (a) transport industry employers/employees, (b) transport users, and (c) residents of areas within which transport has an impact." Approaching the analysis of the ecological model factors from this viewpoint allows one to better evaluate the influence of gender-neutral and gender-sensitive policies on performance measure development.

This paper focuses on the association of U.S. gender-neutral American bicycle policies with low male and female bicycle trip rates. Several important factors that have been associated with different cycling rates in men and women are identified and discussed in terms of gender difference. Then, guided by Hall's conceptual framework (19), the paper explores how nonrecognition of the role of gender in bicycle behavior affects infrastructure design and assessment by comparing gender-neutral and gender-sensitive bicycle infrastructure policies and the resulting measures used in the United States and the Netherlands.

## GENDER DIFFERENCES IN BICYCLE BEHAVIOR

U.S., Australian, and European studies of gender differences in bicycle behavior have identified that differences



in transport needs, safety perception, and effect of bicycle facility type are associated with different cycling rates for men and women (1, 4, 9, 20, 21).

American women's trips are more for household and family support activities than men's, with women in two-working-parent families making twice as many weekday trips as men to pick up and drop off household children under the age of 14 years (22–24). As many of these activities require the transport of goods or passengers, women might prefer the convenience of driving to bicycling to fulfill these activities, especially if they are also using trip-chaining to carry out these responsibilities. Although a preference for driving over bicycling is an individual-level factor, it is heavily influenced by household and family relationships, which are considered a part of the social environment.

A strong bicycle culture—such as experienced in Germany, the Netherlands, and Denmark—provides an environment where performing household chores, such as shopping, by bicycle is accepted as a community norm; in these communities, the share of female cyclists is equal to or greater than the share of male cyclists and shopping trips make up 20% to 25% of overall bicycle trips versus 5% of all bike trips in the United States (9, 25). Other factors come into play, however; the dense structure of European communities allows for easier access to services than the sprawling structure of U.S. communities, where distances to services are greater (2, 26).

These two points are connected: women's role as chauffeur for children and the elderly in the family is heavily influenced by how well the transport infrastructure of the community supports all users. The more the infrastructure allows for children and the elderly to be independently mobile, the less they will have to be chauffeured and more time will be freed up for the chauffeur (9).

Women bicyclists tend to have greater concern for safety from the perspective of both road safety and driver behavior. Women often are more risk averse than men and tend to perceive negative consequences of sharing roads with vehicular traffic more than men do (27). Consequently, women are more likely than men to prefer bicycling separated from vehicular traffic by bicycle paths or on-road lanes but not so isolated that they are vulnerable to attack (1, 28–31). This can affect not only a woman's choice to bicycle but also influence her decision to let her children travel by themselves to school based on her perception of neighborhood safety (32). If bicycle path networks provide safety from vehicular traffic at the expense of convenience to services such as stores and schools, however, then extensive bicycle path networks do not always encourage bicycling in a community—for male or female bicyclists (28, 33, 34).

## EUROPEAN VERSUS U.S. BICYCLE POLICY DEVELOPMENT

American bicycle policies are in their infancy compared with countries that have a tradition of a strong bicycle culture. While the U.S. is still struggling with how to design transportation infrastructure and educate users to allow different transportation modes to safely interact (35), the Netherlands, for example, is now focusing on how to make bicycling more competitive with vehicular travel with respect to travel time and convenience (2, 36).

### U.S. Bicycle Policy: Safety First

Sprawling land development and emphasis on transportation infrastructure that favors the automobile has discouraged development of a strong bicycle culture in most American communities (37). This situation is further compounded by the lack of a national bicycle policy supporting multimodal use of transportation networks. From a gender viewpoint, U.S. statutes require that the U.S. Department of Transportation does not discriminate against women in the planning and policy decisions in federally funded federal projects, but, at the regional level, municipal planning organizations are not required to specifically address the needs of women in their transportation planning processes (38).

In bicycle infrastructure planning, the U.S. focus is on improving safety. This focus is understandable as communities with a small number of bicyclists (as in most American communities) and a strong vehicular culture tend to have more bicycle–vehicle accidents than communities with large amounts of bicycling (39); the more motorists expect to encounter bicyclists, the more carefully they tend to drive (3).

National strategies for advancing bicycle safety have been put forth in the National Strategies for Advancing Bicycle Safety [National Highway Traffic Safety Administration (NHTSA)], and the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU) has provisions for bicycle infrastructure funding (35, 40). NHTSA advances key goals believed to increase bicyclists' safety, including having motorists learn to share the road with bicyclists, having bicyclists riding safely through education and law enforcement, requiring bicycle helmets, revising the legal system to support safe bicycling, and having roads and paths safely accommodate bicyclists (35).

Both the American Clean Energy and Security Act passed by the House of Representatives in June 2009 (41) and the Committee Draft of the Surface Transportation Authorization Act of 2009 (STAA) (42) include a “complete streets” (referred to as comprehensive street

design standards in STAA) component that sets complete street principles as planning goals for state and regional transportation planners that recognize the unique needs of “pedestrians, bicyclists, motorists and transit riders of all ages and abilities (to be) able to safely move along and across a complete street” (43, 44). Although both the climate change bill and STAA strive to encompass the diversity of transportation network users, including children, the elderly, and the disabled, they do not recognize gender as a transport user group with unique needs. This is notable, considering international recognition of the distinct differences in travel behaviors of men and women and resulting policies that have been created to address these differences by the UN and the EU (11).

### Women and Transport in Europe

In a series of three reports published by the UN Economic Council for Europe in late 2008, a review of gender issues and recommendations was submitted to the UN Economic Commission. The reports found that there are “clear and persistent gender differences in travel patterns” (11) but that little attention has been paid to women in transport projects in part because transport is such a strongly male-dominated sector and hence dominated with masculine values and practices. Consequently, gender mainstreaming in transportation sector policies was recommended not only to satisfy human rights requirements but also to help achieve “sustainable human-centered development” (11).

Of note in the reports’ discussion of gender analysis was the recognition that gender analysis challenges the traditional travel model, which assumes household behavior as representative of all household members without taking into account the “power structures and gender relations within the household units” (11). If this is recognized, then transport planning would have to “shift away from a focus on facilitating the movement of motorized vehicles to a people-centered perspective that starts with an analysis of the basic household mobility needs” (11).

### Netherlands Bicycle Policy: Convenience

National bicycle policies were enacted in the mid-1970s in the Netherlands in response to plummeting bicycling rates from increased vehicle usage. This falling bicycling rate was further compounded by communities focusing on increasing vehicle road capacity and parking space while ignoring the needs of bicyclists. In 1975, Dutch bicycle rates had dropped to one-third of 1950 trip rates. After enactment of the Dutch national bicycle policy,

which focused on improving bicycle infrastructure and restricting car use, bicycling rates in Dutch cities had increased by 2006 to 52% of the 1952 level (25).

From 1990 to 1997, the Netherlands developed a national strategy entitled the Dutch Bicycle Master Plan (BMP) to encourage bicycling (2). Gender mainstreaming was not explicitly mentioned in the BMP, as it had not yet become an EU policy requirement (8); however, gender equality in the Netherlands was already “a deeply embedded, cultural and institutional norm” (6, 7) before the adoption of gender mainstreaming by the EU. The Netherlands is often cited in other EU member country bicycle policy papers as an example of successful bicycle policy implementation because of the high bicycling rates, accessibility to all users (men, women, youth, elderly), safety, and extensive bicycle infrastructure as well as other factors (2, 4, 45). Furthermore, the roughly equal number of male and female bicyclists in the Netherlands meant that the public input into the BMP development process had a fairly equal representation of male and female concerns. The current national mobility management plan and municipal plans would be under EU gender mainstreaming guidelines (11).

As hoped for, by the time the BMP was completed, many of the communities in the Netherlands had developed strong bicycling cultures. It is believed that the main value of the BMP was that it provided a clear vision of Dutch bicycling policy and backed up this vision with dedicated bicycle infrastructure funding (2). Bicycling is viewed as an integral part of the Dutch transportation system and current national bicycling policies are now managed as part of the mobility management plan (2).

Most Dutch bicycle planning is now the responsibility of the municipalities, as it was believed that bicycling policies and planning could be better managed at the community level because of the nature of most bicycle trips: usually short distances are traveled. Bicycling rates in Dutch cities differ depending on municipal planning policies and implementation (2, 46).

As Dutch bicycle policies have matured, so has the focus; in the 1970s, the focus was mainly on traffic safety and then on creating complete bicycle path networks; now the focus is on making bicycling more competitive in relation to vehicular travel (5) and on coordinating bicycle access to public transit.

### COMPARISON OF NETHERLANDS AND U.S. BICYCLE FACILITY ASSESSMENT MEASURES

The paper now addresses the valuations or measures of bicycle transportation facilities and discusses the association of U.S. gender-neutral versus the Netherlands’ gender-sensitive measures of bicycling rates. For this discussion,

gender-sensitive measures are defined as measures that (a) use a population sample that is representative of community demographics by gender, age, and abilities and (b) are based on research with a “people-centered perspective that starts with an analysis of the basic household mobility needs” (11).

This definition takes into account both how the measures are developed and how they are implemented. A sample representative of the population that will have access to the bicycle infrastructure is required to develop measures that will be sensitive to all potential infrastructure user needs. A people-centered perspective focuses on connectivity—how the network infrastructure supports all users by providing routes that allow them to bicycle to their destinations in a safe, comfortable, and timely manner. Measures developed from a people-centered perspective would be able to take into account the context in which the infrastructure operates and measure the impact on the social and environmental systems with which it interacts.

The United States applies bicycle infrastructure measures that use the same level-of-service (LOS) rating terms traditionally used to describe how well the road supports vehicular traffic movement. Although the *Highway Capacity Manual*, 2000 edition (47), does not provide standardized LOS criteria for bicycles (48), two indices commonly used by state and U.S. transportation and land planning organizations are the bicycle compatibility index (BCI) (14) and the bicycle LOS index (BLOS) (13). Both measures quantify how suitable a road is for bicycling by evaluating specific roadway geometries and traffic conditions. Roadways with a better (lower) score are generally safer for bicyclists. These measures are used to evaluate existing infrastructure, compare alternatives, and guide improvements to infrastructure design (49).

### Design Bicyclist Categories

Bicycle infrastructure design in the United States is based on the “design bicyclist categories,” which categorize

bicyclists not by their transport needs but by how comfortable they are operating in vehicular traffic. The AASHTO 1999 *Guide for the Development of Bicycle Facilities* defines the three categories of bicyclists (“design bicyclist categories”) as advanced, basic, and children (50). Group A advanced bicyclists are experienced riders who operate under most traffic conditions; Group B basic bicyclists are casual or new adult and teenage riders who are less confident of their ability to operate in traffic without specific provisions for bicycles; and Group C are children (12).

From a gendered viewpoint, a number of studies, as discussed earlier, indicate that female cyclists have different perceptions of safety and different trip needs than male cyclists, regardless of whether they are advanced or less experienced cyclists (1, 20, 24, 29). As summarized in Table 1, this gender difference in risk perception could help explain the small percentage of advanced and experienced women bicyclists observed in studies based on FHWA design bicyclist categories (51) and the BCI index study, which also defines their sample partitioning at least in part by how comfortably bicyclists operate in motor traffic (12–14).

Unlike the complete street or comprehensive street design standards, which advocate all streets being made accessible to everyone within the community (44), FHWA guidelines based on the design bicyclist categories create a two-tiered approach to bicycle infrastructure design in which all streets are “bicycle friendly” with wide curb lanes and paved shoulders to allow bicycles and vehicles to share the road; this meets the requirements for Category A advanced bicyclists. Category B and C bicyclists are served by low-speed residential roads and designated bicycle facilities such as “bike lanes, separate bike paths, or side street bicycle routes” built along key traffic corridors (12). This tiered approach could lead to unequal access to community services as emphasis of design for safety for Category B and C cyclist routes could take precedence over convenience to services that Category A bicyclists would have using on-street routes.

TABLE 1 Summary of Comparison of Design Bicyclist Categories by Gender

	Group A: Advanced Cyclist	Group B: Basic Cyclist	Group C: Children
AASHTO definition	Experienced riders who operate under most traffic conditions	Casual or new adult and teenage riders who are less confident of their ability to operate in traffic without specific provisions for bicycles	Children
Male preference	Even if uncomfortable will more often ride in traffic than women (20)	Routes designed for Group B cyclists could prioritize safety of riders over route convenience to community services	Parental concerns about route safety influence decision about whether children ride
Female preference	Often prefer more separation from traffic, which leads to being categorized as a Group B cyclist		

## Bicycle Compatibility Index

The BCI measures the comfort levels of adult bicyclists on the basis of “observed geometric and comfort levels of bicyclists on a variety of roadways” (14). The study that developed the BCI used a study participant group ranging in age from 19 to 74 years, had a mean age of 36 years, and was 60% male. The methodology used to develop this index required participants to watch a series of video clips showing various road conditions. After viewing each video, participants rated the roadways on a 6-point scale with respect to how comfortable they would be sharing the road with vehicles depending on traffic volume, traffic speed, road width, and overall comfort rating (14). These comfort levels were then translated into bicycle LOSs, which could be used to evaluate how well a roadway could accommodate both motorists and bicyclists. The LOS ranged from LOS A or an index of less than or equal to 1.5 (roadway extremely compatible for average adult bicyclist) to LOS F or an index of greater than or equal to 5.3 (extremely uncomfortable for the average adult bicyclist).

In the BCI study, participants were stratified into three groups depending on how much they bicycled and what bicycle facilities they preferred. The participants who stated they were “comfortable riding under most conditions” (60% of the total sample) tended to be male, rode more on major streets, and rode more miles a week than those who stated they were not comfortable. The three groups were experienced commuter ( $n = 79$ , 67% male, mean age = 34 years), experienced recreational ( $n = 78$ , 59% male, mean age = 36 years), and casual recreational ( $n = 34$ , 41% male, mean age = 36 years). Separate BCI models were run for each category and casual recreational bicyclists were found to have a significantly higher comfort rating (i.e., they are less comfortable) than the experienced commuter or experienced recreational bicyclists (14). The model used in real-world applications is the combined model or “average bicyclist” model, although the BCI model is not recommended for children and LOS C is recommended if primarily casual recreational bicyclists will be using the facility.

There is no explicit analysis of gender differences, which is a weakness of the study, as the groups were stratified along criteria that differ by gender, in particular “types of facility used”; studies have found that women bicyclists of all experience levels tend to prefer more separation from traffic than men (1, 20, 28, 30, 50). Second, the number of participants (60%) who stated that they were comfortable riding under most conditions is not representative of the general population. By design bicyclist criteria, this 60% of the sample would be defined as Group A advanced bicyclists, but according to the Bicycle Federation of America only 5% of American bicyclists are advanced (12).

Participants in the BCI study evaluated videos of road segments; they never actually rode a bicycle on the segment, which brings up concerns about whether they would have rated the road segment differently if they had bicycled on it. Second, the roads were segments shown out of context of the rest of the community’s transport network. The BCI measure reflects the current focus of U.S. bicycle policies: to improve the safety of bicycling without taking into account the larger network that the section of infrastructure being assessed exists in physically or socially.

## BLOS Index

BLOS was developed as an LOS model for U.S. metropolitan areas. The study used a real-time 17-mi course consisting of 30 road segments that represented as many road and traffic conditions and land uses as possible. The event was held over one weekend with 150 participants who bicycled the course and rated the road segments on a comfort level with a 6-point scale similar to the BCI scale of LOS A (most comfortable) to LOS F (least comfortable). The four parameters that most influenced participant ratings were shoulder width, traffic volume, pavement condition, and percentage of heavy vehicle volume (13).

The sample used in the BLOS study did not fairly represent the general population as most participants were club cyclists who were Category A advanced bicyclists (12), which would make the “average” bicyclist in this study more experienced than the general population. There was an almost equal split by gender ( $n = 68$  females,  $n = 77$  males), with no significant difference in comfort scores by gender (3.33 vs. 3.17, respectively). This could be attributed partly to the high percentage of experienced club cyclists of both genders who took part in the survey.

In contrast to the BCI study, the participants did bicycle the roads they were rating, which gives a more realistic riding experience than observing a video of the road. The road course they were rating was chosen to represent a variety of road and traffic conditions but again did not take into account the community context of the network.

## Dutch Cycle Balance: Quick Scan Indicator for Cycling Infrastructure

The Dutch benchmarking process called the cycle balance was developed after the BMP was completed in the late 1990s to evaluate local community bicycle policy results, policy effects, and policy process (36) that had developed due to BMP programs. When the process was

completed in 2002, almost half of all Dutch cyclists had been covered: 115 towns had been surveyed, including all towns with more than 100,000 inhabitants (36).

The cycle balance surveys were administered by Dutch Cyclists' Union (Fietzersbond) volunteers within their communities. Four surveys were used to assess 10 dimensions that reflect local bicyclist conditions: directness of routes, comfort (obstructions), comfort (road surface), attractiveness, competitiveness compared with the car, bicycle use, road safety of bicyclists, urban density, bicyclists' satisfaction, and bicycling policy on paper. The surveys consisted of a survey of the community's cycling policy filled out by the town's administration, a survey assessing bicyclists' satisfaction with the local bicycle infrastructure, a survey of national data on local bicycling conditions, and the quick scan indicator for cycling infrastructure (QSIF), which most closely resembles the American BCI and BLOS bicycle measures.

The QSIF used three measurement instruments: a measure bike, a video camera on a second bicycle, and a car. The measure bike digitally measured per second distance, vibration, noise, speed, and elapsed time (5), while the video camera recorded the route, and the car was driven on as much of the same route as possible for comparison of travel time and distance by car to the same destination.

Five bicycle infrastructure requirements were measured: coherence, attractiveness, directness, safety, and comfort (5), with the main emphasis on directness and comfort. The QSIF criteria for directness are average speed, delay, devious distance, and travel time by bike versus car; the criteria for comfort are vibration, traffic congestion, and number of stops (5). The QSIF measures are much more extensive than the BCI measures of traffic volume, traffic speed, road width, and overall comfort rating (14) and the BLOS measures of shoulder width, traffic volume, pavement condition, and percentage of heavy vehicle volume (13). Unlike the BCI and BLOS measures, which were derived from the study participant ratings of the road segments, the QSIF measures were derived from the readings of the measure bike sensors and the video tapings of the second bicycle. These measure results could then be com-

pared with the surveyed perceptions of the community on local bicycling conditions to see how well community perceptions correlated to QSIF results (5).

The QSIF assessed selected routes from randomly chosen houses in the community to popular cyclists' destinations in an effort to represent how bicyclists travel about their community (36). As summarized in Table 2, this is in contrast to the BCI study, which had participants assess videos of isolated road segments (14) and the BLOS study, which had bicyclists tour a route that was set up to test as many road and land use conditions as possible without taking into account whether the route characterized how bicyclists traveled around their community (13).

Finally, to benchmark the local bicycling conditions, QSIF survey results for each city were compared with results from the other cities and with the standards that had been developed for bicycling infrastructure, so that cities could understand the weak and strong aspects of their bicycle policies (5, 36).

Unlike the BCI and BLOS indices, the QSIF survey in conjunction with the other three surveys of the Dutch Cycle Balance survey set satisfies the previously discussed definition of gender sensitivity by using a survey sample representative of community demographics. Second, by using a combination of surveys, the Dutch Cycle Balance not only rates the condition of the roads and bicycle lanes and paths but does so within the community context in which the infrastructure is used.

## RECOMMENDATIONS AND CONCLUSIONS

Combined transportation and land use planning approaches to multimodal transportation planning, such as complete street movement, most closely approach the Netherland's holistic approach to bicycle policy and infrastructure design. Unless gender-sensitive indices are available to assess bicycle infrastructure, however, even the complete street movement, by not taking gender differences in bicycle behavior into account, is not recognizing the needs of all transportation network users.

TABLE 2 Summary of Evaluation of Bicycle Infrastructure Measures

Measure	Representative Sample	Household-Centered
BCI	<ul style="list-style-type: none"> <li>• 60% male, 40% female</li> <li>• 60% self-identified as experienced</li> <li>• Measures based on participant rating</li> </ul>	<ul style="list-style-type: none"> <li>• Video segments of roads taken out of context of network infrastructure</li> <li>• Analyzes road segments in isolation from household origin</li> </ul>
BLOS	<ul style="list-style-type: none"> <li>• 50% male, 50% female</li> <li>• Mostly experienced bicyclists (cycling club members)</li> <li>• Measures based on participant rating</li> </ul>	<ul style="list-style-type: none"> <li>• 17-mile route of 30 road segments representing as many road and traffic conditions and land uses as possible</li> <li>• Segments out of context of infrastructure network</li> <li>• Analyzes road segments in isolation from household origin</li> </ul>
QSIF	<ul style="list-style-type: none"> <li>• Quantitative measure of infrastructure done on two bicycles: measures collected through sensor input and video taping</li> </ul>	<ul style="list-style-type: none"> <li>• Network context emphasized: analyzes routes starting from randomly selected homes to popular bicyclist destinations</li> </ul>

In the United States, indices that measure comfort and practical needs and the community context in which the transportation infrastructure is used by all bicyclists would help state and regional transportation planners evaluate how successful they are in meeting the unique needs of all bicycle users. Neither the BCI nor BLOS meets these requirements, as the narrow range of measures they survey does not adequately assess whether bicycle infrastructure is meeting the comfort or practical needs of all users. Second, the sample demographics of both studies are not representative of all bicyclists; there is male and experienced sample bias in the BCI study and experienced bicyclist sample bias in the BLOS study (13, 14). The QSIF survey objectively measures road conditions of household-centered routes and then presents the quantitative findings in conjunction with the other three Cycle Balance surveys' results to give a person-centered perspective of the community infrastructure being assessed.

The following recommendations, taken from the Dutch BMP model and gender mainstreaming literature are presented in the belief that they will help U.S. bicycle infrastructure designers create bicycle networks that safely and effectively serve the needs of all community members:

- Create a national bicycle policy that explicitly recognizes that bicycling is experienced differently by bicyclists of different ages and abilities as well as by gender.
- Because bicycle trips are usually short distances, it is best to leave control of community bicycle policies with local governments.
- Use the national bicycle policy in conjunction with federal funding to encourage and give focus to the development of local bicycle policies.
- Create new measures for infrastructure assessment that are based on community demographics, not on the gender-neutral "design bicyclist."
- Conduct comprehensive bicycle surveys that subjectively and objectively measure the quality of community bicycle infrastructure networks and are based on basic household mobility needs instead of the vehicular movement model.

The imbalance of U.S. bicycle trip rates by gender can be viewed as an indicator that American bicycle infrastructure does not serve the needs of all bicyclists, but until indices take into account factors that contribute to this imbalance, it will be difficult to identify possible ways to address this issue. One approach is to revise the index models currently used to assess U.S. bicycle infrastructure to be gender sensitive. The Dutch Cycle Balance benchmarking model with its dedication to improving bicycling conditions for all Dutch citizens is recommended as a model the U.S. could follow to help

develop the most "direct, attractive, comfortable and safe routes possible within a coherent cycling network" (36) for both male and female bicycle riders.

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# Gender Mainstreaming in Transportation

## Impact of Management Control

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In international surveys, Sweden is considered to be the *locus classicus* for gender mainstreaming. At a macro level, the picture is clear, as government directives include specific goals for gender equality and the expectation that public agencies will mainstream gender into their core business. At a micro level, the situation is more complex. Formal governance meets with gendered norms and cultures that are equally strong, but informal, driving forces among civil servants. The question raised here is how the management control system functions under the pressure of mainstreaming gender. With an interpretive approach, research has been conducted to disclose constructions that tend to enable or to hamper gender equality in the practice of management control at a micro level. The evidence stems from a case study of the Swedish Road Administration and the Swedish National Rail Administration. Interviews, observations of meetings, and close reading of documents furnish this paper with data covering the years 2002–2007 with regard to a policy goal of a gender-equal transport system. Applying a gender perspective together with a sociological institutional perspective makes gendered rules, norms, and culture visible. The results show how management control is involved in integration of gender by assimilation and by decoupling, obstructing transformative gender mainstreaming. The administration is busy keeping up the appearance of fulfilling the goal, legitimizing its activities by reporting relative fulfillment in accordance with the rules of the control system, regardless of the relevance connected to the norms of gender equality. The management control system perpetuates a culture in which reliability lies in measurability; therefore, the goal of gender

equality results in a quantitative perspective on women and men instead of a qualitative gender perspective on the transport system.

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**T**ransportation is equally important to men and women, but a majority of men control the management of transport systems. The Swedish government recognized this as a problem, and a specific policy goal of a gender-equal transport system was introduced into governance of the national transport agencies in 2002<sup>1</sup>:

A transport system that is managed by and serves the interests of women and men equally: The transport system shall be designed to meet the transport requirements of both men and women. Women and men shall be given equal opportunities to influence introduction, design and administration, and their assessments shall be afforded the same importance.

The goal is equal division of power and influence between women and men in the transportation sector

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<sup>1</sup> The objective of the Swedish government's transport policy is to ensure that all parts of Sweden are provided with efficient transport solutions. This is formulated as an overall transport policy goal supplemented by five subgoals embracing accessibility, high transport quality, safety, sustainable environment, and positive regional development. The latest added sixth subgoal is that of a gender-equal transport system.

(author's translation of the Swedish formulation of the sixth transport policy subgoal: "a gender-equal transport system" in the annual appropriation directives issued by central government to the Road and Rail Administrations; [www.esv.se](http://www.esv.se)).

This goal is in line with gender mainstreaming, a strategy implying that a gender perspective and attention to gender equality are present in all decision making and performance in any kind of core business. In this case, it is applied to planning, implementing, and monitoring the transport sector.

Management by objectives is the management control system in use in the Swedish government. State agencies receive lump sums of financial resources to be used at their discretion with claims from the state ministries of reaching certain policy goals. The policy goal stated above is in line with the normal management control system, a system that delegates responsibility to each agency to turn policies decided upon by central government into real-life experiences for citizens (Holmblad Brunsson 2002).

Gender mainstreaming has been known for several years, as it was the strategy decided upon in 1995 at the United Nations World Conference on Women in Beijing. Sweden is a country that is known for its status of gender equality and government promotion of gender mainstreaming.

The first, with Sweden as the locus classicus, can be styled an "integrated approach." Gender mainstreaming is employed in a global fashion, whereby responsibility for gender equality is extended to most, if not all, actors involved in public policy and is embedded across institutions in society. (Daly 2005, p. 438)

The description of Sweden as the locus classicus for gender mainstreaming (Daly 2005) is based on results from international surveys held at a macro level, indicating government actions for gender equality. To reveal more about this favorable picture, research on a micro level is required.

By including the sixth transport policy subgoal quoted above, gender mainstreaming is successfully effected at the macro level. The challenge is at the micro level: to mainstream gender equality into the core business of transport agencies.

Research with a gender perspective on the transport system (Eriksson and Garvill 2003; Friberg et al. 2004; Polk 2001, 2004; Transek 2006) discusses the gender blind spots of transport systems, giving evidence of, for example, unequal accessibility for women and men and safety arrangements that need to be adjusted from a standard male body and mind toward an inclusion of female needs. Accordingly, the transport system plays an active

role in regional development that is strongly connected to labor markets, to which gender aspects are vital. The above research shows that there are several failings to gender equality within the transport sector and that the transport system is a male construction, a deficiency that a gender mainstreamed management of the transport system is supposed to change.

Benschop and Verloo (2007) stated that there is an abundance of propaganda about gender mainstreaming written by advocates of this strategy. The rhetoric on progress impedes serious discussions on why they call for academic analyses and reflections. Parker (2008) argued that people need to know much more about the gendered dimensions of managers' and accountants' involvement in strategic planning and decisions: the technician and quantitative terms of management control "embody gendered dimensions which to date have been opaque to both research and practitioner communities" (Parker 2008, p. 627).

The research question is formulated as follows: How is the political goal of a gender-equal transport system, which is congruent with gender mainstreaming on a macro level, treated within the management control systems of the agencies concerned within the transport sector on a micro level?

## METHOD

A research project, designed as a case study (Yin 2006) within the frame of what Van de Ven and Johnson (2006) called an engaged scholarship in which "researchers and practitioners coproduce knowledge that can advance theory and practice in a given domain" (Van de Ven and Johnson 2006, p. 803), furnishes this paper with empirical findings from the Swedish Road Administration and the Swedish National Rail Administration. The two agencies took part in a research program at the School of Business, Stockholm University, to examine the development of performance management practices in Swedish central government. The research project was longitudinal, conducting 70 interviews over 3 years, with observations from about 30 meetings and analyses of official and unofficial archival data. It focused on how management control is shaped under the pressure of integrating gender (Wittbom 2009).

Interviewees were civil servants: some were responsible for managing the gender-equal transport system, and some were accountants, business controllers, and project leaders for investments in the national road and rail transport systems. The observation stems from both internal and open meetings with regard to gender equality in the transport sector: open meetings for development of the transport system and internal meetings for strategic planning of the management control system.

Transcribed interviews, notes from observations, and a close reading of steering documents and accounting reports furnish this paper with data covering the years 2002–2007 with regard to the policy goal of gender-equal transport systems.

### THEORETICAL FRAMEWORK OF A FEMINIST APPROACH TO MANAGEMENT CONTROL

The empirical findings are discussed with an interpretive approach of social constructions with feministic theorizing (Bacchi 1999–2008; Minnich 2005) aiming for the transformation of existing knowledge and new gender mainstreamed knowledge concerning management control and accounting (Haynes 2008a). Kirkham (1992) translated Walby's (1988) discussion of gender awareness in four steps into the accountancy field, which provides a fruitful analytic concept for gender mainstreaming in a situated management control system—in this case, public agencies in the transport sector. The first step is gender blind, described in research without any gender analysis at all. An ultimate goal of gender equality can be formulated as conditions of power in which gender turns out to be a neutral factor. Gender awareness is important in this respect, as gender neutrality is an ambiguous concept. In general, many phenomena tend to be regarded as gender neutral (i.e., sex and gender do not matter). But behind apprehensions of gender neutrality, one often finds gender blindness (Collinson and Hearn 1994; Hearn 2000)—that is, a lack of gender awareness.

Historically, with a growing feminist movement, questions were raised in several research fields about what kind of knowledge was missing because of gender blindness. This development constitutes the second step (Kirkham 1992) in which critical questions were asked, calling for gender awareness. The response came with the third step where considerable feminist research was conducted, mainly by women concentrating on the conditions of women and femininity. They found that powerful male norms were taken for granted. In the fourth step, one finds gender mainstreaming; gender is present in the analysis, challenging prevailing norms with discussions of gendered power relations. The discussions cover the experiences of women as well as of men, masculinities, femininities, and nonheterosexuals, thus opening up for transformative strategies (Butler 1990; Rosenberg 2002). With a gender perspective from the fourth step, the policy goal of a gender-equal transport system will be discussed confronting a mainstream—gender blind—management control research approach. The goal talks about gender-equal opportunities and gender-equal division of power and influence; the theories presented below will help one understand how the control system in use relates to gender sensitivity.

Broadbent (1995, 1998) entered the fourth step of gender awareness in explaining accounting as a metaphor for reality, representing a particular set of values that result in visibilities and invisibilities. Accounting practice in Europe is normatively based on the main principle of a “true and fair view” (International Accounting Standards Board, <http://www.ifrs.org/Home.htm>). This principle has many interpretations, and from a gender perspective it is crucial. As Broadbent (1995) pointed out, only a reduced image of phenomena is made visible in accounting. From feminist accounting research, it is also found that management control systems are constructed to support a technocratic male norm (Haynes 2008b; Hines 1992; Parker 2008; Shearer and Arrington 1993), which implies no gender sensitivity and consequently problems in implementing gender mainstreaming.

The awareness of how gender is constructed within organizations is vital to disclose gender orders (Connell 2002) and prevailing gendered norms (Kanter 1977). Acker (1990, 1992) and Connell (2002) provided a model for examining gendered structures: (a) division of men and women in horizontal and vertical dimensions by mapping the presence of women and men; (b) symbols and discourses that construct gender; (c) interactions between women and men, women and women, men and men, how alliances and exclusions are created, enacting dominance and subordination; and (d) individual identity and personal thoughts of fitting into a certain context based on the three previous aspects. Altogether, these characteristics give a picture of gendered power relations, revealing the organizational logic in formal and informal dimensions.

Only the first four characteristics above relate directly to statistics. Mapping the presence of men and women in the organization provides the basic data to discover the possible existence of organizational glass ceilings and glass walls—that is, gendered segregation resulting in professional areas or hierarchical levels to which only one sex is welcome. To understand why such segregation occurs, organizational processes have to be illuminated with gender awareness (Connell 2002). If the agencies' performances toward fulfilling the goal of a gender-equal transport system are to be evaluated, gendered orders and norms must be followed up by the management control system.

Gender equality is often handled out of a perspective of “gender as a variable,” treating women and men as separate categories (Alvesson and Billing 1997). Such division is problematic, as gender mainstreaming focuses on gendered power relations and not on men and women as separate groups (Squires 2007). The “doing gender” perspective constantly redefines gendered relations (West and Zimmerman 1987), and symbols, discourses, interactions, and the shaping of individual identity are all aspects of a more diffuse and discursive type that is impossible to

represent in figures (Martin 1994). To understand these phenomena, a more narrative approach in accounting is of interest (Bjurklo 2008; Ely and Meyerson 2000), an approach that mainstream control systems prohibit (Bromiley and Euske 1986; Hines 1992).

Research has shown that women who enter male organizations tend to assimilate into the male norms to empower themselves. If they do not accept the male culture, they tend to be placed in powerless positions (Gherardi and Poggio 2001). Saidel and Loscocco (2005) pointed out that, when it comes to priorities, the gender that is embedded in the context is more important than the gender of the decision makers. This means that the gendered context, gendered relationships, and gender on an individual basis are important to illuminate (Acker 1992; Connell 2002). This knowledge is vital when analyzing how the management control system of the studied agencies treat the goal of gender-equal transport systems. It means that it is not relevant to count the sex of the decisions makers, which is a relatively easy task for any control system. Instead, the control system shall register facts of contexts and relationships of a qualitative nature.

From Squires' (2005) theorizing of gender mainstreaming, three main strategies can be modeled. One is the inclusion of women in the prevailing (male) norm. Such processes of assimilation and normalization come from the perspective of sameness feminism, supporting a strategy based on understanding gender differences as obstacles that are being eliminated by women adapting to an unchallenged male norm.

Another strategy comes from the difference feminist perspective, appreciating femininity as a value to be preserved. It leads to an agenda-setting model with the aim of recognizing marginalized groups. However, from a gender mainstreaming perspective, the outcome is usually unsuccessful within organizations. The tendency is that the core business has an overwhelming power that places all movements for gender-equal rights and feminist thought in separate, decoupled processes. The presence of gender-equality issues is accepted, but the strategy is to never let them influence core business processes.

The third strategy can be seen as a more advanced form of difference feminism and even a form of "queer theory thinking" (Butler 1990), as it challenges the prevailing norm and calls for a transformation. It requires gender awareness and open minds from all actors in order to have negotiations ending up in new norms, where gender equality is normalized within the core business process, inhibiting reconstructions of inequalities. Squires (2005, 2007) pointed out that gender mainstreaming as a strategy will result in such a transformation into a gender-equal norm. In this case, with the sixth subgoal of a gender-equal transport system, it means that the values, needs, and reflected experiences of both women and men

will permeate every aspect of the transport system. As a consequence, a critical perspective on functioning of the management control system in relation to transformation, decoupling, and assimilation is called for.

To gender mainstream, gendered norms must be questioned. One way to scrutinize norms is to view them as deeply rooted habits of thought, as institutions. Within sociological institutional theory, Scott (2001) conceptualized institutions as being carried by three pillars: regulative, normative, and cultural cognitive. Rules constitute what is allowed by regulations, norms are how it should be done in accordance with professional values, and culture indicates how it is being done in a societal context. Rules and norms are external pressures, while culture-cognitive aspects of institutions can be seen as shared social constructions of meaning. Together the three pillars form a stable foundation for meanings that are taken for granted within institutions.

Dambrin et al. (2007) pointed out that institutional change is not complete until an idea has been internalized in practice by members of an organization. This implies that, when institutionalization is effected, all three institutional pillars (Scott 2001) are congruent at a micro level. In the case study presented here, research is conducted to disclose whether the control system is gender sensitive and has the ability to gender mainstream the core business—that is, to determine whether gender equalities and inequalities are being evaluated through critical gender glasses within rules, norms, and culture. The government has formulated a goal, a rule to follow, but one question is how agencies interpret this rule within their norms and cultures.

Gender-equality efforts tend to be met with resistance (Pincus 2002; Squires 2007). A common obstacle is that the normal organizational processes are seldom used (Acker 2000). The activities conducted specifically for gender equality are often separated from the core business. The resistance can be both active and passive, often ending up steering questions of gender equality away from the decisions made in relation to the core business, but still kept in practice on a legitimizing level (Meyerson and Kolb 2000; Meyer and Rowan 1977; Pincus 2002). In this case, however, the decision to formulate gender equality as a transport policy subgoal is to integrate gender through the normal tool of government management control systems. Consequently, this appears to be an opportunity to study the integration of gender equality in a favorable environment.

## MANAGEMENT CONTROL FOR A GENDER-EQUAL TRANSPORT SYSTEM

The Swedish government and its ministries issue annual appropriation directives to the agencies, setting the goals

to be attained within a financial budget. The directives also give instructions on how agencies should report their performance (Holmblad Brunsson 2002). The goal of a gender-equal transport system (as quoted above) should be reported:

An analysis of women's and men's utilization of the transport system shall be reported, including their possibilities to influence on the development and management of the transport system with respect to i.e. travel patterns, time spent on travels, transportation modes and travel costs, accessibility to accurate travel information, number of killed and seriously injured persons and increased mobility between local labor markets divided between women and men.

The instructions quoted above are mainly qualitative, with a narrative approach (Bjurklo 2008). The agencies shall give their story of a gender-equal transport system and of how their work is progressing. The second part of the sixth subgoal ("The goal is equal division of power and influence between women and men in the transportation sector") shall be accounted for by

indicating the representation of women and men in external groups taking decisions about the transport system.

The government, in response to the notion of gendered power relations, chose to call for quantitative terms, using the problematic "gender as a variable" concept (Alvesson and Billing 1997). From a gender perspective, this is disputable, as a qualitative approach is more valid than a quantitative approach (Acker 1990; Connell 2002; Squires 2007).

The director generals make agreements for annual performances with each regional manager in the agencies. These agreements are concise, dominated by regionally adapted balanced scorecards (Kaplan and Norton 1996), specifying measures and targets emanating from the visions, missions, and strategic goals that are based on the government transport policy goals. The balanced scorecard model was adopted by the agencies to find systematic ways to make their visions and strategies concrete and measurable with the purpose of concentrating on performance. This is stated in internal documents, and several interviewees responded with a firm conviction of the need for a technical, systematic approach to management control.

"The railway is a natural part of the transportation of people and goods" and "we make the good travel possible" are the visions formulated by management. Together with the mission "to provide individuals and the business community with good conditions for trans-

port and travel," these formulations visualize an ongoing reorientation in the agencies. They try to progress from being production oriented to customer oriented, which requires a quest for lateral management processes, giving priority to customer satisfaction instead of vertical, hierarchical processes of management (Modell and Wiesel 2009; Wiesel 2008).

Four or five perspectives are included in the studied balanced scorecards. One focuses on the performance of meeting with the requirements of the principal—the government. Another covers customer needs. A third perspective concentrates on creating effective internal work methods. Although money is considered to be a mere means necessary for reaching political goals in public administration, one scorecard includes financial goals in this internal perspective. In that case, a special staff perspective is added, stating a strategy of creating commitment and securing competence. The last perspective covers development of the core business.

In each perspective, strategic goals are formulated followed by success factors, performance measures, and targets leading to activity plans (Figure 1).

All performance targets are designed strictly from the so-called SMART criteria—making them specific, measurable, accepted, realistic, and time set. Interviewees confirm that the measurable and realistic dimensions are unconditional. Measurability implies a translation into quantitative digits and realistic signifies that the target must be reachable during the measured period. Only critical success factors that can be transformed into measurable performance indicators are allowed on the scorecard model. If a success factor is strategically important but not measurable, it is not included on the scorecard.

In the first years, scorecards include targets of even representation of women and men in various decisions groups. Action plans call for a counting of male and female bodies in this respect. A change in logic can later be traced. A target of how many persons on the staff have attended education on gender issues is introduced, together with targets on a number of activities aimed at the goal of a gender-equal transport system. The production of a handbook on how project leaders can work with a gender-equal transport system is also presented as a scorecard target. Throughout the research period, targets related to the sixth policy subgoal of a gender-equal transport system are entered into the principal, internal, and development perspectives. This development can be interpreted as positive from a political gender mainstreaming perspective. The customer perspective is never used for the purpose of promoting gender equality; this is noteworthy, as there is an ongoing reorientation within the agencies from a production- and output-oriented control to a more customer-oriented business and outcome-focused performance control. But the top management of the

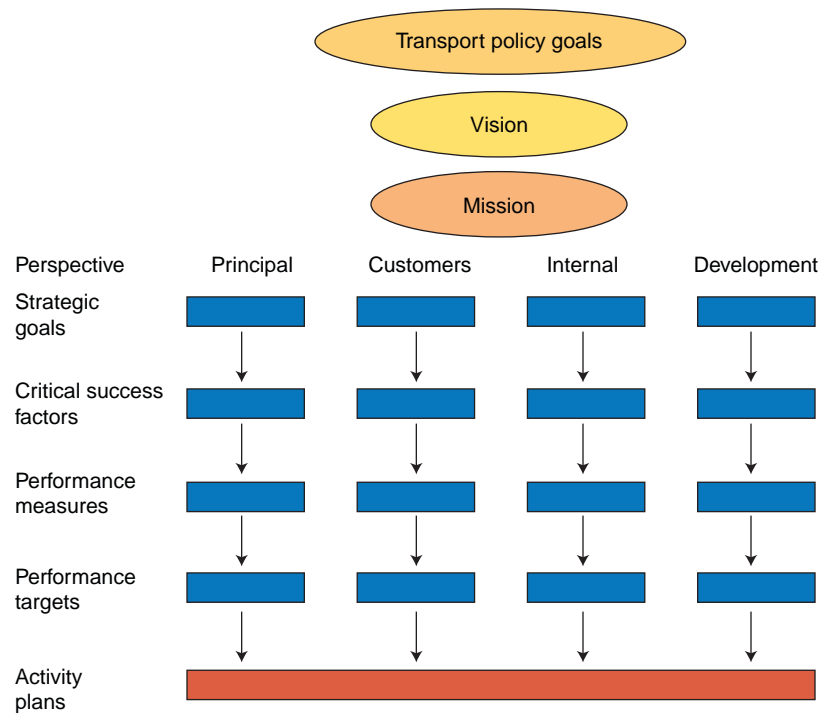


FIGURE 1 Balanced scorecard model related to this case study.

agencies did not have the capacity to integrate the goal of a gender-equal transport system in developing management control of customer orientation. Such development points at a marginalization and decoupling of gender issues in transportation (Squires 2005, 2007).

From a gender perspective, the SMART criteria constitute major problems as they reduce the performance to having done something that can be labeled promotion of gender equality but do not include any qualitative evaluation. New insights make no difference in constructing transport systems and might just as well be left outside the core business. Gender mainstreaming can be marginalized instead of engaged in a transformative process (Squires 2007).

There were several signs of marginalization of gender aspects. The following quote from an interview is characteristic:

Interviewer: You said that the planning had been gender neutral. What do you mean by that?

– Yes, but we didn't wish to divide people into women and men. We plan for what is good for people. Overall, it's not until now that such a discussion is starting, about possible differences in needs and experiences of security [in the transport system] between women and men. Maybe we have to look into that. (Informant VV8b, Swedish Road Administration)

The above quote shows that gender neutrality is understood by the respondent in a gender-blind way, disclosing a point of view that there are no gender aspects worth relating to (Collinson and Hearn 1996; Hearn 2000).

Another example of lack of commitment to gender equality within the core business is the minimal resources—time and money—spent on managing the gender-equal transport system goal. The human resources staff, who had experience with gender-equality policies in general, were not included in the work. In one agency, the first manager made responsible for the gender-equal transport system did not have a budget. Some civil servants had the responsibility to do something about this goal, but they met with resistance:

It's hard to get on speaking terms, difficult to get through. To whom should you talk, whom should you approach with your ideas? Things are not easy. (Informant VV10a, Swedish Road Administration)

In another agency, staff quickly managed to conduct seminars to implement knowledge of a gender-equal transport system involving all project leaders in every region throughout the country. However, the resources to follow up on integration of gender aspects in the planning and executing processes were missing.

Case study results from interviews and observations indicate that the technical norms in the agencies created

a strong gendered order that opens career paths only for those employees who assimilate into the prevailing technocratic culture. One example comes from the process of formulating a management tool for customer orientation. In the meetings, female and male civil servants worked together on equal terms. The discussions were vivid and good tempered; everyone listened to one another and reflected on different aspects. But some topics were not welcome. During discussions on how to classify different groups of customers and customers' needs, a woman tried to bring up the question of gender connected to the goal of a gender-equal transport system. But her colleagues (both male and female) counteracted with deep sighs and silence. Gender and gender equality was not an approved topic. The final documents became gender blind. This example gives evidence to the interpretation that gender equality is not institutionalized on a micro level (Dambrin et al. 2007). It can also be interpreted that the glass ceiling is present—not for female bodies but for feminine experiences.

In the first year's reporting back to the ministry on achievements made on a gender-equal transport system, a wish to augment the share of women in decision making was presented. In the following years, agencies reported statistics of even distribution of women and men in different ways.

Out of the total number of meetings with four or more participants, 72 per cent have a representation of not less than two persons of any sex. Out of these meetings, 24 per cent have a representation level of at least 40 per cent of either sex.

Taken together, these assessments indicate that the goal is partly attained. [Swedish Road Administration, Annual Report 2004, p. 29 (author's translation from Swedish)]

It may not be easy for the reader to understand that the above calculations result in a value of 17%. In gender-equality terms, an even distribution between women and men is attained in reaching at least 40% of representation—that is, when no gender is represented by more than 60% or less than 40%. When a goal is considered to be partly attained by having reached even participation at 17% of all meetings, the expectation seems to be devalued because a complete goal fulfillment can be defined only at somewhere around 100%.

The next year statistics are presented indicates that of 200 meetings where women and men were counted, female representation was 30%. A footnote explains that the target was set at 27% (Swedish Road Administration 2005, p. 31). The goal attainment was related to the agency's scorecard target of 27%, which does not correspond to the general notion of gender-equal distri-

bution of representation asking for at least 40%. The same procedure continues the next year. The gender-equal transport system is discussed separately and goal fulfillment is stated for 32% female representation (the target for the year) in the meetings that were registered during the year.

A discussion of the difficulties in measuring goal attainment emerged in the agencies. Management began to appreciate that there was not enough information or knowledge to give a stable base for evaluating goal attainment with regard to gender equality. Reference was made to government policy goals of gender equality in which power relations are the main focus—relations that cannot be measured quantitatively. In this respect, it is worth mentioning that agencies produce two kinds of official annual reports: an annual report on the agency's own performance monitored by accounting rules and annual reports that cover the entire road and rail sectors. The sector reports are optional and there are no specific rules to follow. The Swedish Road Administration quit giving indications on goal attainment on the gender-equal transport system in the sector report once they discovered a lack of evidence but kept them in the annual report in accordance with the SMART criteria. The Swedish Rail Administration did not report on goal attainment in the sector reports. In the annual reports, they always report that they have made some progress but never reached the goal. As one interviewee put it:

We cannot say that the goal is fulfilled and certainly not indicating failure, since that would give the impression that we are not even trying to achieve a gender equal transport system. That's why we indicate "partly attained" every year. (Informant BV20, Swedish Rail Administration)

The quote can be interpreted as a form of legitimization (Meyer and Rowan 1977) that the agency is eager to report something to satisfy the ministry.

In the first meeting with a manager who was responsible for the goal of a gender-equal transport system within the Swedish Road Administration, he stated: "Give me three useful metric indicators of a gender equal transport system!" This turned out to be an obvious request coming from an administration permeated by technocratic thinking relying only on the measurable (Kallinikos 1996).

Another manager, responsible for management control systems in the same agency, stated during a presentation of this research project: "We must keep this goal away from the staff working with human resources in the personnel department, if not it will be labeled as sissy." He explained that the transport system requires a technical and not a humanitarian skill set. This is another statement disclosing the agency's technocratic culture.

A qualitative investigation of what is occurring in the planning process for the transport system is lacking, precluding the evaluation of gender equality. How is the agenda set? What kinds of questions are welcome? Who has the power to decide the relevance and validity of different aspects? How is that power used? These are the types of questions that need to be reflected upon, giving a fair view of the state of gender equality. The agencies' project leaders were satisfied by the mere counting of attendant women and men. The answers from the interviewees to the author's questions of how they use these metric results or what they do about the more or less even representation at the meetings indicated that they were only following orders to do the counting. Any actions, or consequent reactions, promoting gender equality were not on their agenda. This means that they did not deal with questions about whether the agenda let female voices be heard to the same extent as those of men and whether the agenda covered topics that are of equal interest to both sexes. Ignorance of whether the needs experienced by women are taken care of to the same extent as those of men was noted. Such questions on gender were not important to the normal civil servant—woman or man.

In expert-driven activities, such as planning transport systems, attention needs to be paid to the *modus operandi*, whether the project leaders are open to a lateral process together with civil society or remain in top-down planning for civil society (Larsson 2006). The results from the case study indicate that a vertical process with civil servants on top is valid. Lateral customer-oriented processes remain in the early planning stage at some civil servants' desks. More problematic, research results signify that decision makers, regardless of their sex, are not aware of the potentially different viewpoints of men and women. This is in line with the explanations of Saidel and Loscocco (2005) of how the current gendered order determines the actions of the present actors.

## CONCLUDING REMARKS

The percentages of men and women in agencies' accounts say little about the distribution of power. It can be of interest to follow the development of sex distribution quotas over time to disclose gendered forums, glass ceilings, and glass walls. However, the statistics do not reveal which type of integration (assimilation, decoupling, or transformation) is in process and to what extent women—as well as men with feminine values—are allowed (and allow themselves) to contribute with their experience to a transformation of the core business to gender-equal normality. An equal representation of women and men can function as a means of reaching gender equality (Squires 2007), but counting the bodies

of women and men is far from enough for giving a true and fair view of gender equality.

The functioning of management control systems depends on the opinion on stated goals. For those who do not have faith in gender equality, a search for effective means is not meaningful and an instrumental handling of the management control model becomes the main objective. Such a priority is not a problem if the management control system is a gender-neutral model; however, that is not the case. The model clings to the rationalistic idea of facts of reality as represented by figures (Hines 1988). In addition, research shows that gendered institutions or the gendered nature of an agenda is important for the priorities and decisions being made that is independent of whether the persons in charge are women or men (Dwyer and Roberts 2004; Saidel and Loscocco 2005). The transport system is still considered to be a man's world and thus is gender biased and not gender neutral.

Measurability is deeply rooted, and all three institutional pillars (regulative, normative, and cultural cognitive) embody this at the micro level. Both government and agencies have clear instructions for using SMART criteria, which also are supported by the professional norms of engineers and business administrators, creating a culture in which figures constitute facts and trustworthiness. In this case, the criteria turn out not to be smart but misleading.

A critical discussion of gender neutrality is needed when analyzing different logics for effectiveness and efficiency. On the one hand, if goal attainment is prioritized, effectiveness and relevant outcomes are in focus (Figure 2), thus including qualitative dimensions of gendered power relations. On the other hand, if efficiency is of greater interest, measurable output will be seen as relevant, giving misleading sex distribution quotas and numbers of activities a status of achievements (Figure 2). In the mainstream management control system, the question of gender-equal transport systems is on the agenda. However, as the goal is processed through the balanced scorecards within the technocratic norm, gender equality is reduced to figures, thereby becoming imperfect and marginalized as it is stripped of all qualitative characteristics.

Norms based on professional engineering had created a culture in which only the measurable is valid. The previous section of this paper shows that the management control system in use reinforced the quest for measurability. In accordance with the rules, the goal of gender-equal transport systems was translated into measurable targets. The quotas for the presence of women are used as a proof of degree of equality. This means that the vision of gender equality could easily be satisfied by adding a few women but without asking whether something in the ongoing core business needs revision and transformation.



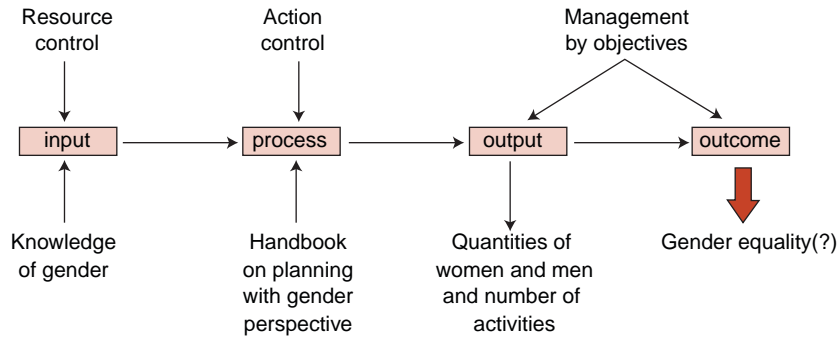


FIGURE 2 Management control for gender equality.

It can be questioned how the outcome can be visualized with the logics of mainstream management control, a logic that calls for specific and measurable targets in search of perfection. Bromiley and Euske (1986) discussed this logic by stating that “It is better to work towards a vague imperfect objective than towards a precise imperfect objective” (p. 318). This statement is based on studied management experiences of huge difficulties in finding precise characteristics to measure and that actually are relevant to measure. In the case of the sixth subgoal of a gender-equal transport system, the objective is considered to be both vague and imperfect when viewed from a technocratic norm. Viewed with a gender perspective, the policy goal is both precise and perfect; it formulates the idea of a process for making a gender-equal transport system. Nobody knows what a gender-equal transport system looks like. The goal is the process, not the outcome. As long as the process is performed with gender awareness, it is not relevant to foresee a specific outcome.

In practice, the agencies have gone beyond the management by objective model by implementing resource control and action control. As presented in the preceding section, managers have concentrated on education to bring in more knowledge about gender, and they have worked on methods described in handbooks for the project leaders to be used in the planning process.

Walby (2005) raised the question of whether gender mainstreaming as a strategy of reaching gender equality and gender equality as a vision can be separated from each other, or if the vision and the strategy can be seen as two dimensions of the same process. This is relevant when analyzing the efforts being made in the transport agencies. So far, management has not had success defining a gender-equal transport system; there is no vision of what it looks like. It is difficult to know whether the goal has been reached, as it is invisible, which makes management by objectives difficult (Figure 2).

This paper treated the transport policy goal as a given success for gender mainstreaming. However, although often used as arguments in promoting gender equality, gender mainstreaming is not a question of seeing women

or femininity as extra resources or of women adding values to the male norm (Squires 2007). The only sustainable argument is equity and fairness that questions the male norm and transforms it into a norm of gender equality (Young 2000). Transformation would mean changing from a technocratic management control system to management by a gender mainstreamed action control of core business processes, promoting a qualitative gender perspective on the transport system instead of a quantitative perspective on women and men.

The agencies seem to have problems finding a way that fits both the sixth transport policy goal and the requirements from the internal management control system. But their priorities are clear. They hold tight to the control system and only vague implications of behavior transformations stemming from gender mainstreaming can be traced. On the contrary, the management control system has proved to have an impact on hampering gender equality.

Normatively, a conclusion can be formulated that to improve the visibility of gender equality the control system needs to be gender mainstreamed and transformed to enable accounts beyond measurement. However, there are no signs of norms or culture that support such a qualitative paradigm. As long as education in gender equality does not bring about internalized (Dambrin et al. 2007) gender awareness, and as long as gender awareness is not combined with action, the break of the male norm to open up for a gender-equal norm cannot take place (Figure 3).

Figure 3 is inspired by the four steps discussed earlier with reference to Walby (1988) and Kirkham (1992) here placed in the perspective of management control for a gender-equal transport system. Gender blindness characterizes the technocratic passion for measurability, a situation that is questioned by the emerging gender awareness. Many of the actions made are marginalized and kept decoupled from the core business, mainly based on the presumption that gender equality is an entirely female affair. A breakthrough that would internalize a gender-equal norm into the core business of the transport agencies is still premature.

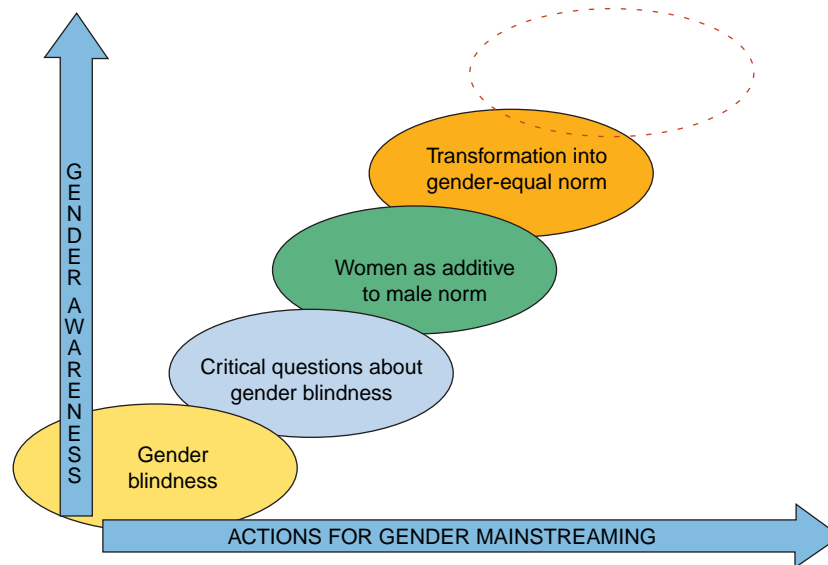


FIGURE 3 Breaking norms for gender equality.

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# Young Women's Transportation and Labor Market Experiences

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This paper examines the transportation and labor market experiences of women at a stage of life that has been called “emerging adulthood,” “young adulthood,” and even “older youth.” Although young children and older individuals have been the focus of transportation policy research, research on mobility and transportation issues facing young adults is much more limited. The main research questions addressed by this paper are (a) how do the transportation and labor market experiences of young women compare with those of young men and (b) what factors are likely to contribute to the transportation experiences of young women? The National Longitudinal Survey of Youth, which is a panel data set of a large sample of respondents since 1979 and continuing until the present, was used. Gender differences were examined in several labor market indicators, including the age at entry into the labor force, the number of jobs, the number of weeks worked per year, and average earnings. The transportation indicators analyzed are perceptions of young women with regard to difficulties associated with transportation, job search distance, and the duration of time they remain carless after entering the labor force. Compared with men, a higher proportion of young women perceived difficulties with their travel and transportation conditions, were likely to restrict their job search geographically to a smaller area, and acquired a vehicle earlier through their husbands or later if single. More research is needed to better understand gender-based mobility policies that apply to a large cross section of young women.

Recent research on the travel needs of children and seniors has highlighted the importance of having transportation policies that are relevant to the varying needs of individuals in different stages of their lives. There is no universal definition of “life stages,” which are socially constructed life stages that are not fixed; instead, life stages have expanded and contracted in length and new ones have emerged in response to broader social changes. Many authors have written about a stage between adolescence and adulthood, variously called “emerging adulthood,” “young adulthood,” and even “older youth,” which plays an important role in an individual's later life (Arnett 2004; Santrock 1999; Shanahan 2000). The objective of this paper is to explore the transportation conditions of women in this life stage by considering their experiences between the ages of 18 and 24 years. Data from the National Longitudinal Survey of Youth 1979 (NLSY79) were used, which is a nationally representative longitudinal data set in the United States, over a moving window of years that extend from 1979 until 1992.

During young adulthood, individuals face several choices and opportunities and experiment with or otherwise establish significant life trajectories concerning work and family. Whereas a part of the published literature has focused on identity explorations, formation of adult identity, and social and cultural growth during this period, other parts have focused on the economic aspects, such as those related to education and the labor market. Almost all U.S. adolescents between 12 and 17 years of age live with one or more parents, are enrolled in school, and are unmarried and childless. In contrast, the lives

of young adults are characterized by diversity. "About one-third of young persons in the United States go off to college after high school, another 40 percent move out of their parental home for independent living and work, and about 10 percent of men and 30 percent of women remain at home until marriage" (Arnett 2004).

It is a "time of extended economic and personal temporariness" (Santrock 1999), marked with moving out from home (Goldscheider and Goldscheider 1987), high school dropout (Sum and Harrington 2003) and graduation from school (Greene 2002), relocation (Brown and Orthner 1990), residency on college and university campuses (Jordyn and Byrd 2003), entry into the labor force and schooling or training concurrently with working (Kerckhoff 2003), frequent job changes (Topel and Ward 1992; Bureau of Labor Statistics 1993), and holding of multiple jobs concurrently (Mishel et al. 2003). Moreover, during young adulthood, individuals are more likely to move into and out of the labor market because of decisions relating to schooling, marital status, childbearing, and other factors (Bureau of Labor Statistics 1993). Researchers have reported that the dynamics of young adulthood—how young adults transition into adulthood—is changing. What was once a sequenced and orderly transition to adulthood to complete one's education, begin career or work, and form a family has lengthened, is more varied, and is generally characterized by instability.

Although young children and older individuals have been the focus of transportation policy research, research on mobility and transportation issues facing young adults is much more limited. Policy and programmatic activities targeted to this stage of the life cycle have been limited as well and isolated from one another. Transportation can be a major barrier for young adults who are pursuing job skills education and training programs because many such programs are given in educational institutions, which can be located far from the home location of needy youth. Many young adults also work part time and are simultaneously enrolled in school or college, requiring them to make complex trip chains.

Young women in the United States have undergone significant changes in their labor market experiences in the last 45 years (Blau 1998; Schrammel 1998). From a historic perspective, in 1963, when the Equal Pay Act was passed, about 36% of women were working, and their average pay was about 58% of men's. This trend has changed over time: by the late 1990s, that difference had changed to about 57% of women being employed and women's average earnings—hourly, weekly, or annual—being 75% of men's. "The convergence of women's and men's earnings among full-time, year-round workers in the 1980s constitute the most significant change in the employment experiences of women in the past four decades" (Spain and Bianchi 1996, p. 194). Cohany and Sok (2007) noted that the most striking feature of wom-

en's labor market gains during the post-World War II period was the entry of married mothers into the work force. In 2009, 60% of all women were in the labor force, compared with nearly 75% of all men; women now account for 47% of the labor force and among married-couple families in which both husband and wife work, about one-fifth of the wives earn more than their husbands (Bureau of Labor Statistics 2009a).

One of the most significant effects the baby-boom generation had on the young adult labor market was the dramatic increase in the number of young women working or looking for work (Schrammel 1998). Over the 1970–1989 period, the young adult women's labor force grew at an annual rate of nearly 6%; the growth rate for young adult men over the same period was about 3%. Similarly, significant gains in employment–population ratios for young adult women occurred over the period 1970 to 1989. In 1970, 42% of young adult women were employed; by 1989, the ratio had risen to 69%. From 1989 to 1996, the employment–population ratio for young adult women continued to increase, but only to 71%. Over the period from 1973 through 1998, a relatively constant share of the female labor force, 25% to 30%, has worked part time (Blank 1998). More recently, in 2008, 25% of women worked part time—fewer than 35 h per week (Bureau of Labor Statistics 2009b).

Despite these labor market gains, young women are more than three times as likely as older women to report that their ability to find a good new job is compromised by their gender (Antecol and Kuhn 2000). The authors estimated probit regressions on the propensity of 1,586 female respondents from the 1995 Canadian workforce between the ages of 15 and 65 years to report gender-induced harm in their job search since their last separation from a job as a function of demographic factors, gender composition of the respondents' occupation, and Canadian province dummies. The authors noted that this phenomenon cannot be statistically attributed to observed personal or job characteristics or to any "objective" measure of discrimination. This line of research is focused exclusively on labor market discrimination; however, it appears that there is a research gap relating to the effects of other factors in a young women's environment that may contribute to labor market successes of young women and that partly motivates this paper. Key among them is the spatial environment as perceived by women and transportation barriers.

Gender differences in male and female commuting time and transportation use have been noted by several authors (Sermons and Koppelman 2001; White 1986). A historic perspective on women's commuting behavior can be obtained from Shea et al. (1970), who conducted a 5-year study of the labor market behavior of women in the United States who were 30 to 44 years of age in 1967. Most working women in this cohort drove per-

sonal vehicles to work, although there was a substantial difference in this respect between white and black women.

Women's travel choices reflect the balance they seek between their jobs and their household responsibilities (Sarmiento 2000). Women tend to make more trips than men for both work and nonwork trips (Michelson 1983; Rosenbloom 1987; Rosenbloom and Burns 1993; Skinner and Borlaug 1980). For work trips, women tend to travel shorter distances than men (Al-Kazily et al. 1994; Giuliano 1979; Gordon et al. 1989; Hanson and Johnston 1985; Hanson and Pratt 1990; Madden 1981; Michelson 1983; Pickup 1985; Rosenbloom 1987; Rutherford and Wekerle 1989). Married women in particular tend to have shorter work trips than unmarried women (Erickson 1977). Compared with men, women are more likely to link their commuting trips with other purposes, especially when their children are younger (Al-Kazily et al. 1994; Rosenbloom 1987; Rosenbloom 1989; Strathman and Dueker 1994). As for women's mode choice, previous findings are quite mixed: some studies show that women are more likely than men to use public transit for their travel (Giuliano 1979; Hanson and Johnston 1985; Koppelman et al. 1980; Michelson 1983, Pickup 1985); other studies have found that women, especially working mothers, are more likely to commute by car (Gordon et al. 1989; Rosenbloom and Burns 1993, 1994).

The purpose of this paper is to examine mobility, transportation, and labor market conditions of young adults from a gendered perspective and to develop a profile of young women as they transition from adolescence to adulthood or from school and training to the labor force. The paper is guided by the perspectives on young adulthood, labor market dynamics, and travel behavior factors described above. As young women transition to the labor market and into marriage and family life, for the first time they face the dual demands of a job and raising a family, which brings with it the complexities of balancing work with at-home time with family and children, family-supportive activities such as dropping off children at school or daycare, and shopping. The paper reports on gender differences in a number of mobility-related indicators during young adulthood.

The paper is organized as follows: the next section describes the research goals and the data used for the analysis. The third section provides background information on the young adults considered. In the fourth section, the gendered trends in perceived transportation difficulties experienced by young adults are described, and the variations in job search distance are discussed in the fifth section. The sixth section focuses on car acquisition by young men and women and differences in the duration of time they remain carless after they enter the labor force. A summary and conclusions are presented in the final section.

## RESEARCH QUESTIONS AND DATA

This paper addresses the following main research questions:

1. How do the transportation and labor market experiences of young women compare with those of young men?
2. What factors are likely to contribute to the transportation experiences of young women?

NLSY was used, which is a panel data set collected by the Bureau of Labor Statistics on individual respondents since 1979 and continuing until the time of writing the paper. NLSY79 is a nationally representative sample of 12,686 individuals who were 14 to 22 years old when they were first surveyed in 1979 (49.53% of them were women). These individuals were interviewed annually through 1994 and are currently interviewed on a biennial basis. Respondents were interviewed over the years by in-person and telephone interviews; for most of the years considered in this paper, the data were gathered by in-person interviews. The retention rate is quite high—77.5%; more than 6,000 individuals have completed all rounds of this survey to date.

The paper focuses on individuals between 18 and 24 years of age, who conform to Arnett's (2004) concept of emerging adults and are the object of many labor market studies. As described in the first paragraph, the concept of a "moving window of years" is used for each individual. An individual who was 14 years old in the first NLSY79 interview year of 1979, turned 18 (the first age of interest in this paper) in 1983 and became 24 years of age in 1989. Hence, the years considered for that individual are 1983 through 1989. Similarly, someone who was already 18 years old in 1979 turned 24 years of age in 1985—hence the data considered for this individual are for the years 1979 through 1985. However, for some measures, labor market outcomes 3 years after entering the first job were evaluated. If the first individual described entered the workforce in 1989, that would mean the years 1990 through 1992. Hence, the total span of years considered in this study from NLSY79 is 1979 through 1992.

NLSY79 is a composite of several different data collection efforts including respondent interviews about their work, family, and other life experiences and a series of separately fielded administrative data collections. It is a very large database with more than 2,000 questions asked each survey year. Besides the aforementioned information, it also provides the family background, personal or household characteristics, working history, substance use, and criminal behavior, which can help researchers build a detailed profile of those individuals. NLSY provides information on the transition of those young people from school to work and from their parents' homes to being

parents and homeowners. It also has information about vehicle ownership, perceived transportation problems, and transportation services provided by the government job or training programs to those surveyed youth.

On the basis of the literature review and what is possible with the NLSY data, the paper focuses on the transportation and labor market indicators shown in Table 1. This is only a subset of the total list of indicators that potentially could be used to develop a picture of the experiences of young women, but it is believed to be rich enough for the analysis presented here. Data on commuting time are also available from some survey years; however, for reasons of brevity, an analysis of commuting time is not included in this paper.

### GENDER DIFFERENCES IN SOCIAL ECONOMIC STATUS

Table 2 summarizes background information on gender differences in young adults in the age group considered. The factors considered are the percentage of all young adults and percentage of males and females who live with their parents, are married, are in school or college, and have children. These factors may contribute to an understanding of the transportation needs at each age.

Table 2 shows that young women and men differ significantly at virtually all ages considered in terms of whether they live with parents, whether they are married or in school, and whether they have children. Young women tend to leave their parents' home and marry earlier and they also tend to have children earlier than young men. Gender differences in being in school vary

with age; at the earliest and latest stages of young adulthood, more young men than women are in school but the trend reverses during the ages 18 through 21 years, when a greater percentage of women are in school. These factors imply that in the same age group more young women than young men need to take care of their family and need to seek a balance between work and family.

### PERCEIVED DIFFICULTIES WITH TRANSPORTATION

Perceptual and subjective measures are useful indicators of the overall degree of comfort that a person feels with a particular aspect of her life. Rather than "hard" measures that quantify difficulties with transportation (e.g., the number of times an individual was late for work because of unreliable transportation or because his car broke down during a year), perceptual measures of difficulties are not necessarily associated with any specific event associated with transportation but are a composite of many different factors that affect the individual, including lack of travel options, high cost of options, problems with scheduling, unreliability, and other factors.

The role of these factors (e.g., cognitive or subjective distance, which is defined as a measure of the perceived distance rather than just physical distance) has been studied previously in various contexts, ranging from why care was forgone for cancer treatment (Guidry et al. 1997), tourists and their decision process (Ankomah et al. 1996; Walmsley and Jenkins 1992), sociodemographic factors among commuters (Collantes and Mokhtarian 2003; Golledge

TABLE 1 Transportation and Labor Market Indicators Used

Transportation Indicators	Labor Market Indicators
<ul style="list-style-type: none"> <li>• Perceived difficulties with transportation (yes, no)</li> <li>• Job search distance (miles)</li> <li>• Car ownership status (yes, no)</li> <li>• Time point at which car is acquired in relation to entry into labor force (years)</li> </ul>	<ul style="list-style-type: none"> <li>• Age at time of first job (years)</li> <li>• Total weeks worked annually in first 3 years after entry into labor force</li> <li>• Total jobs worked annually in first 3 years after entry into labor force</li> <li>• Earnings in first 3 years after entry into labor force</li> </ul>

TABLE 2 Summary Demographic Statistics at Each Age of Young Adulthood

Age (years)	Percent Living with Parents			Percent Married			Percent in School			Percent Having Children		
	Total	Female	Male	Total	Female	Male	Total	Female	Male	Total	Female	Male
18	79.96	<b>76.53</b>	<b>83.39</b>	7.29	<b>11.66</b>	<b>2.92</b>	55.36	<i>53.91</i>	<i>56.81</i>	1.01	<b>1.80</b>	<b>0.20</b>
19	68.12	<b>64.36</b>	<b>71.91</b>	12.20	<b>17.83</b>	<b>6.52</b>	34.02	34.46	33.57	3.85	<b>6.07</b>	<b>1.50</b>
20	56.70	<b>52.11</b>	<b>61.38</b>	17.88	<b>24.47</b>	<b>11.16</b>	26.34	27.01	25.64	6.89	<b>10.24</b>	<b>3.32</b>
21	46.47	<b>41.18</b>	<b>51.91</b>	23.62	<b>30.46</b>	<b>16.59</b>	22.78	23.41	22.14	9.84	<b>14.33</b>	<b>5.02</b>
22	39.01	<b>33.76</b>	<b>44.46</b>	29.57	<b>36.02</b>	<b>22.87</b>	17.00	<i>16.25</i>	<i>17.78</i>	14.88	<b>21.06</b>	<b>8.31</b>
23	32.06	<b>26.77</b>	<b>37.46</b>	35.31	<b>41.46</b>	<b>29.02</b>	12.09	<b>11.11</b>	<b>13.10</b>	21.72	<b>29.42</b>	<b>13.52</b>
24	26.79	<b>21.62</b>	<b>32.08</b>	40.10	<b>45.38</b>	<b>34.70</b>	9.59	9.10	10.09	28.92	<b>37.80</b>	<b>19.47</b>

NOTE: Bold = significant difference between male and female percentages at .01 level; italic = significant at .05 level.

SOURCE: NLSY79, Bureau of Labor Statistics, U.S. Department of Labor.



and Zannaras 1973); and low-wage workers using transit services to reach jobs (Thakuria et al. 2006, 2008).

Perceived difficulties with transportation appear to have persisted with some of the young individuals through several years of their life. The measure of perceived difficulty used here is a composite of several factors: if the person indicated that transportation was the reason why he or she was not looking for work, did not want a job at that point, or did not complete a job training program, then that individual was recorded as having perceived difficulties with transportation that year. However, respondents were not asked the same questions each year; hence, a dummy variable was created that takes a value of 1 if they said "yes" to any perceived transportation difficulties at least once throughout the time period when they were 18 to 24 years of age.

Table 3 shows the summary statistics on several measures relating to perceived transportation difficulty experienced by individuals when they were 18 to 24 years of age. The table presents information on the proportion of young people in this age group who experienced transportation difficulty, as defined above. It also presents a number of labor market statistics, including the mean age when the respondent worked at her first job (i.e., entered the labor force) and four additional factors in the early years (3 years after entering the labor force) of her work life: mean total weeks worked per year, mean number of jobs worked per year, and average annual earnings (indexed to 2002 dollars). The results are classified into three groups: all respondents, respondents who did not report any transportation difficulties when they were between 18 and 24 years of age, and respondents who did.

Overall, about 42% of young individuals reported some type of transportation difficulty. A significantly greater proportion of young women reported difficul-

ties with transportation (43%) compared with men (40%). Individuals perceiving transportation problems were from a broad cross section of society and were not restricted to low-income and minority populations, although a larger proportion were from economically disadvantaged and minority families. NLSY79 does not give parents' income; about an equal proportion of individuals with and without perceived difficulty were from families with low and high levels of father's and mother's maximum level of education. Close to 45% of minority individuals reported difficulties, whereas close to 37% of nonminority individuals reported difficulties.

### Age at First Job

Perceived transportation difficulty has several implications in labor market outcomes. Overall, young men entered the labor force at a significantly younger age than women (19.12 years and 19.90 years, respectively). Of all respondents, those who reported difficulty were older at the time they entered the labor force (19.77 years) compared with those who did not report difficulties (19.31 years). The average age differential between young women who reported difficulty at the time of labor force entry and those who did not is 0.84 year.

### Weeks Worked per Year

All respondents in the 18- to 24-year age group worked an average of about 29 weeks per year during the first 3 years after entering the labor force. Those who did not report facing transportation problems worked an average of 31 weeks per year, whereas those who did

TABLE 3 Perceived Transportation Difficulties and Labor Market Indicators

Category	Total	Female	Male
Proportion (18 and 24 years) with transportation difficulties			
All respondents	0.42	<b>0.43</b>	<b>0.4</b>
Mean age at first job (years)			
All respondents	19.51	<b>19.9</b>	<b>19.12</b>
Without reported difficulty during ages 18 to 24 years	19.31	<b>19.6</b>	<b>19.02</b>
With reported difficulty between ages 18 and 24 years	19.77	<b>20.24</b>	<b>19.25</b>
Mean total weeks worked for first 3 years after entering workforce			
All respondents	29.26	<b>29.01</b>	<b>29.72</b>
Without reported difficulty during ages 18 to 24 years	30.98	<b>30.56</b>	<b>31.41</b>
With reported difficulty between ages 18 and 24 years	27.1	26.95	27.26
Mean total jobs worked annually for first 3 years after entering workforce			
All respondents	1.42	<b>1.4</b>	<b>1.44</b>
Without reported difficulty during ages 18 to 24 years	1.39	<b>1.38</b>	<b>1.42</b>
With reported difficulty between 18 and 24 years	1.45	1.43	1.48
Average earnings in first 3 years after entering workforce (adjusted to 2002 dollars)			
All respondents	9,645.04	<b>8,122.11</b>	<b>11,590.52</b>
Without reported difficulty during ages 18 to 24 years	10,394.08	<b>9,029.89</b>	<b>12,053.57</b>
With reported difficulty between ages 18 and 24 years	8,804.55	7,148.97	11,039.62

NOTE: Bold = significant at .01 level in the independent sample test; italic = significant at .05 level.

SOURCE: NLSY79, Bureau of Labor Statistics, U.S. Department of Labor.

worked about 3 weeks less on average. Gender differences in the mean weeks worked overall are not large; gender differences become greater when one takes perceived difficulty into account. Young black women in the labor force in rural areas reported working the fewest number of weeks per year (about 19 weeks); almost 60% of young rural black women reported experiencing problems with transportation, the highest of any location and racial group.

### Total Jobs Worked per Year

In the first 3 years after entering the labor force, young men and women worked an average of 1.42 jobs. Women tended to work significantly fewer jobs than men overall; however, urban women who did not perceive difficulties with transportation worked more jobs than their male counterparts. White women in urban areas worked the highest number of jobs annually of all groupings of women considered, at 1.89 jobs on the average.

### Average Earnings After Entering the Labor Force

Young adults who entered the labor force in the early 1980s earned \$9,645 on average in the first 3 years of being a worker. There is a substantial wage difference of more than \$1,500 between those who reported transportation difficulty and those who did not. Young men overall earned an average of \$11,590 per year for those first 3 years (those who did not report transportation difficulties earned an average of \$12,053), which is significantly greater than earnings by young women, who, as a group, earned an average of \$8,122 (those who experienced no transportation difficulties earned \$9,027). However, the difference between parents' education level and minority status of the two groups did not differ significantly. This gives reason to believe that it is not only the traditional low-wage laborers who suffer from transportation difficulties but a larger group of individuals. The wage differential between young women who did not experience difficulties and those who did is close to \$1,900; in contrast, this wage differential is only about \$1,000 in the case of men.

### JOB SEARCH DISTANCE

Job search behavior has also been extensively studied in the academic literature. Keith and McWilliams (1999), using the NLSY data, noted that both men and women were involved in substantial job search activity in the early years of their careers. Topel and Ward (1992) found that the first decade of work experience is characterized by high job mobility (moving from job to job) and wage

growth. Different authors have attributed this high rate of mobility and corresponding growth in wages to different factors. For example, Johnson (1978) noted that job mobility and wage growth may be attributed to the quest to determine the individuals' comparative advantage, while Jovanic (1979) attributed these conditions to the search for higher-quality job matches. The search for better pay is also thought to motivate job searching, job mobility, and wage growth (Burdett 1978; Parsons 1973). Job searching is usually associated with a desire to transition from a state of unemployment to employment, to progress from school or training to the labor force, and to improve the employment conditions of current workers. Hanson and Pratt (1991) examined job searching and occupational segregation among women.

Regardless of the underlying motivations, spatial mobility and transportation are important aspects of the job search and job mobility process (Smith and Zenou 2003; van Ommeren 1998; van Ommeren and van der Straaten 2008). NLSY provides some data (but only for a limited number of years) on whether a person indicated that transportation was the reason why he or she was not looking for work or did not want a job at the time. These variables may be used to construct indicators that allow a determination of whether an individual experienced limitations in the job search process. The NLSY data also provide the farthest distance from home within which an individual looked for jobs.

Table 4 shows that gender differences in job search distances are statistically significant. The overall mean commuting time is about 17 min and the largest difference is between rural women and men. Table 4 also shows that the mean job search distance of all NLSY respondents is 3.41 mi. Women search for jobs over a smaller area, at a mean distance of 3.14 mi from their homes, whereas men reported a job search space over a larger area, at 3.65 mi. Rural men and women have larger job search areas (3.39 and 4.11 mi, respectively) than their urban counterparts (3.08 mi for urban women and 3.52 mi for urban men). The reason for this difference is possibly that economic opportunities in rural America exist at great distances from residential locations and sometimes in neighboring towns and counties.

A Tobit model of job search distance of 18- to 24-year-old adults was estimated to explore the factors that are likely to contribute to explaining job search distance. Since the response variable DIST\_JOBSEARCH is censored at zero, a Tobit model described in terms of a latent variable DIST\_JOBSEARCH\* was used:

$$\begin{aligned} \text{DIST\_JOBSEARCH}_i^* &= X_i' \beta + \varepsilon_i \\ \text{DIST\_JOBSEARCH}_i &= \begin{cases} 0 & \text{if } \text{DIST\_JOBSEARCH}_i^* \leq 0 \\ \text{DIST\_JOBSEARCH}_i^* & \text{if } \text{DIST\_JOBSEARCH}_i^* > 0 \end{cases} \quad (1) \end{aligned}$$

TABLE 4 Statistics on Carlessness, Commuting Time, and Job Search Distances of Young Adults

Category	Total	Female	Male	Urban		Rural	
				Female	Male	Female	Male
Mean commuting time (min)							
Respondents who were 18 to 24 years	16.99	<i>16.66</i>	<i>17.28</i>	<b>17.73</b>	<b>18.81</b>	<b>15.09</b>	<b>20.18</b>
Mean job search distance (mi)							
Respondents who were 18 to 24 years	3.41	<b>3.14</b>	<b>3.63</b>	<b>3.08</b>	<b>3.52</b>	<b>3.39</b>	<b>4.11</b>
Mean age in which first (personal or spousal) vehicle was acquired (years)							
All respondents	24.63	<b>24.86</b>	<b>24.38</b>	<b>24.86</b>	<b>24.39</b>	<b>24.5</b>	<b>24.11</b>
Respondents who were unmarried while 18 to 24 years	25.06	<b>25.62</b>	<b>24.62</b>	<b>25.54</b>	<b>24.59</b>	<b>25.55</b>	<b>24.38</b>
Mean duration of carlessness (years) after first job							
All respondents	5.35	<b>5.23</b>	<b>5.47</b>	<b>5.32</b>	<b>5.49</b>	<b>4.78</b>	<b>5.3</b>
Respondents who were unmarried while 18 to 24 years	5.68	<b>5.86</b>	<b>5.54</b>	<b>5.89</b>	<b>5.52</b>	<b>5.53</b>	<b>5.45</b>

NOTE: Bold = significant at .01 level in the independent sample test; italic = significant at .05 level.  
 SOURCE: NLSY79, Bureau of Labor Statistics, U.S. Department of Labor.

where

$DIST\_JOBSEARCH_i$  = observed dependent variable.

$X'_i$  = vector of independent variables described below,  
 $\beta$  = a vector of parameters,

$\epsilon_i \sim N(0, \sigma^2)$   $DIST\_JOBSEARCH^*$  = uncensored or latent (unobserved) level of job search distance, and

The results are shown in Table 5 in the columns labeled Model I. The first column under this heading provides the estimated marginal effects of the model and the second column gives the standard errors of the marginal effects. After controlling for the number of weeks worked, the age at which the individual entered the labor force, number of children in the household, mother and father's schooling level, presence of a per-

TABLE 5 Estimated Models of Job Search Distance and Duration of Carlessness After First Job

Variable	Variable Description	Model I: Tobit Model of Job Search Distance (mi)		Model II: Proportional Hazard Model of Duration of Carlessness After First Job (years)		
		Coefficient	Standard Error	Parameter Estimate	Standard Error	Hazard Ratio
Intercept		<b>1.606085</b>	0.285007			
D_Gender	Dummy indicating gender (female = 1)	<b>-0.4244</b>	0.04914	0.5662	0.36488	1.7610
AGE	Age of respondent (years)	<b>0.1182</b>	0.01308	<b>0.1085</b>	0.06352	1.1150
PercentWageGrowth	Percent increase in annual income (adjusted to 2002 dollars)			<b>-0.0052</b>	0.00496	0.9950
Jobs	Number of jobs worked per year	<b>0.0618</b>	0.01763	-0.1003	0.29372	0.9050
Nweeks_worked	Number of weeks worked per year	<b>-0.0065</b>	0.00177	0.0079	0.01098	1.0080
Agefindjob	Age at which respondent entered the workforce (first job)	<b>0.0004</b>	0.00019			
Agefirstcar	Age at which respondent or spouse purchased vehicle	0.0000	0.00008			
Children	Number of children in household			0.0629	0.13087	1.0650
M_Grade	Maximum education level of mother	0.0011	0.00704	<b>0.0058</b>	0.05709	1.0060
F_Grade	Maximum education level of father	-0.0077	0.00554	<b>-0.0507</b>	0.03816	0.9510
D_Minority	Dummy indicating minority status (minority = 1)	0.0056	0.05550			
Black	Dummy indicating if respondent was Black (Black = 1)			<b>-0.0473</b>	0.41455	0.9540
D_Veh	Dummy indicating if respondent had car (yes = 1)	<b>-0.1471</b>	0.08871			
D_Marital	Dummy indicating respondent's marital status (married = 1)	<b>-0.0254</b>	0.07579	<b>-0.1871</b>	0.39217	0.8290
D_Urban	Dummy indicating urban-rural status (urban residency = 1)	<b>-0.2837</b>	0.05407	<b>-0.1773</b>	0.15706	0.8380
D_PerDiff	Dummy indicating perceived difficulty with transportation (perception of difficulty = 1)	<b>-0.0114</b>	0.04993	<b>0.3594</b>	0.32916	1.4320
Log-likelihood		-5200.5				
Likelihood ratio chi-square statistic and associated degrees of freedom				10.21; 0.550		
Pseudo-R <sup>2</sup>		0.51				

NOTE: Bold italic = significant at .05 level; bold = significant at .10 level.

sonal or spousal vehicle, minority status, marital status, urban–rural residency, and perceived difficulties with transportation, the differential between women's and men's job search distance is estimated to be about 0.42 mi. The model estimates that the total number of jobs held in a year increases job search distance, indicating that “job-shopping” motivates individuals to experiment with positions farther from home. The implication of this fact, as indicated by the negative marginal effect of the number of weeks worked, is that a longer time worked during the year, with no breaks in employment, decreases job search distance because the motivation to job-shop decreases. The presence of a car significantly decreases the job search distance. There are several possible explanations for this fact. As Model II on duration of carlessness shows, there is reason to believe that young adults on a higher economic ladder and with better educated parents are more likely to be without a car for a shorter time. The implication of this fact for the negative effect that car ownership has on job search distance may lie with the job search strategy used by those with better means, education, and a car—these individuals are more likely to utilize formal methods of job search such as nonpersonal labor market intermediaries including job postings, newspaper advertisements, and employment agencies and direct job applications, most of which do not require the individual to travel. Informal job search strategies, more common among women, include employee referrals, responding to help-wanted signs, temporary employment agencies, and social networks (Huffman and Torres, 2001), which have strong implications for travel. Informal search strategies include personal contacts, which also have implications for travel (Granovetter 1974) and, potentially, physical distance traveled.

Exploring the gender dimensions of the job search factor is complex for a number of reasons because several additional factors are noted to have an effect on men's and women's job search processes. The factors are ultimately the reasons why differences persist among men's and women's job search behavior. For example, Keith and McWilliams (1999) noted that gender differences in the intensity of job searching could occur because of the costs of the job search; the costs of the job search are inversely related to the intensity of the job search. Job search costs include direct costs such as expenses in employment services, travel and transportation, and others as well as opportunity costs, which include the cost of nonwork time that is used for searching rather than nonwork activities; in the case of women, especially married women, it includes the production of household activities such as cooking and looking after children (Hersch and Stratton 1997). Therefore, the opportunity costs of searching may be higher for women than for men.

Keith and McWilliams (1999) noted that they have no reason to believe the direct costs associated with job searching differ for men and women. However, as the results in this section show, this conjecture needs to be further researched. Women are more likely to have a greater degree of discomfort with their transportation conditions and to acquire a vehicle later in their life than men (discussed in the next section), thus leaving them to depend on public transportation or informal means of transportation such as ridesharing to a greater degree and for a longer period of their lives compared with men. These reasons could also contribute to why job search and job mobility in young women are more limited than in young men.

### STATE AND DURATION OF CARLESSNESS

NLSY79 asks respondents about car ownership, but the question is phrased as “did you (or your spouse) personally own, or are you making payments on any cars, vans or trucks?” If the respondent answered yes, it was assumed that the person had access to a personal vehicle, although, as Table 4 shows, direct ownership with this question can be ensured only if the respondent is single; otherwise, it could be a family vehicle that is at the disposal of the respondent or her or his spouse.

Table 4 shows that the mean age at which the vehicle was acquired is significantly higher for unmarried females, indicating that some young women may “acquire” a vehicle through their spouse. The average age at which all females acquired a vehicle, as assumed above, was 24.86 years, whereas for unmarried women the average age was close to 26 years. Table 4 also shows the mean time spent without a car after entering the labor force. Unmarried women were carless for longer (5.62 years) compared with all women (2.85 years). This is the case for men as well, indicating that the means for acquiring a vehicle may be through marriage in some cases or because married individuals may have children and the attendant commitments may motivate them to purchase a vehicle earlier than unmarried individuals.

To estimate the duration of carlessness after entering the labor force, a duration model of carlessness after the first job was estimated. The time duration of young adults without a car after beginning a job is assumed to follow a hazard function, expressed as follows:

$$\lambda_i(t) = \lambda(t; Z_i) = \lambda_0(t) \exp(Z_i'\beta)$$

where

$\lambda_i$  = arbitrary and unspecified baseline hazard function;  
 $Z_i$  = vector of explanatory variables including gender, raise in annual wages between  $t$  and  $t - 1$ , number of weeks worked, age at which the individual entered

the labor force, number of children in the household, mother's and father's schooling level, minority status, marital status, urban–rural residency, and perceived difficulties with transportation; and

$\beta$  = associated parameters.

The estimated parameters of the model are given in the columns labeled Model II in Table 5.

The hazard ratios in Table 5 (relative risks) provide some insights into the contribution of the different covariates into carlessness. Being female increases the hazard of carlessness by 74%. A 1% increase in wages slightly decreases the hazard of carlessness duration. Perceiving difficulties with transportation increases the hazard of carlessness by about 34%, indicating that some transportation difficulties may be associated with not having a personal automobile and with having to depend on public transportation, other means of transportation, or not being able to make certain trips. Rural residents are estimated to have shorter durations of carlessness than urban residents. As indicated by the summary statistics, pathways to vehicle ownership in certain cases may be through marriage—the hazard of carlessness duration declines by about 23% for married individuals.

## CONCLUSIONS

The paper discusses mobility and job-related conditions of young women in the late 1970s and early 1980s and draws conclusions about gender differences according to these conditions. The main finding of the paper is that, as a group, a higher proportion of young women perceived difficulties with their travel and transportation conditions, were likely to restrict their job search geographically to a smaller area than young men, and acquired a vehicle earlier through their husbands or later, compared with men, if single. These factors may interact in complex ways with their labor market outcomes, along with family, education, training, attitudes and motivation to work, childbearing history, socialization, and myriad other factors. The analysis in this paper shows that it is not only young women with low incomes or from low-income families who face difficulty during the years of labor market entry, but that assistance is needed by a larger segment of the population.

Specifically, the following approaches may be considered for better policies and services targeting young women.

### Tax and Earned Income Tax Credit

A combination of pretax transit benefits, earned income tax credit, loan programs for auto ownership and use,

and commuter vouchers might be available to benefit young women as they transition into the labor market. However, qualifying as low income is an eligibility requirement in most cases. Moreover, having access to information about these options is key to their effective use, and information often is not accessible for those most in need. Strategies are needed to expand the scope of these programs and for their effective information dissemination and marketing to serve a larger segment of young women.

### Travel Training

Numerous programs operate across the country for specialized one-on-one or group-based instruction to give individuals the skills to travel independently on existing transit services. The range of topics covered by travel training programs is vast and may include trip planning, boarding transit vehicles and negotiating transfers, time awareness and money management skills, and personal safety and stranger awareness. A major function of these programs is to break cognitive or perceptual barriers between points in the local labor market and the residential locations of workers. These programs already play an important role with women workers—however, more funding is needed to make services available to a larger segment of the population.

### Expansion of 311 Service

A 311 service has been approved by the U.S. government as a three-digit dedicated phone number to reach important government services from any location at any time. The service can provide a major point of contact to connect young women with major workforce development needs, including transportation, mobility managers, travel training programs, and tax and other programs related to transportation and should be effectively disseminated to school and college campuses, employment counselors, job-search web portals, employment-related blogs, and placement agencies.

### Information Referral Service, Mobility Managers, and Transportation Coordination Programs

Many transit agencies and transportation providers already have useful trip information, planning, and scheduling as a function offered to customers via their websites or by phone. However, these functions are about information and not door-to-door or door-through-door connectivity with employers. Information referral services, mobility managers, and transportation coordina-

tors provide access to information about transportation services, including routes, schedules, and fares and may be connected to workforce development or placement services. Their most effective use will be in serving young women during job searching, placement, and mobility needs to connect to multiple jobs.

### School, College, and University Transportation

Given that a large segment of women are in school or college during young adulthood, school, college, and university transportation programs can play a vital role in assisting mobility improvements during the period of labor market entry by young women. Transportation coordinators on campus can play a critical role in serving as a point of contact for information, trip itinerary planning, travel training, coordinating rides, or arranging school or university transportation vehicles for job placement.

### Women-Centered Employee Commute Options

Several opportunities exist to expand employee commute options among women. Online or dynamic ridesharing for women, organizing walking groups of women to and from transit groups, and group itinerary planning are some options that should be available to young women to ease their discomfort as they transition into the labor market.

### Car Ownership and Car-Sharing Programs

Many car ownership and auto loan programs are available across the country, including Ways to Work, Opportunity Cars, and others. Most of these programs have a (low) income eligibility requirement, and given the strong role car ownership has played with employment outcomes, such programs should continue and expand. However, reaching a larger segment of the population may require consideration of other strategies, including auto loan interest rates and down payment discounts that reward a good scholastic record and clean employment records that may be financed partially from private funds and scholarships. It may also be useful to consider partnerships with local car dealers—a “first-time car buyer” toolkit that includes not only financing and related information but also information about mobility services and options available in the region to connect young adults to jobs. Federal funding for car sharing to job interviews and job training programs with infrequent schedules may also be useful to serve the needs of young women.

### Collaborative, Content-Rich Information Systems and Peer Social Networks Connecting Transportation to Labor Market Information

The power of information technology and the extent of young users of blogs, social networking tools, and information systems has yet to be fully harnessed in the transportation sector. The scope for expanding intelligent transportation systems and location-based services—which are mainly geared toward transportation information and traffic management—to connect users to meaningful personalized information about employment is an area that should be supported by future policies. One strategy to follow is to bring together stakeholders from the coordinated human services transportation planning process, the United We Ride initiative, and others in the employment sector together with transportation organizations to develop a system architecture for such services that software developers can then use (perhaps using the 511 travel information model) to create applications that connect employment-related information to transportation that can be disseminated on demand to young women via the Internet, portable digital assistants, and other mobile devices.

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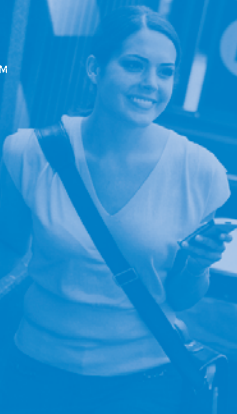
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