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65 pages | 8.5 x 11 | PAPERBACK  
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National Academies of Sciences, Engineering, and Medicine 2006. *Research on Women's Issues in Transportation, Volume 1: Conference Overview and Plenary Papers*. Washington, DC: The National Academies Press.  
<https://doi.org/10.17226/23274>.

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**CONFERENCE PROCEEDINGS 35**

# Research on Women's Issues in Transportation

*Report of a Conference*

VOLUME 1: CONFERENCE OVERVIEW AND PLENARY PAPERS

November 18–20, 2004  
Chicago, Illinois

*Sponsored by*

Transportation Research Board  
Federal Highway Administration  
Office of Planning, Federal Highway Administration  
Office of Interstate and Border Planning, Federal Highway Administration  
Office of Transportation Policy Studies, Federal Highway Administration  
Department for Transport, United Kingdom  
Michigan Department of Transportation  
General Motors Corporation  
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New Mexico Department of Transportation  
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Oak Ridge National Laboratory

TRANSPORTATION RESEARCH BOARD  
OF THE NATIONAL ACADEMIES

Washington, D.C.  
2006  
[www.TRB.org](http://www.TRB.org)

## Transportation Research Board Conference Proceedings 35

ISSN 1073-1652

ISBN 0-309-09956-0

### Subscriber Categories

IA planning and administration

IVB safety and human performance

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Printed in the United States of America.

NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competencies and with regard for appropriate balance.

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.

The views expressed in the presentations and papers contained in this report are those of the authors and do not necessarily reflect the views of the committee, the Transportation Research Board, the National Research Council, or the sponsors of the conference.

The conference was sponsored by the Transportation Research Board; the Federal Highway Administration; the Office of Planning, Office of Interstate and Border Planning, and Office of Transportation Policy Studies of the Federal Highway Administration; the Department for Transport, United Kingdom; the Michigan Department of Transportation; General Motors Corporation; the Iowa Department of Transportation; the New Mexico Department of Transportation; the National Highway Traffic Safety Administration; the Federal Transit Administration; the Maritime Administration; the Washington State Department of Transportation; and Oak Ridge National Laboratory.

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# Preface

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On November 18–20, 2004, the Transportation Research Board (TRB) convened a Conference on Research on Women's Issues in Transportation in Chicago, Illinois. The conference—TRB's third held on this subject—was sponsored by the following agencies, organizations, and companies with an interest in advancing the understanding of women's issues in transportation: TRB; the Office of Planning, Office of Interstate and Border Planning, and Office of Transportation Policy Studies of the Federal Highway Administration; the Department for Transport, United Kingdom; the Michigan Department of Transportation; General Motors Corporation; the Iowa Department of Transportation; the New Mexico Department of Transportation; the National Highway Traffic Safety Administration; the Federal Transit Administration; the Maritime Administration; the Washington State Department of Transportation; and Oak Ridge National Laboratory.

Approximately 120 individuals from across the transportation research community—at national, state, regional, and local levels and from the public and private sectors and academia—participated. An unusual number of international participants attended, including individuals from the United Kingdom, Denmark, Norway, Sweden, Finland, Germany, the Netherlands, Bangladesh, Cambodia, Cameroon, Australia, Canada, South Africa, and Burkina Faso.

## BACKGROUND

This event followed two earlier conferences on women's issues in transportation, the first of which was sponsored by the U.S. Department of Transportation in 1978. Attendees at that groundbreaking conference were predominantly researchers and scholars. By the time the second conference was held in 1996,

concerns about women's issues had moved well beyond the research community into policy making and the planning and engineering processes. The second conference, sponsored by the Federal Highway Administration, was organized by the Drachman Institute of the University of Arizona and by Morgan State University. The third conference has continued the trend of expanding the sponsorship, breadth of topics covered, and participants' backgrounds.

## CONFERENCE PLANNING

This conference had two primary objectives: (a) to identify and explore additional research and data needed to inform transportation policy decisions that address women's mobility, safety, and security needs and (b) to encourage research by young researchers. TRB assembled a committee, appointed by the National Research Council, to organize and develop the conference program. The committee members, who are listed on page ii, possessed expertise in the wide range of transportation topics that affect women's travel.

The committee selected four subject areas as a basis for organizing the conference, and four committee members assumed responsibility as the topic leaders, as follows:

- Understanding Travel Issues—Sandra Rosenbloom, committee chair;
- Transportation, Access, and Community Design—Susan L. Handy;
- Injury Prevention and Ergonomics—Susan A. Ferguson; and
- Policy and Planning—Michael D. Meyer.

After identifying the four main topic areas listed above, the committee issued a call for abstracts. The

process for soliciting and conducting peer reviews of full papers to be presented at the conference is described in Volume 2 of this proceedings.

Topic leaders drew on information and findings in the papers to be presented at the conference, together with their own extensive knowledge, to prepare an overview paper to frame the issues within their respective topic areas and to summarize the findings of the accepted papers. The overview papers were peer reviewed and are published in this volume.

## CONFERENCE FORMAT

The conference program was designed to maximize the exchange of information and perspectives among the participants. The four overview papers were each presented in a plenary session, and each paper was followed by an open discussion with the audience. Breakout sessions followed each plenary session to encourage the exchange of research findings and relevant information and experience. Additional papers were presented in poster sessions during the conference. Each type of session is described in further detail below.

### Plenary Sessions

The plenary sessions began with each of the topic leaders making a presentation (based on the leader's written overview paper). The plenary sessions were designed to

- Frame the issues within the respective subject areas,
- Provide a summary of current issues,
- Summarize the state of current research, and
- Summarize the conclusions of research papers presented in the related breakout sessions.

### Breakout Sessions

Following each plenary session were three or four concurrent breakout sessions, during which several peer-reviewed papers were presented. These sessions allowed the participants to hear more in-depth information on specific research or policy issues. The sessions also provided an opportunity to share similarities and differences in the communities represented by the participants.

### Poster Session

Additional peer-reviewed papers accepted by the committee that could not be accommodated in the breakout sessions were presented in a poster session. The poster

session allowed for a lively exchange of ideas directly with the authors.

## CONFERENCE PROCEEDINGS FORMAT

### Volume 1

This volume contains the overview material. The conference summary was prepared by Susan Herbel, Cambridge Systematics. The peer-reviewed topic overview papers are provided in the order in which they were presented at the conference. The keynote presentation, given by Ann Frye, Department for Transport, United Kingdom, is included. Finally, the appendix contains the list of all conference participants.

This volume, including the peer-reviewed topic overview papers, has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the National Research Council's Report Review Committee. The purposes of this independent review are to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the committee's charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process.

TRB thanks the following individuals for their review of this report: Marsha Anderson Bomar, Street Smarts, Inc., Duluth, Georgia; Nancy McGuckin, consultant, Washington, D.C.; and Abigail E. McKenzie, Minnesota Department of Transportation, St. Paul.

Although the reviewers listed above provided many constructive comments and suggestions, they did not see the final draft of the report before its release. The review of the final draft of this report was overseen by C. Michael Walton, University of Texas at Austin. Appointed by the National Research Council, he was responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered.

The contributions of the conference committee were essential to the success of the conference. Beyond their role on the conference committee, the authors of the overview papers contained in this volume contributed their time and expertise. Susan Herbel supported the committee in its development of the conference program and invitation of selected speakers and participants. She kept everyone on task and on schedule. The topic leaders managed most of the review process, communicated fre-

quently with authors, prepared the overview papers, and led interactive plenary sessions. The keynote presentation, by Ann Frye, helped set the tone for the conference. The sense of shared responsibility conveyed by Ms. Frye was frequently echoed in the remainder of the conference.

## **Volume 2**

Volume 2 contains 22 full papers from the breakout and poster sessions and 9 abstracts of papers on subjects of particular interest to the committee that were selected for publication through the committee's peer review process.

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# Overview

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**T**ransportation systems are shaped by system users and their everyday lives; however, the reverse is also true—system policy and design can also dramatically affect people's lives. Thus, it is relevant to ask whose views and preferences are taken into account during planning and policy making, construction, and design and management of the transport system. This deliberation applies to roadways, transit, vehicles, and policies that affect user behavior and the environment as a whole.

Gender is an important factor and should be explicitly integrated into transport research, practice, and policy. A better understanding and definition of gender equity in transportation are needed to determine what gender equity means and how such equity can be accomplished. Achieving a better understanding of gender equity is a significant challenge for future research.

## BACKGROUND AND PURPOSE

The TRB Standing Committee on Women's Issues in Transportation championed this conference from its inception to the completion of the two volumes of the conference proceedings. The committee had three main goals for the conference:

- **Research.** The conference was designed to provide a forum for sharing existing research and data, stimulate new research, and identify future research needs including a

focus on ethnic and racial differences as well as cohort and period effects in the study of gender issues in transportation.

- **Improved awareness.** The committee wanted to raise awareness in the transportation community and the public of the importance of research on women's transportation issues. The committee also wanted to provide a focus on actions and policies related to women's transportation issues.

- **Community building.** The committee wanted to reach out to the next generation of researchers, academics, and program managers. Further, the committee was interested in creating opportunities for public and private partnerships.

A specific objective of the conference was to identify and catalogue current knowledge so as to set the stage for identifying cross-cutting issues and gaps in the literature and research programs. That is, what is known and what needs to be determined to improve women's mobility, safety, security, and access? Discussions took place at standing committee annual and midyear meetings and other venues to narrow the plethora of questions of interest. The following questions provided the basis for decisions on conference content and process.

## Research

- What are the data needs in studying women's transportation issues?

- What analytic techniques are available for studying women's issues from the National Household Travel Survey and what changes need to be made to the survey to understand women's issues better?

- How can the crash investigation process be improved to understand better the safety issues relevant to women?

### Mobility

- What are the mobility issues for older women in urban and rural areas?

- To what extent does concern for personal safety guide a woman's decisions regarding transportation options?

- What are the linkages between mobility and quality of life, especially for women in developing nations?

- What is the impact of trip chaining on mode choice and alternative modes?

- What are the interrelationships among mobility, poverty (access to jobs and social services), ethnicity, and religion?

### Safety and Health

- What are the linkages between transportation and health?

- What variables should be included in research models for examining women's crash and injury risk (transportation mode and purpose, types of crashes, types of vehicles driven, etc.)?

- What is the interrelationship between vehicle design (crashworthiness) and injury patterns for women?

- How do pedestrian safety issues differ for women?

- What is known about ergonomic issues related to women's use of vehicles as a function of their work, especially truck and bus drivers?

### Policy

- To what extent are women involved in the transportation decision-making process?

- Does involvement by women in transportation decision making result in different outcomes?

### Other

Strong interest was expressed in two other areas that could not be accommodated by the research agenda:

career development and methods for networking, information sharing, and outreach. These topics will be further explored at the TRB annual meetings and midyear meetings, conferences, and other venues.

### CONTENT OVERVIEW AND RESEARCH NEEDS

The following are brief summaries of the discussion that took place during each plenary session and its accompanying breakout sessions.

#### Understanding Women's Travel Issues

The first plenary session was led by Sandra Rosenbloom of the University of Arizona. The authors in this session focused their research on understanding such women's travel issues as what is known about differences in women's and men's travel, how major societal trends are related to differences in travel by gender, and what the research, policy, and planning implications are. Three breakout sessions followed the plenary session on the topics of

- Disadvantaged and elderly women in the United States and internationally,

- Women's complicated activity patterns, and

- Time, travel, and activity in women's lives.

Gender differences in women's travel experience are found on the basis of miles or kilometers of travel, number of trips, trip purposes, types and distribution of trips, trip complexity, licensing rates, crash rates, and crash severity. Some differences, such as the physical impact of a crash on the body, are inherent. Other differences narrow when socioeconomic factors such as income and age are held constant. Some are related to socially constructed artifacts, such as household role, which may change over time. However, simply understanding these differences, which are large and persistent, is not sufficient, especially when gender disparity arises because women are a substantial majority of the group in question, such as the poor, single parents, and those primarily responsible for household chores and management.

In the discussion of future research needs, mobility issues were frequently mentioned. The mobility subjects of special interest include racial and ethnic differences, cohort and period effects, the differential impact of household responsibilities on travel, the impact of family travel on women's mobility patterns, and the differential impact of employment patterns on women's daily travel experience.

## Transportation, Access, and Community Design

The second plenary session, led by Susan Handy of the University of California, Davis, was followed by breakout sessions focusing on various aspects of community design:

- Community design and mode choice—implications for women,
- Community design and walking—how women are affected, and
- Personal security in transportation—issues and solutions.

The session began with a definition of community design and an examination of how it affects travel, particularly for women. Access to transit, ability to walk and bike, and personal security were the dominant themes. The questions raised and examined included the following:

- How and to what extent does community design affect women's access to transit and other modes of transportation, such as walking and biking?
  - What effect does access have on women's health and quality of life?
  - How do the personal security concerns of women differ from those of men when it comes to using transit? What kinds of technologies are being used to increase transit safety and to what degree do these technologies address the safety concerns of women?

The authors and audience members identified several future research areas, beginning with the need to examine how community design affects women's travel behavior. Variables in need of study include density, land use mix, network characteristics, aesthetic qualities, regional structure, trip frequency, destination choice, mode choice, and total vehicle miles traveled.

In addition, the methods used to study the interaction between community design and travel issues need to be expanded beyond cross-sectional survey designs and include quasi-experimental designs and intervention studies. Qualitative studies focused on women that examine family, health, and safety concerns could enhance the ability to clearly define the issues and seek appropriate solutions in design and policy.

## Injury Prevention and Ergonomics

The third plenary session was led by Anne McCartt of the Insurance Institute for Highway Safety. The overview paper was by Susan A. Ferguson and Keli A. Braitman.

Three breakout sessions followed to delve further into the topic of injury prevention:

- Pregnant women's travel patterns and safety,
- Injury and fatality among women of different ages, and
- Perception and crash survivability.

Many critical issues, including those discussed in the following paragraphs, were raised during this portion of the conference.

### *Pregnancy and Motor Vehicle Safety*

As many as 370 traumatic fetal deaths may occur annually in the United States, of which about 82% are related to motor vehicles. Placental abruption is the leading injury mechanism of fetal death, with crash severity being the strongest predictor of fetal outcome.

### *Gender Differences in Crash Experience*

The number and rate of driver fatalities are increasing for women but decreasing for men. Driver fatal crash rates per mile have decreased about the same for men and women. The number of licensed drivers has been increasing at a faster rate for women than men, so that there are now as many women licensed as men. Fatal crash rates per licensed drivers are decreasing more slowly for women than men. Mileage is increasing faster for women, but men still drive more.

### *Driver Crash and Injury Rates Among Men and Women*

Women are more likely than men to be injured in crashes of the same severity; however, men's crashes are more likely to be fatal. Men have higher driver fatal crash rates per driver and per distance traveled in both the United States and Australia. Injury patterns in the same type of crash sometimes differ between men and women.

### *Vehicle Safety Issues*

Frontal airbags reduce driver deaths by 12% for women but only 6% for men. Head protection side airbags reduce the risk of fatality among female and male drivers by 33% versus 44%. Torso-only airbags reduce the risk of fatality by 21% for men but do not significantly reduce women's risk. Safety belt effectiveness is the same

for men and women (45% for cars and about 60% for light trucks).

### *Other Issues*

The conference attendees discussed additional research needs in this session. Several participants mentioned the need for more research on occupant protection for women in general, especially pregnant women. Participants also mentioned the need for more information on factors beyond increased exposure that account for the increase in women's crashes as well as the injury variance among women and men under similar crash circumstances. It might be fruitful to develop, implement, and evaluate countermeasures focused on women drivers, passengers, and pedestrians. Since women are less likely to be involved in crashes due to poor driving behavior and more likely to wear safety belts, deterrent strategies based on understanding the crash experience of women and men might be more successful.

### **Policy and Planning**

Michael D. Meyer, Georgia Institute of Technology, led the fourth session, which was followed by three panels:

- What are the implications of women's trip behavior for planning practice?
- What are the implications of women's transportation issues for policy?
- What has been the international experience in planning and policy development based on gender?

The authors and the subsequent discussions focused on planning and policy. There was considerable discussion about the implications of gender in a range of transportation policy areas and in broader policy areas. Also explored were the supporting roles that transportation policies can play in meeting other societal goals important to women. The experience of women's engagement or participation in the planning and policy-making processes was also discussed, in particular barriers to and opportunities for women's participation.

Within this plenary session and its breakout sessions the discussion on future research needs fell into three areas: research focus, data, and analysis tools and methods.

### *Research Focus*

Much of the conference focused on increasing the understanding of women's transportation issues, but the real challenge may be in understanding future issues not necessarily as a projection of the past, but rather as the dynamics of future population demographics and the potential impact of technology and other behavior-forming influences. Hence, one of the next great challenges to the policy and planning research associated with women's transportation should be to focus not only on what is happening but also on why these events and circumstances are occurring.

### *Data*

Many authors found access to data one of the largest challenges. The data issues involved quantity, quality, definition and interpretation, and collection methods. Often it is difficult, if not impossible, to distinguish clear gender differences by examining a particular data set either because of the way the data are collected or because of how they are arrayed and managed in the database.

### *Analysis Tools and Methods*

Analyses carried out in the late 1960s and early 1970s focused on the substance and form of transportation demand models and examined them for questioned modal bias. Increasingly, research is focusing on how gender and demographics affect transportation demand behavior theories, databases, and model constructs.

Current approaches to evaluation and presentation of information to decision makers seldom examine distributional (or equity) impacts of plans, strategies, or investment actions, not only for women but also for other groups. In many ways, exploration of differential impacts is a key precursor to changing policies and plans. Little advancement has been made in terms of modeling joint household allocation decisions that result in trip differentials between members within a household. Activity-based models seem most promising for capturing household activity decisions and subsequent travel choices.

# Keynote Address

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Ann Frye, *Department for Transport, United Kingdom*

Samuel Johnson, the famous 18th-century English writer, once said: “A woman preaching is like a dog on its hind legs. It is not done well but you are surprised to find it done at all.” So I suppose we should all be congratulating ourselves on the extent of our modest achievements and recognize how far short we fall of the achievements of men.

However, Dr. Johnson was prone to comment unfavorably on all sorts of things. On the subject of Americans, for example, he said: “They are like a race of convicts and ought to be thankful for anything we allow them short of hanging.” So maybe it’s better to consign Dr. Johnson and his free-thinking views to the history books and talk instead about why we are all here in Chicago.

I wanted to talk in particular about why the British government is supporting this event and why we have come all this way to share experiences and ideas.

Our starting point is a simple one. Transport is a world designed, built, and operated predominantly by men and used predominantly by women. As a result we have

- Transport systems and pedestrian areas that women are frightened to use;
- Vehicles designed with seats and seat belts that are not appropriate for a woman’s body mass;
- Transport planning decisions that do not reflect the different work–life balance that many women have, for example, juggling child care with running a home, keeping a full-time job, and caring for aging parents; and

- Fare structures and job requirements that work against those who need to work flexibly or on a part-time basis.

The world is slowly changing. Increasingly we have

- More women in senior positions in the transport industries, changing attitudes and perspectives and challenging old ways of working;
- More research that has identified gender issues; and
- A clearer focus on understanding people’s needs as a starting point for developing and delivering transport services.

One of the initiatives we took a few years back in the United Kingdom to try to raise awareness and understanding of these issues was to develop the gender audit and checklist. This is a simple working tool intended for those at the local level in planning and delivering transport services and the pedestrian environment. The audit highlights the gender differences in a transport context, and the checklist suggests systematic and practical ways to address them.

Another important new UK development that will, I believe, be helpful in refocusing our transport planning on the diverse needs of the communities and individuals who make up our population is accessibility planning. This development represents a major shift in the way that local administrations work and consider needs.

Essentially, all local authorities in England bid for resources on a 5-year rolling basis to fund the capital costs of transport infrastructure and the provision of non-commercial local transport. As a basis for that funding they have to produce a local transport plan setting out their priorities and explaining how they will spend the money. Accessibility planning, which will come into operation next year, adds a new dimension to that process by requiring a thorough and systematic analysis of the problems experienced by those most in need (i.e., people with low income, reliant on public transport, etc.) and of the impact that transport has on those people's ability to access key services: employment, education, health care, and food shops. In other words, transport planners must be focused on people, their needs and expectations. They will be assessed against their performance in tackling social exclusion on the basis of this analysis.

This is just a very brief summary of some of the key factors that we believe are important in helping to establish a better balance in the transport world so that women's voices are heard and women's needs are recognized and met.

We believe that this conference—and the people who have come together to contribute to it—is an important step toward that goal.

I did not have the good fortune to know Pat Waller, to whom this conference is dedicated, but I have heard a great deal about her and I would like to close with a quote from the writer Anatole France that sums up what I know of her approach to life: “To accomplish great things we must not only act, but also dream, not only plan, but also believe.”

# Understanding Women's and Men's Travel Patterns

## The Research Challenge

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Sandra Rosenbloom, *University of Arizona*

Men and women have long had different travel patterns. However, there is increasing convergence in those travel patterns, at least at the aggregate level. Trends in women's and men's travel patterns over time are evaluated to determine whether comparable men and women have similar travel patterns. It is concluded that (a) women's and men's aggregate travel behavior is 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 are tied to sex in society 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. There is more than adequate justification for a focus on women's transportation issues and the need for continued research on the nature and expected duration of the travel differences between women and men to supply the information needed to make effective transportation and other policies.

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**W**omen, on average, have different travel patterns from those of men (1–3). Most studies show that women make more daily trips but travel fewer miles, are less likely to be licensed to drive, are more likely to make trips with the purpose of serving passengers (such as taking children to activities or other adults to medical appointments), and are more likely to link or chain trips together than do comparable men (4,

pp. 75–87; 5–8). Moreover, women are less likely to have automobile crashes, although they are more likely to be hurt seriously in those crashes than are men (9–12).

Although there is agreement over the basic facts, there is some controversy about the reasons for these differences and the extent to which comparable men and women behave or react differently in comparable situations. Early women's travel studies were dismissed by some researchers and policy analysts on the grounds that women and men often led different lives; it was no surprise that women not in the labor force (or only working part time outside the home) had different travel patterns than did men in full-time employment. Many researchers believed that (a) the focus on sex was normatively rather than scientifically driven and (b) research on women's travel missed the fact that household roles, employment status, occupation, income, or residential location actually explained why men and women made different travel choices (13, 14). Schintler (15, pp. 351–358) argues that traditional models assume that each traveler's primary concern is to minimize travel time or costs; thus they do not correctly characterize gender differences in travel.

In the safety area, some observers believed that the differences in crash rates between men and women simply reflected differences in exposure (i.e., number of miles traveled) rather than differences in driving ability or behavior (16). Moreover, several presentations given at this conference have argued that whatever the historical causes, men's and women's travel patterns are converging, in part because so many of the underlying causes of travel behavior (employment, income, licensing, automobile ownership, etc.) have equalized.

The trends in women's and men's travel patterns over time are evaluated here, with an analysis of where, when, and why those patterns appear to be converging. Consideration is given to whether variables other than sex better explain travel differences between men and women and whether currently observed travel differences are likely to disappear. Also questioned is whether comparable men and women have similar travel patterns and whether the answer to that question actually makes a meaningful difference. Finally, some reasons are suggested for why different researchers address travel behavior studies differently and how that may affect their findings.

Three major findings are discussed. First, although there is little doubt that women's and men's aggregate travel behavior is converging, it is still far from equal on a number of measures and trends toward convergence may be slowing. Second, disaggregate analyses sometimes tell a different story. When one controls for age, life cycle, race, or ethnicity, one often sees major differences between men and women. Third, critics of the women's travel behavior literature are themselves missing the point. Sex does and will continue to explain many important travel differences because most underlying variables—from household role to income patterns—are so closely linked to sex in modern society. It ultimately begs the question to assert that other factors create differences in travel behavior when those factors are so intensely gendered.

There is still an important need for a special focus on women's travel. Ongoing travel differences between men and women at many levels of disaggregation raise a host of important research and policy questions. It is important to single out and separately evaluate women's travel patterns (*a*) when gender differences are large, (*b*) when the differences are persistent, (*c*) when women are a substantial majority of any group under study, or (*d*) when all three characteristics are present. At the same time, future research must take into account the complexity of travel behavior, use a combination of qualitative and quantitative methods that carefully consider the social context and environment, and control for a wide variety of variables that might affect the trip making of women and men.

The three major societal trends that create convergence in aggregate travel behavior are examined first: women's employment outside the home, changing household roles, and the growth of nontraditional households and families. Next the countervailing forces that act to differentiate further women's and men's travel are considered, forces that arise from these very same societal trends. Third, it is questioned whether it makes a difference if roughly comparable men and women have the same travel patterns if most of the people in question

continue to be women. Finally, the major findings are summarized and the kinds of research are identified that are needed on women's and men's travel behavior in order to develop effective transportation planning policies and programs.

## CONVERGENCE IN TRAVEL PATTERNS

Fifty years ago it was easy to see why men and women had different travel patterns: most men were in the paid labor force and most women were not. Thus most men's travel was shaped by their paid employment in locations generally some distance from where they lived, whereas that of most women was shaped by their (unpaid) domestic and childcare responsibilities, generally close to their homes (17–19). Of course, not everyone believed that this distribution of duties was fair (20) or that the transportation system was responsive to women's specific needs (21; 22, pp. 607–632), but the causes of gender differences seemed clear. However, in the past three decades most industrialized countries have seen three dramatic and related trends:

- The increasing involvement of women, particularly those with children, in the paid labor force;
- Changes in the distribution of household responsibilities (roles); and
- Substantial alterations in household and family structure combined with the aging of society.

These trends—which have set off an avalanche of travel-related changes—have clearly caused women's travel to more resemble men's in key ways and to differ sharply, when viewed carefully, in other ways.

## Women's Labor Force Participation

For generations women traveled fewer miles and were less dependent on the private car for their travel than men. However, there have been substantial increases in all indices of women's travel and automobility over the past three decades, and most experts believe that they are directly linked to the increasing involvement of women in the paid labor force (23, pp. 149–155; 24). Almost 62% of all U.S. women aged 16 and over were in the labor force in 2002, up from 42% in 1975. However, the overall figures hide the substantially higher employment rate among younger women: more than 75% of women aged 25 to 34, for example, were in salaried employment in 2002 (25, Table 1). Even among slightly older women there has been a dramatic growth in employment; 70% of women aged 45 to 54 were in the labor force in 2001 (26).

As more women have gone to work their miles traveled, trips made, driver licensing, and vehicle ownership have increased substantially. And it is no surprise that women have become more dependent on the private car to engage in their increased travel (24, 27). Some of the increase in travel was simply arithmetic: women who never before made one to five round trips to work per week began doing so. The U.S. Department of Transportation noted, "Simply being a worker increases the probability of making more trips and traveling more miles" (28). So as women entered the labor force, the gender gap in miles and automobile use began to rapidly disappear.

### Changing Household Roles

One of the most dramatic features of the increased labor force participation of women in the past four decades is the large number of working mothers, and especially the mothers of small children (29). Although there are differences between married and single mothers, the majority of all mothers work outside the home; 71% of married women and almost 82% of single mothers with children under 18 worked full time in 2003 (25, Table 5). Having younger children did affect the likelihood of paid employment although not generally the numbers of hours worked; 57% of married women with children under 3 and 53% with children under 1 were in the labor force in 2003, almost two-thirds in full-time employment.

When married women with children are in salaried employment, their household and family obligations create ripple effects through their daily and weekly travel choices (as it does for single mothers, a topic discussed in the next section) (28).

Many employed married women face a "double day" or a "second shift" combining paid and unpaid work. On average employed wives work fewer hours for pay than husbands and earn less, while their husbands still do less than a third of the domestic labor. (30)

Because of the complicated demands on their time, two-parent families face significant pressures to change the traditional ways in which individual members relate to one another and divide household responsibilities, and these changes clearly have transportation implications. More men are assuming domestic and childcare responsibilities, especially if their wives or partners work outside the home (31–34). A 1993 study concluded that in the previous three decades men had begun to spend more time on household activities; between the 1970s and the 1980s they did more household chores, but these were the traditionally male ones such as household repair and lawn care. Since the mid-1980s, however, men

have also helped more with what have been called "female chores," such as cooking, cleaning, and laundry.

A growing number of working parents arrange their employment schedules so that the father can watch the children while the mother works, and vice versa. For example, in 1999 18.5% of preschoolers were cared for by their father while the mother worked (35). In addition, there are a growing number of "househusbands"—men who stay at home to care for children while their wives work for pay (25, Table 5). In 2003, 1.4 million fathers in two-parent families with children under 16 were not in the labor force (25).

A study by the University of Florida's Center for Urban Transportation Research directly linked the growth of vehicle miles traveled (VMT) to the parenting role (although not by gender):

VMT levels grow with age and are at their highest levels for young to middle age adults who are in the peak levels of work-related travel as well as peak levels of household-serving travel. This is the stage where parents serve as chauffeurs to youth activities, travel to meet work and personal needs, and to accomplish other household serving trips such as shopping and errands. (36, p. 11)

Although traditionally women traveled fewer miles and less often in a car, for decades women have made more daily trips than men, which is probably related to their household responsibilities (1) whether or not they are in paid employment. Table 1 shows the average daily trip rates of men and women in two-adult households at different stages of the life cycle in 1990 and 2001. Although not the major purpose, the most striking message in Table 1 is the dramatic increase in trip making by adults in all life situations in the 11-year period but particularly among those with young children. More to the point, the data in Table 1 show that although women still make more trips than men, trip making has generally increased faster among men than among women. As a result, the index of men's to women's travel was closer to parity (1.0) in 2001 than it was in 1990; that is, men's and women's patterns have converged over the time period in all life cycles except the last (in which the youngest child is 16 to 21).

These data support the hypothesis that because household roles are changing and men are assuming more household responsibilities, men's travel has come to more resemble women's, at least in daily trip making.

### Changing Household Composition

Overlapping, or perhaps complementing, the increasing involvement of women in the paid labor force and the

**TABLE 1 Daily Trip Rates by Life Cycle and Sex, 1990 and 2001: Two-Adult Households**

Life Cycle	1990	2001	Percentage Change
No children			
Women	3.4	4.2	22.9
Men	3.3	4.1	24.8
Index M/W	0.97	0.99	
Youngest child < 5			
Women	3.5	4.6	30.6
Men	3.2	4.4	37.5
Youngest child 6–15			
Women	4.0	4.9	22.5
Men	3.3	4.5	35.8
Index M/W	0.83	0.91	
Youngest child 16–21			
Women	3.4	4.5	32.1
Men	3.3	4.6	29.4
Index M/W	0.97	0.95	

SOURCES: Unpublished data from the 2001 NHTS and Rosenbloom (1).

changing distribution of household responsibilities is the changing composition of families and households.<sup>1</sup> Today a substantial share of all U.S. households are composed of only one person (37); this category includes young people leaving their parents' home before marriage and those maintaining a household after a divorce. It also includes older people, divorced or widowed (or increasingly never married), who live alone. As a result single-person households accounted for more than 26% of all households in 2003, up from 17% in 1970 (38, pp. 43–142; 39).

In addition there are a growing number of single-parent-family households—that is, those with children under 18. In 2003 married couples with children accounted for only 23% of all U.S. households, down from 40% in 1970. But single-parent households accounted for more than 16% of all households and almost 24% of all family households (40).

Changing household structures affect travel by sex differently than do either employment or role changes. The trend toward convergence in travel patterns is driven within specific categories of single-person and single-parent households. That is, it is accepted that single-parent households have significantly different travel patterns than two-parent households (41), but there are more single-father households than ever before. It is possible, therefore, that both male and female single parents will have similar travel patterns.

<sup>1</sup> The U.S. census defines a household as the people occupying a housing unit. A family household contains at least two persons, the householder (usually the person who owns or rents the living quarters) and at least one other person related to the householder by birth, marriage, and adoption. It should be noted that a family household need not include children; it could be a husband and wife or a brother and sister, for example. The census recognizes three broad categories of family households: married-couple families, other families with female householders, and other families with male householders.

Young singles obviously have different travel patterns than married people and parents, but perhaps not from each other. And although there are clearly large travel differences between older men and women today, these differences may well disappear as more older women enter their retirement years as drivers.

### *Single-Person Households*

The creation of single-person households is one source of the growth in almost all indicators of U.S. travel (24). Two otherwise comparable unmarried people will have very different travel patterns if one lives alone—the latter will make significantly more trips. Some analysts, and presentations at this conference, have suggested that the growth of young single-person households may create a large number of male and female travelers whose transportation patterns are roughly the same if income, employment, and other relevant variables are held constant. This is a variant of the observation that it is household role and not gender that better explains travel patterns: comparable young men and men who live alone may have very similar travel patterns because neither group has childcare or major family responsibilities. The data in Table 2 suggest that, at least for those between 25 and 44, men and women living alone made roughly the same number of trips (although the very youngest men do make 13% more trips than younger women).

The same convergence may be true of older single-person households. It is likely that both older men and women who live alone will face the same set of domestic responsibilities. Moreover, the travel gap between older men and women has been closing, in part because the trip making and distance traveled by the elderly has increased faster over the past 30 years than for any other group in society and most significantly among older women (42). A recent U.S. report stated:

Improved health and growing automobile availability and licensure rates, particularly among [older] women, have driven growing travel.... Dispersed population (suburban living), smaller household size due to high divorce rates and lessened multigenerational living in the same household, and improved economic conditions also contribute to higher older adult VMT [vehicle miles traveled] rates.... Improving longevity

**TABLE 2 Average Daily Trips by Sex and Age, 2001: People Living Alone**

	16–24	25–34	35–44	45–54	55–64
Women	4.56	4.78	4.65	4.37	4.16
Men	5.17	4.77	4.59	4.66	4.25
Index M/W	1.13	1.00	0.99	1.07	1.02

SOURCE: Unpublished data from the 2001 NHTS.

and health combined with additional technology aids to assist driving are anticipated to produce continuing growth in the elderly VMT levels. (36, p. 11)

Figure 1 shows that although there were large gaps between the oldest licensed men and women in 2003, licensing rates among women and men who will turn 65 by 2013 are closer to parity (92% versus 97%). Thus the travel patterns of single adults over 65 may well converge in the future.

### *Single-Parent Households*

Another important component of the changing structure of households is the large and growing number of single-parent families. In 2003 more than 35% of all families with children under 18 were headed by a single parent, up from 20% in 1980. In fact, between 1993 and 2003 alone, the number of single-parent households increased more than 50%.

Several demographic factors explain these trends:

A larger proportion of births occurred to unmarried women in the 1990s compared with the 1960s and 1970s, increasing the proportion of never married parents. A partial explanation is that the delay of marriage also increased the likelihood of a nonmarital birth, because adults were single for more years. Another factor was the growth in divorce among couples with children. (43)

Traditionally, the overwhelming majority of single parents were women; in 1980, for example, in almost

90% of families with children headed by one parent, the household head was a woman. In 1995 the number of single male parents in the Nationwide Personal Transportation Survey (NPTS) was too small for any meaningful analyses of their travel patterns. However, the number of single-parent households headed by men increased 267% between 1980 and 2003—71% in just the decade between 1993 and 2003. As a result, today almost one in five single-parent households is headed by a father (44, 45).

Most unmarried parents are employed; in 2004, 76.1% of single mothers and 84.8% of single fathers had salaried employment. Among those employed, more than 81% of single mothers and 97% of single fathers worked full time (46). Thus single parents are often forced to balance both employment and domestic responsibilities without the help of another resident adult. This balancing act has traditionally had important transportation implications for single mothers: studies have shown that they make more trips, trip-link more often, and are more constrained by their children than married parents of either sex (42, 47, 48). If single fathers face the same constraints, their travel patterns may well be similar to those of single mothers, not differing by sex but rather by household structure.

### Summary

As women have joined the paid labor force some of their travel patterns have come to more resemble men's in several key areas—increased licensing, dependence on the car, trip making, miles traveled (and driven), and commuting. As men and women more evenly balance house-

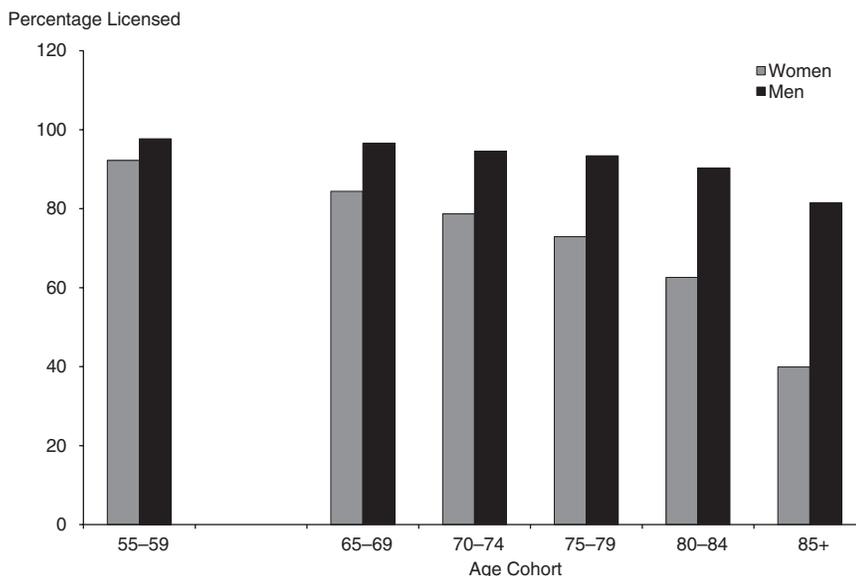


FIGURE 1 Driver's license rates by sex and age, 2003.

hold responsibilities their travel patterns may also converge. In fact, in 2001 U.S. men's and women's daily trip rates equalized for the first time; on average both sexes made 4.4 trips each day.

The growing number of younger single-person households as well as the increasing percentage of single-parent households headed by men may reflect underlying trends in which the behavior of women and men in these categories is explained by their obligations and roles rather than by their sex. The travel patterns of older single persons may reflect the convergence seen among those younger: as more women become licensed and come into their retirement years with substantial driving experience, their trip making may become more and more like that of their male counterparts.

### SOCIETAL PATTERNS THAT INCREASE DIVERGENCE

Changes in employment, the division of household responsibilities, and new household structures have clearly helped create many more similarities in the travel patterns of men and women than in the past. However, there are also some strong countervailing forces. First, societal trends such as increasing employment among women do not always close the travel gap between men and women, although they may superficially appear to do so. Second, household roles are not changing that much or that rapidly; although the direction is clear, neither the speed nor the magnitude of change is as dramatic as one might assume given the talk of growing equality between the sexes. Third, the growing number of new household structures often significantly involves, and more likely disadvantages, women than men.

### Employment Disparities

Women and men may have different experiences in, and outcomes from, their involvement in the labor force, factors that ultimately have travel implications, the most significant of which are

- Income,
- Occupation and industry of employment, and
- Part-time and flexible labor force employment.

First, women, on average, earn less than men, even men in the same industries and occupations. In 2002 women working full time made, on average, 77.9 cents for every dollar made by men, up from 62.3 cents in 1979 (25, Table 13). Moreover, U.S. working women aged 16 and older were 25% more likely to be living below the poverty level than comparable men, with the

gap being the largest at the youngest ages. For example, working women 20 to 24 were 53% more likely to be living below poverty than comparable male workers (25). There are various explanations for these income disparities, including discrimination, differences in training and education (49), and varying commitment to the labor force, for example, working part time and withdrawing from the labor force temporarily to raise children (50–53).

A second major reason, both for the lower income received by the average salaried woman and for differences in travel patterns between men and women, is the changing nature of the economic base of most developed countries. The U.S. economy has shifted from reliance on traditional manufacturing, farming, and mining to dependence on service-sector employment, in a process that has been described as the deindustrialization of society. Women are overrepresented in the service sector; almost 60% are employed in service-sector jobs (54). Unfortunately many, although far from all, service-sector jobs are low paid and intermittent, offering little chance for advancement. Thus the growth of service-sector employment has helped trap more women in inherently poorer-paying and less secure industries (55). A U.S. government report commented:

Even though married women have made progress in entering occupations predominantly held by men (especially executive and professional speciality occupations), the majority of women [are] still employed in traditional “female” occupations. For example, of the 18 million people in administrative support occupations (including clerical), 79 percent were women. In contrast, 91 percent of the 14 million people in precision production, craft, and repair occupations were men. (56, p. 3)

Industrial restructuring affects more than income. Women's greater concentration in certain occupations also has both spatial and temporal dimensions, which affect their travel patterns more than those of men. Temporally, a U.S. Department of Labor study found that almost 40% of women workers do not have a day-shift job, that is, one in which at least half of their work hours are between 8:00 a.m. and 4:00 p.m. In fact, almost one in four full-time U.S. women workers and more than 60% of those working part time did not work as many as three hours of their shifts between 8 a.m. and 5 p.m. (57).

Third, women are also more likely to be employed part time; even if working 40 or more hours per week, women are more likely to work variable hours. In the first quarter of 2005 women constituted two-thirds of all part-time U.S. workers, although only 25% of all U.S. working women were employed part time (58). Moreover, women are a majority of what has been called the

flexible work force—those who work full time but for less than a full year or who work at different locations or different schedules over a week or month for the same employer.

U.S. women are also the majority of those working at home (59). In 2003 women were also more likely to work for temp agencies and to work on call than were comparable men. And since 1999, a greater percentage of women workers than men have held multiple jobs (25, Table 31). All these temporal patterns have transportation implications and act to create real differences between men's and women's travel patterns (60).

Spatially, service industries, in which more women are employed, are substantially more dispersed across a metropolitan area than traditional manufacturing plants and rarely create any kind of spatial agglomeration. Thus women in the service industry can, and do, work anywhere in a region rather than at specific sites like factories, which tend to locate near one another (61). Thus their employment sites are less likely to be served by public transport, and they may have less opportunity to find neighbors with whom to carpool. In addition, having multiple jobs or multiple job locations means that women are more likely to have different, and varying, commutes than men.

Moreover, women still tend to work closer to home than comparable men, which may be the result of some combination of the employment opportunities open to them, their transportation resources, and their household responsibilities, a topic that has been debated for at least three decades (62–68). Although their work trip commute does increase with income earned, it never equals that of men with comparable incomes (69), although this may be more true of white non-Hispanic than minority women (70–73). Sometimes women's unwillingness to travel as far as men creates localized labor markets; Hanson and Pratt, for example, found small labor catchment areas surrounding suburban firms in the United States that hire low-skilled women. They argue that such firms may have located specifically to tap female labor markets, knowing that women will seek nearby job opportunities that men will not (74).

As a result of these trends, women often have more variable travel patterns than men or than did women in the past. They may commute at different times and to different locations than comparable men (and their commutes may change more frequently). They may also

make different mode choices because of the nature of their employment. In a U.S. Department of Transportation study (75) and two presentations at this conference, it was suggested that mothers who worked part time had the most complicated travel patterns of all workers.

Even though women are still more likely to use public transit than men, it is difficult for transit systems to serve the far-flung locations of service-sector jobs effectively. This situation may explain why in 1990 women with incomes under \$25,000 were actually more likely to drive alone to work (and less likely to carpool or use public transit) than men with comparable incomes (62). Sometimes there is no meaningful service outside of traditional peak periods (late at night, for example) or in low-density areas. Security concerns may prevent women from using the existing transit services (76–78); women's security while traveling was a major topic at this conference.

The fact that employed women generally work closer to home than comparable men can be seen in mileage data. Although women's mileage has increased substantially over the past decade, and at a rate higher than men's, women still travel fewer miles each day, on average, than men. Table 3 shows the vast differences in miles driven by female and male drivers in 2001; only the youngest women come even close to parity—women 16 to 24 drive roughly 82% of the miles driven by comparable men. For the rest of the age cohorts women drive roughly 6 mi for every 10 mi driven by comparable men.

Overall, although employment trends cause women to increase their trip making to levels more comparable with men's and to depend more on the private car to do so, the microlevel aspects of their travel patterns may continue to diverge from men's because so many work more varied schedules and in industries, jobs, and locations that differ from most men's while earning lower average salaries. Their household responsibilities may continue to be an important factor in their travel patterns, as is discussed next.

## Household Roles

The traditional family model—in which the husband works outside the home for pay and the wife works at home caring for her family without pay—has largely dis-

TABLE 3 Average Daily Miles Driven by Sex and Age, 2001

	Total	16–24	25–34	35–44	45–54	55–64
Women	26.9	25.4	27.0	29.8	27.8	21.9
Men	42.9	30.7	43.7	46.8	47.0	42.2
Index W/M	0.63	0.82	0.62	0.64	0.59	0.52

SOURCE: Unpublished data from the NHTS, 2001.

appeared in most industrial countries.<sup>2</sup> This change has created some significant pressures for changes in how family members relate to one another and how they divide household responsibilities. As suggested in an earlier section and in some papers given at this conference, the division of household responsibilities is becoming more equal in response to these pressures. This growing equality might bring convergence in travel patterns. However, the actual data suggest that observations that household obligations are becoming more equal may have correctly assessed the direction of such changes but neither their speed nor their magnitude.

Men are assuming more domestic and childcare responsibilities, especially if their wives or partners work outside the home (79). Unfortunately, what most explains the closing gap between the sexes is that the total time the entire household spends on household chores falls when women enter paid employment. A 2000 study using travel diary data showed that domestic labor—not counting childcare and shopping—has continued to decline since 1965 as women's paid employment has grown.

This finding is mainly due to dramatic declines among women (both in and out of the paid labor force), who have cut their housework hours almost in half since the 1960s.... In contrast men's housework has almost doubled during this period (to the point where men were responsible for a third of housework in the 1990s). (34)

Thus men are doing a higher share but one that involves less total work.

A 2002 study found that wives still do more than their husbands in the most egalitarian of countries (80). A 2004 international comparative study of 22 largely developed countries found that the division of household responsibilities was more influenced by macrolevel variables, such as wage rates and the state of economic development, than by any variables open to individual determination (such as personal attitudes about equality in household roles). The study concluded that "changes in individual-level factors may not be enough to achieve an equal division of housework, without the reduction of macro-level gender inequality in economic and political power" (81).

Most studies have found that employment makes a difference; when both adults are employed, the distribu-

tion of chores is more "equal" (34, 82, 83). But even in dual-earner households women are responsible for the majority of all household and childcare chores, although they do less than nonsalaried housewives (84). Research shows that employed men married to employed women do more housework than men in single-earner families, but this finding seems to be mediated by the number of hours the men work and their salaries—the higher their salary or working hours the less household work men do relatively independent of their wives' salaries or schedules. Moreover, the chores done by men and women remain different; women tend to do the "traditionally feminine" tasks such as cooking and cleaning while men do "episodic discretionary tasks" (34).

A 1996 review of the literature on this subject commented:

The most notable characteristic of the current division of household labor is that, whether employed or not, women continue to do the majority of housework. Current estimates are that men do between 20% and 35% of the housework. In spite of disagreement over the significance of change in the division of household labor, the nature of recent shifts is clear. Women still do the majority of housework, but they are doing less and their spouses more than in the past. (85)

Children have a profound impact on the division of household labor. Having children under 11 increases the amount of time both spouses or partners put into household chores, but that amount is three times more for wives than husbands independent of employment status. Thus having young children substantially increases the housework gender gap (34). The authors of a 1996 study concluded: "Gender remains a more important determinant of housework than any other factor" (86).

A 2003 study found that women experience less leisure time than comparable men and that these differences are greatest when young children are present. Women's free time was more often "contaminated" by their need to watch their children: "Mothers, more so than fathers, bear sole responsibility for children during their free time." Moreover, fathers experience greater subjective net benefits from their free time than do women; the researchers suggest that this may be because mothers simply "spend more time worrying about undone work or family issues during their free time."

This difference may result from the different ways that men and women are socialized to behave. If women have a more inter-connected work-family life experience, they may not get as much practice at turning off the concerns of one sphere when they enter another. This may spill over into their leisure experiences as well. (87)

<sup>2</sup> Trenchant observers have noted that the traditional model is more an artifact of the late industrial revolution than a description of how families have operated for a number of centuries. Women almost always worked, generally without pay, in the family business or farm. Women en masse staying home to care for their families was a late 19th-century model of middle-class life more than a description of how the majority of families lived.

Although the subject is not much discussed in the travel behavior literature, it has been known for decades that women are overwhelmingly the persons responsible for direct care of aging parents and in-laws (88, 89). Studies have shown that such responsibilities are a tremendous burden on working women (90). Since fewer older people live with their adult children than at any other time in U.S. history, these responsibilities must affect women's travel patterns (91).

Although there has been some media focus on househusbands, the data do not indicate that this is an important trend. In 2003 only 4.3% of men in married-couple households with children under 16 were out of the labor force, and only 16.3% of that small number said that they stayed home to care for their family (compared with 88.3% of married mothers who said that they stayed out of the labor force for family reasons). It appears that a large percentage of men performing the househusband role are only doing so temporarily while ill, unable to find work, or in school (25, Table 5).

In the past five years there has been a leveling off in men's assumption of a greater share of household work, which

could indicate merely that men will continue to increase their allocation to housework over the next decades, but at a slower rate than in the 1970s and 1980s. Alternatively there may be some relatively stable "ceiling" for how much time men will contribute to housework, unless there are significant changes in how paid work is structured, or to gender relations more generally. (34)

Where and when women work, combined with their household and family roles, create ripple effects through their daily and weekly travel choices. A recent U.S. Department of Transportation report noted:

The commuting pattern of workers continues to determine the location and time of other activities—the location of work anchors some trips and the location of home anchors others. People commonly make stops on their way to and from work ... research on trip chaining shows that on an average work day one out of four men and one out of three women make stops during their commute. (28)

In a 1998 Transportation Research Board report, it was commented that

the ways in which salaried women balance their domestic and childcare responsibilities ... create substantially greater and different effects on the modes they chose, the hours they travel, the routes they take, and how they organize and combine their out-

of-home activities.... How—and where—working women take care, or arrange for care, of their children while they work have important transportation implications... Because they retain multiple responsibilities when they enter the paid labor force, women often link trips together, dropping children at daycare on the way to work or going grocery shopping on the way home. (61)

A 1993 Seattle study found that women were more likely to make stops on the way home from work than comparable men and noted that "this reflects the role of females in society and the variety of activities they pursue (for example, shopping, personal business, and recreation) to satisfy personal and household activities" (6). Trips including several stops between one origin and the final destination are referred to as linked or chained trips. A Southern California study found that employed women were twice as likely as employed men to report needing to bring a vehicle to work so that they could take their children to daycare and school.

An analysis of a 1994 Portland, Oregon, activity and travel survey found that women heads of household performed more activities, made more trips, were more likely to link trips, and created more complicated trip chains when they did than comparable men (92). A 1990 study in four Chicago, Illinois, suburbs found that employed women made twice as many trips as comparable men did for errands, groceries, shopping, and chauffeuring children (93).

Both the 1990 and 1995 NPTS showed that employed mothers of small children linked trips far more often than did comparable male parents. In 1990 more than 40% of married women workers with children under 6 linked trips home from work compared with 30% of comparable male workers. In fact, no matter the age of their children, women workers were always more likely than comparable men to link or chain trips. Employed women were also more likely to have complicated chains with multiple stops between home and work (94, 3).

Several presentations given at this conference suggested that trip-chaining behavior is becoming more similar for women and men if measured in terms of propensity to link trips to or from work. However, these studies did not control for trip purpose or other relevant variables. The study by McGuckin and Nakamoto in Volume 2 of these proceedings, which used the 2001 National Household Travel Survey (NHTS), found that women still make more linked trips and that the purposes embedded in those trips vary more, with women doing more serve-passenger and household-serving trips than men.

Table 4 suggests how these factors play out in slightly disaggregated travel patterns. The data make clear that women younger than 45 almost always made more trips than men in comparable households. This finding may

TABLE 4 Average Daily Trips by Sex, Age, and Life Cycle, 2001: Two-Adult Households

Life Cycle	16–24		25–34		35–44		45–54		55–64	
	Women	Men								
No children										
Trips	4.43	4.00	4.24	3.97	4.14	4.10	4.24	4.22	3.87	4.34
W/M Index	0.90		0.94		0.99		1.00		1.12	
Youngest child 0–5 years										
Trips	3.96	3.97	4.66	4.32	5.09	4.74	4.13	4.26	3.03	3.59
W/M Index	1.00		0.93		0.93		1.03		1.18	
Youngest child 6–15 years										
Trips	4.21	4.00	4.65	4.19	5.24	4.63	5.18	4.71	3.30	4.57
W/M Index	0.95		0.90		0.88		0.91		1.38	
Youngest child 16–21 years										
Trips	4.36	4.01	5.31	4.53	4.40	4.32	4.67	4.59	4.21	4.48
W/M Index	0.92		0.85		0.98		0.98		1.06	

SOURCE: Unpublished data from the 2001 NHTS.

TABLE 5 Married People's Trip Purposes in Percentage of All Trips by Selected Life Cycles and Sex, 2001

Trip Purpose	In Work Force						Retired	
	No Children		Youngest Child < 6		Youngest Child 6–15		No Children	
	Women	Men	Women	Men	Women	Men	Women	Men
Shopping	14.8	11.8	14.0	11.0	13.1	10.1	19.5	16.1
Serve passenger	3.8	3.1	14.0	7.7	13.8	7.5	4.3	3.6
Social and recreational	10.7	10.3	9.5	9.0	8.5	10.3	11.1	12.2
Family and personal business	10.1	8.6	8.6	7.1	8.5	7.9	10.5	11.2
All other (including returning home)	60.6	66.2	53.9	65.2	56.1	64.2	54.6	56.9

SOURCE: Unpublished data from the 2001 NHTS.

reflect the fact that their travel is still more constrained by their childcare and other responsibilities than is that of men.

Table 5 shows that there are important differences in trip purpose<sup>3</sup> between otherwise comparable men and women, but particularly among those with children. In every life-cycle category women made a greater percentage of their trips for shopping than comparable men did. This finding may, of course, indicate that they like to make those trips more than men; it may also mean that they are required to do more household provisioning because it is seen as their role. Women in the labor force are also more likely to make a greater share of their trips than are comparable men for family and personal business. Perhaps most striking is the difference in the share of serve-passenger trips; in every life-cycle category women made a greater percentage of their trips to accommodate other people. When children were involved, women made almost twice as many of their total trips to take someone somewhere as did comparable men.

Overall, household roles are changing slowly, as are the travel patterns that parallel those roles. Although men are doing more household work than ever before, the rate of increase is more impressive than the actual

amount. Starting with a low base produces some notable percentage increases based on relatively small absolute changes. Almost all studies suggest that men do no more than a third of all domestic work even when their partner or spouse works full time. Thus the travel patterns of comparable men and women, patterns that shadow the distribution of household obligations, continue to diverge.

### Changing Household Structures

Despite the previous discussion about changing household composition, there is no compelling evidence that the travel patterns of women and men in single-person households composed of older people or in single-parent households are converging as much as they might have. The reason is that even if somewhat comparable, men and women in these groups appear to face different problems. Unfortunately, there is almost no information on the travel patterns of younger single-person households.

### Single Parents

**Underlying Trends** Although the number of families headed by a man alone is growing, it is still true that single-parent households are substantially more likely to be headed by a woman than by a man. In the United States between 1970 and 2003, the number of single-

<sup>3</sup> To isolate the trip purpose "serve passenger," it was necessary to use the NHTS codes, which include as a trip purpose "going home," which accounts for just over 40% of all trips. The problem is that using that purpose artificially lowers the importance of all other trip purposes, since going home is always the second half of a trip for some other purpose.

mother families grew from 3 million to 10.1 million, or a 237% increase; single-father families grew from 0.39 million to 2.3 million, or a 490% increase (43, 45). Although the large percentage growth in single-father households has captured media attention, in 2003 only 4.6% of all U.S. children under 18 lived with their father. Only 17% of U.S. children living with one parent lived with their father (the same percentage as in 1986) because single-mother families have more children than single-father families (95). In 2003 almost two-thirds of all families headed by a man had only one child and only 10% had more than three children. Conversely, roughly 17% of single mothers had three or more children and only half had only one child.

Although the majority of single parents worked outside the home in 2004, single fathers were more likely to be employed than single mothers. The younger their children were, the less likely single mothers were to work outside the home, but the age of their children had little impact on single fathers. Among those whose youngest child was younger than 6, 57.4% of single mothers but 91.2% of single fathers were employed; the participation rate was the same for fathers of older children but jumped to 73.8% of single mothers with children 6 to 17 (46). Differences in employment and family size probably explain why families headed by a female parent were twice as likely to live below the poverty level as were single-father families. In 2001 in the United States,

of the families maintained by women with no spouse present, 17 percent had an income below \$10,000 and only 8 percent had an income of \$75,000 or more. In contrast, of the families maintained by men with no spouse present, only 8 percent had an income below \$10,000 and 17 percent had an income of \$75,000 or higher. (56, p. 4)

In 2003 almost one-third of all single-mother households lived in poverty compared with less than 16% of single-father households (25). A recent study found that single custodial fathers spend more time in leisure pursuits with their children than do single mothers (87), which may be linked to income and family size.

**Diverging Travel Trends** A study of single-parent households in the mid-1980s noted:

Employed single mothers have different travel patterns from both comparable married fathers and mothers at all income levels, as do their children. These travel patterns appear to reflect the way in which single mothers juggle complex domestic and employment roles with very limited resources and assistance. (27)

Earlier studies found that single mothers are substantially more likely to make trips solely to chauffeur their children and are more likely to be the most frequent travel "mode" for their children than are married parents. However, these studies were conducted at a time when there were far fewer single male parents than today. Is it possible that despite average socioeconomic differences between single male and female parents, their travel patterns may be similar because of the common demands they face?

Additional unpublished data from the 2001 NHTS show that single mothers whose youngest child was younger than 6 made more than 80% more of their total trips to serve passengers than single fathers with children younger than 6 (17.5% versus 9.6% of all trips). When their youngest child was between 6 and 15 years of age, single mothers took roughly 14% of all their trips to serve passengers compared with less than 9% for single fathers. Single mothers also made a greater percentage of their trips for shopping and personal business than did single fathers. Conversely, single fathers took the largest component of their nonwork trips for social and recreational purposes (15.4% when their youngest was younger than 5 and 11.6% when their youngest was 5 to 15 compared with 10.7% and 8.5% of all trips, respectively, for single mothers).

At the same time, single fathers do have different travel patterns than married fathers with children of the same age. Unpublished 2001 NHTS data show that single fathers of children younger than 6 make a smaller percentage of total trips for shopping but a greater share for serving passengers and family business, although oddly also for social and recreational trips, than comparable married fathers. Single fathers with young children made 9.6% of all trips for serving passengers compared with 7.7% of all trips of married fathers. When their youngest child is older, the trip patterns of single and married fathers are more similar; the greatest difference is still in the share of serve-passenger trips (8.5% versus 7.5%). Single fathers also make more daily trips on average than do married fathers.

Regardless of income, all single parents are at a disadvantage in U.S. society because there is no second parent to assume any of the multiple responsibilities. But low-income single mothers, and those from ethnic or racial minorities, may face additional problems that affect and are affected by their transportation choices. Although the majority of single mothers are white, there are substantial concentrations of single parents among women of color. Because of historical and current patterns of racial segregation and discrimination, many of these single mothers have more limited access to employment concentrations (96).

In the United States many single mothers are stranded in the center of major cities whereas the majority of new

job growth has occurred in the suburbs (97, 98). Thus these women may be forced to travel a substantially longer time than comparable married women for fairly low-wage jobs, although Blumenberg and Hess found greater variability in job locations and transportation needs than was previously assumed (99) and others have not found the clear link between low income and commute distance (100). Still, most studies have found that single low-income women workers generally travel further than comparable married women and have a greater need for, or tendency to use, a car for those commutes (71, 101–105).

Overall, single fathers and mothers do not appear to have similar travel patterns, in part because they do not have families of the same size or comparable employment or income characteristics and in part because female and male single parents appear to make different activity and travel decisions. Even with lower incomes, female single parents make more trips and are more constrained by their children's needs than are comparable fathers. Given the sometimes large differences in travel behavior, some of which are counterintuitive, it is unlikely that the small number of comparable single female and male parents have similar travel patterns. It does not appear that meaningful convergence in travel patterns among single male and female parents is occurring, whether or not they are in comparable situations.

### *Older Single People*

**Underlying Trends** Most single-person households of older people are composed of women living alone. Women 65 and older are four times more likely to be widowed than their male counterparts and 20% more likely to be divorced (56). The disparities in household structure increase substantially with age. In 2004 slightly less than half of all women older than 75 lived alone—twice the comparable rate in 1970. But in 2004 only 23% of comparable men lived alone, not much more than the 1970 rate of 19% (106). In 2003 among those 85 and older only 14% of the women but more than 59% of men were married and living with their spouse; unmarried men were substantially more likely to be living with another family member than were comparable older women (107).

Moreover, older women have lower average incomes and are substantially more likely to be living in poverty than comparable men. In 2004 the median income of older women was roughly 59% of that of older men (106). In 1997 almost 14% of U.S. women but only 7% of men older than 65 lived below the poverty level (108). In 1990, 58% of women older than 75 living alone—but only 42% of comparable men—had incomes under \$10,000, whereas 40% of women older

than 85 living alone were poor compared with 27% of comparable men.

Over the next three decades the overwhelming percentage of those older than 65 will live in suburban or low-density areas either because they have aged in place or because they moved there on retirement (109). In 2000 almost three-fourths of the older population, single or married, lived within metropolitan areas but largely in the suburbs of those areas. A study using 1995 NPTS data found that only 9% of those aged 65 and older lived at the kind of high densities that would support public transit use (118) even if they lived in the central city. This pattern has been intensifying for decades; as demographer William Frey noted:

The suburbs aged more rapidly in the 1990s than the nation as a whole. In large measure, this “graying” of the suburbs resulted not from migration to the suburbs in the 1990s, but from residential location decisions made long ago. (91, pp. 3, 4)

These patterns both require and support increased automobility and create significant mobility patterns for those unable to continue driving (111).

In short, because women still outlive men and live alone more often than comparable men, the majority of older single-person households are female. Most of these single-person households will be located in low-density areas, either in the suburbs of metropolitan areas or in rural communities, where options to the car rarely exist. When older women are unable to drive, they are substantially less likely to have someone else in their household to drive them (or bring them goods and services in lieu of travel). Thus the overwhelming number of “stranded” older people are and will continue to be women (112, 113).

**Diverging Travel Trends** Given current licensing trends, most women will enter their retirement years as drivers and that factor may create convergence in older people's travel patterns. Older women will have greater mobility than comparable women in the past if mobility is measured by making more and longer trips, mostly in cars. Older women will also have more crashes as their exposure increases. Because so many live in suburban or rural locations, they may be more disadvantaged when they lose their ability to drive than their counterparts of a few years ago, who lived near and used public transit (114–117). In all these ways their travel patterns are converging with men's.

However, there are still sometimes substantial differences in the travel behavior of comparable older men and women. Although older women are more likely to be licensed than ever before, and their trip and mileage rates increased faster than any other group between

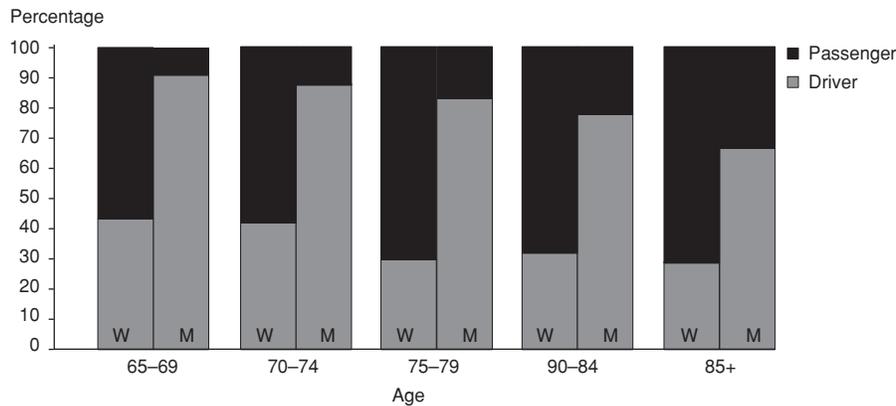


FIGURE 2 Driver versus passenger status in all privately owned vehicle trips by licensed drivers 65+ by age and sex, 2001.

1995 and 2001, the 2001 NHTS shows that they still take fewer trips in all age cohorts older than 65, including the youngest (65 to 69). The data also show that older women travel considerably fewer miles than comparable men. Both older men and older women are heavily dependent on a private vehicle for the overwhelming percentage of their trips; people older than 65 take at least 88% of all their trips in a private vehicle at all ages. However, men are slightly more likely to use that mode at all ages than women; for example, between the ages of 70 and 74, men take almost 92% and women 88% of all trips in a car (Figure 2). The 2001 NHTS data also show that older men rarely use public transit; more than 85% of all public transit ridership among those older than 65 is by women.

Because the trip gap between older men and older women remains so large despite the substantial increases in women's travel, when the travel patterns of older people are removed from aggregate U.S. totals by sex the convergence in trip behavior disappears. As several presentations at this conference noted, in 2001 all men and women 16 and older made, for the first time, the same number of average daily trips—4.0. However, because older men make so many more trips than older women, they increase the total male daily trip rate; when all travel by those 65 and older is removed, women 16 to 64 still make 21% more daily trips than comparable men. In short, the daily trip rates of comparable older men and women are so different that their inclusion distorts the total trip-making picture by sex.

A more important difference between comparable seniors is that women who drive do not actually drive the car in which they are traveling as often as older men do. For example, in 2001 men older than 85 made 89% of all their trips in a private car, and they were driving that car for two-thirds of those trips. Conversely, women older than 85 made almost the same proportion of their

trips—86%—in a private vehicle but were only driving a third of the time.<sup>4</sup>

This difference has a number of long-term consequences. Older women often sharply reduce their own driving as they age because they do not have confidence in their abilities (118–120). As a result, older women self-regulate more and give up driving at earlier ages and for less specific reasons than older men (121–126). These trends are related to long-term mobility differences even among older men and women who have been drivers for most of their lives.

Whether the mobility differences persist as the current generation of young and middle-aged women ages will be an important research topic. Unpublished data from the 2001 NHTS show that older women accounted for 83% of all those older than 65 who did not drive. This finding is partially because so many of the current generation of older women never drove but increasingly because those who did drive gave it up earlier than men did. Older women who do not drive are substantially less likely to live in a household with another driver than comparable men; even when they are married, their husbands are likely to be older and also unable to drive (112).

Overall, there is far less convergence in travel patterns among older women and men than might be predicted on the basis of the growing automobility of the elderly. Although older women have increased their trip making faster than has any other cohort of travelers, substantial gaps still remain between comparable older men and women. Moreover, because so many more older women are transportation disadvantaged than men—in that they lack access to a car or a family member to drive them or have substantially lower incomes than older men—their

<sup>4</sup> This finding is not because women have given up driving (or their licenses) entirely since the NHTS imputes driver status to those who drive; it does not question licensing status.

travel patterns will continue to differ from those of older men in important ways.

### COMPARABILITY OR NOT?

Do men and women have different travel patterns? The answer is clearly yes—as it has been for decades—even in the face of growing convergence in some aggregate patterns. A second and more important question is, Why are there differences between men and women? Do men and women have different travel patterns even if they are in comparable positions? The answer also appears to be yes although the travel differences between the sexes may not be as great as in the past and there are situations of greater equality.

But a third question may well be the most important: What difference does it make if roughly comparable people have the same travel patterns if most of the people in question continue to be women? To reconsider some of the data given earlier,

- Older women (65+) constitute more than 80% of all elderly people who live alone, don't have a driver's license, exist below poverty, and have no access to a household driver; they are also substantially more likely to give up driving than comparable men are, even in the absence of illness or crashes.
- Single mothers compose 80% of all single-parent households and of all single-parent households living below poverty, and their travel patterns are fairly different from those of single fathers.
- Married women who work full time still do at least two-thirds of all household and childcare tasks and even greater shares if their husbands make more money or work longer hours, independent of the hours they themselves work; thus they do the majority of household-serving travel.

In addition to these facts, there is substantial evidence that women have different preferences, values, and concerns about safety (127), security (128), the environmental problems associated with the car, and the various attributes of cars themselves (129–132). All of these facts and trends seem to more than justify a continuing and specialized focus on women's travel issues.

The overall focus of this paper has been on whether men's and women's travel patterns are becoming more similar. But the emphasis on convergence and divergence has slightly other possibilities. It is possible that some men and women will change their activity and travel patterns over time to create new patterns, different from those seen historically. And some men's and women's behavior may converge in old or new patterns whereas others do not. For example, if some men take on more

household duties but different duties than their wives or partners, perhaps their travel patterns will be both new and still different from those of their spouses. Other men and women may equally share the same family duties, creating new travel patterns, which are similar for both sexes.

Another key issue is the long-term impact of race and ethnicity; the United States is rapidly becoming a diverse country through immigration from abroad and higher birth rates among some ethnic groups (133, 134). In fact, white non-Hispanics are no longer the majority of the population in major metropolitan areas from Los Angeles to Miami. Although not widely considered in travel behavior research, important travel differences by race and ethnicity in young and old travelers have been found in licensing rates, miles traveled, number of daily trips, and propensity to carpool or use transit (114, 135–137). Unpublished data from the 2001 NHTS show similar patterns; white women, for example, are substantially more likely to be licensed and depend on the car for their travel than are minority women, even when income and other relevant variables are controlled for. As in the past, in 2001 there were greater differences between men and women within each ethnic and racial group than between white non-Hispanic men and women.

Several conference presentations addressed these issues as well and suggested that some aggregate differences in travel by women and men may actually be explained by gender differences in race, ethnicity, immigration, or assimilation status, or all four variables, because those variables are linked to either major differences in income, family structure, household roles, and employment status or substantial differences in cultural norms and values. It is possible that the patterns of white, non-Hispanic men and women are converging while those of other ethnic and racial groups are creating the differences that remain between the sexes in the aggregate. But this discussion begs another important question: with assimilation will Hispanics or Asians or other major ethnic and racial groups begin to resemble white non-Hispanics in many ways, including greater convergence in the travel patterns of men and women? Or will they too develop new travel characteristics, different from their own historical or traditional patterns but perhaps also different from those of the majority culture? And will gender differences be embedded in these new ethnic or racial travel patterns over time?

A more comprehensive understanding of the impact of key sociodemographic factors on activity and travel patterns and consideration of whether these factors are likely to have differential implications for some or all women and men are needed. It is necessary to move beyond the simple question: When and why do men's and women's travel patterns differ? Instead one should ask which men's and women's patterns are becoming

similar and when and if new or hybrid patterns are evolving that converge or diverge by sex and why.

## CONCLUSIONS AND NEEDED RESEARCH

### Summary

Overall, women's travel patterns are likely to continue to diverge substantially from men's in a variety of areas even as they continue to converge on some aggregate measures. The analyses presented here strongly suggest that many of the ways in which women's travel differs from men's are distinguished by any or all of the following characteristics:

- The differences are major and will persist because the underlying causes are not likely to change rapidly (or at all),
- They occur because women continue to be a substantial majority of groups with specific travel needs and patterns, and
- They reflect real differences between the sexes, either physical (such as effects of crashes) or societally constructed (such as making employment and ultimately travel decisions based on household roles).

### Why Continued Resistance to Study of Women's Travel?

Given the foregoing characteristics, why is it so difficult to get some researchers and particularly travel behavior researchers to accept that study of women's travel behavior is justified? The history of the three conferences on women's transportation issues (these are the proceedings of the third conference) is illustrative. The first conference, sponsored by the U.S. Department of Transportation (DOT), was held in 1978; when the initial conference announcements were issued, DOT was considered for the humorously named golden fleece award given to the public agency that most wasted taxpayer dollars; the political commentator George F. Will wrote a column in *Time* denouncing the conference, the organizers received hate mail, and many notable travel behavior scholars made clear their reluctance to be involved in such an activity. Each of the two subsequent conferences faced opposition, albeit diminishing, but still some influential scholars believed that there was no scholarly justification for addressing women's travel issues.

Does it really make sense to assert that a major variable explaining travel behavior is not really sex but rather household role or income or marital status? Isn't that assertion beside the point when so many of the "explanatory" variables are and have been so closely

associated with being female, and hardly in an accidental way? Why it is so difficult to get researchers in this area to confront the fact that men and women have different travel patterns, differences likely to continue for a long time? When sex is an easy bit of data to gather and household role is difficult, why is there so much resistance to associating behavioral differences with sex?

Some resistance to studying women's travel behavior lies in the fact that women's behavior was never a major component of research on travel behavior, and it is always easier to continue long-term trends than to establish new ones. Although various disciplines (mainly geography, sociology, and anthropology) have addressed household and personal travel for decades, most of the systematic research on travel behavior grew out of the need to facilitate the development of U.S. highways and address peak period traffic congestion (138). Because this approach focused narrowly on work travel, which is only a small part of most people's travel, it omitted women, who did not work outside the home as often as men in the 1950s and 1960s, when such research began (139, pp. 1–11). Thus from the beginning, most systematic travel behavior studies did not need to examine women's travel patterns. Even when women entered the labor force in greater numbers, the emphasis on only their commute behavior gave a distorted view of their travel patterns and obscured differences between the sexes (for example, for decades regional studies did not analyze linked trips because it was thought they were too small to matter).

Probably just as significant, it appears that resistance to studying women's travel per se is a response to the possible political nature of the research agenda; indeed, some feminist researchers have made various political or equity arguments in support of research on women's travel (140; 141, pp. 158–168; 142).

A negative response to demands for research on women's travel based on feminist or advocacy positions assumes, of course, that most travel behavior studies are apolitical in the questions they ask, the methods they use, the data they gather, and the analyses they produce. In reality, the way in which different researchers conceptualize travel behavior questions (or other complex questions) and the methods they use to answer them significantly affect their outcomes in ways that are often just as subjective as overt advocacy.

Unfortunately, there are as many difficulties with these so-called scientific approaches as with more qualitative ones and they strongly affect how research on women's travel is treated. Indeed, many researchers fail to recognize that some mathematical relationships can be statistically significant without being at all important and that some relationships that cannot be measured in ways that allow their statistical significance to be calculated are important.

Probably the most significant problem with many quantitative approaches to understanding travel behavior is that researchers are required to make large and sometimes debatable assumptions in all aspects of their research and modeling. For example, many studies begin by assuming that women's travel will not differ from men's in ways that cannot be explained by traditional socioeconomic variables. That initial assumption may lead researchers to make other assumptions, for example, that in a one-car household all drivers have equal access to the car, an assumption that is unlikely to be true. It is not surprising then that such approaches do not find that women's travel differs from that of comparable men.

Other problems flow from the first. Quantitative researchers often need large amounts of data, and they are often forced to rely on what is available rather than on what they need. This requirement causes researchers to use proxy variables for many factors, which may poorly reproduce the phenomenon being studied, including underlying differences in how women and men made travel decisions. Even if researchers are able to collect the data they need, it is often difficult to accurately quantify the important social variables that underlie travel behavior—from personal attitudes to cultural beliefs.

In fact, there is a vicious cycle at play. Because many travel behavior researchers do not respect more qualitative or less statistically based research, they do not read it and fail to profit from the insights offered by that literature. Thus they do not recognize or challenge the questionable assumptions in their models and methods. A superficial analysis of the travel behavior and modeling literature over the past two decades shows little acknowledgment of the vast body of research on women's travel issues in geography, sociology, public policy, and city planning.

For all these reasons many travel behavior researchers have developed models that simplify reality—although they are often enormously complex—but come nowhere near describing, let alone understanding, the multifaceted social environment within which most women and men make their travel decisions. This approach has carried over into many program analyses or policy studies that fail to collect gender data or analyze their data by sex (for example, incentive programs for carpooling or transit use) (7, 143). Relying on such work, many transportation planners tried to develop transportation programs that did not differentiate between men and women. Guaranteed-ride-home programs, for example, were designed to encourage transit and carpooling by allowing people who did not drive alone to work to get home quickly to respond to their children's or aging parents' needs in an emergency. Early studies found that these programs were mostly used by men in middle or upper management because most women were less secure, "pink collar" workers who did not want their

employer to think that family responsibilities interfered with their job or were worried that the costs would be subtracted from their pay (144).

Indeed, qualitative approaches can have the problems that more quantitative researchers ascribe to them: they can reflect solutions in search of problems, fail to apply rigor to their analyses, and, as with quantitative researchers, assume things they ought to be proving. But many disciplines and researchers argue that if done correctly, such approaches add tremendously to the understanding of complex societal phenomena (145–147). To advance research on women's travel issues, it is necessary to bring various research communities together and develop multiple and interconnected approaches to understanding the complex societal factors that influence the travel behavior of women and men.

In the best traditions of social science research, all researchers need to build on or challenge the full body of work that has gone before, using the insights of both qualitative and quantitative studies to sharpen their focus, define their hypotheses, and give meaningful context to their analyses. In so doing, the right questions about women's and men's travel behavior can be asked—and, it is hoped, can start to be answered—by using a combination of methods without advantaging either qualitative or quantitative approaches, or indeed specific quantitative approaches (148).

## Needed Research

The large and continuing differences between women and men have substantial policy implications in a variety of areas from safety to security, from equity to environmental pollution, from mobility to sustainability. It is crucial that continued resistance to studying women's travel behavior be surmounted and research be structured that provides the information needed to (a) evaluate fully the impact of governmental policies like road pricing, transit subsidies, or sanctions on automobile use and (b) develop and plan key transportation, community design, employment, housing, and public health programs and a host of related programs and facilities. Given the substantial growth in all aspects of women's travel, an effective and efficient—let alone equitable—transportation system cannot be developed unless the underlying causes of the differences in the travel patterns of women and men are recognized.

The foregoing analyses suggest that multiple approaches are needed that

- Examine convergence and divergence in detailed travel patterns by traditional and nontraditional socioeconomic variables, including both those that can reasonably be described quantitatively and those that require more qualitative analyses;

- Evaluate the implications of differences between men and women in attitudes, beliefs, preferences, and values about the underlying causes of travel (security or safety concerns, concerns about the driving task, willingness to be a passenger rather than a driver, etc.);
- Expand the knowledge of the travel behavior of groups long studied and fill in the data blanks for groups about whom little is known, such as younger single adults living alone and those working part time; and
- Identify travel differences or similarities by sex associated with land use and community design and the availability of different transport options for both young and older adults as well as for their children and grandchildren.

In addition, as other papers in these proceedings comprehensively describe, there are substantial differences in the safety needs of men and women, in part because men and women differ in their exposure rates and risks and in part because there are still important safety differences for men and women with comparable exposure and risk rates. Therefore research is also needed on differences in crash rates and crash outcomes by sex as well as a focus on physical or innate differences between the sexes in key aspects of travel from the dimensions of cars and other vehicles to passive and active vehicle safety systems, roadway attributes and signage, and transit service characteristics.

This kind of research is needed to

- Provide a better understanding of why most women's travel or safety patterns are not the same as most men's,
- Question if and for how long the differences will last, and
- Evaluate whether and what policy or planning responses are required.

Of course, not all travel differences between women and men, even if long-lasting, are a problem; not all disparities indicate transportation barriers that must be addressed. Variations in personal preferences, attitudes, and beliefs may underlie some of the differences; historical constraints and traditional values that are changing may underlie others. But it is important to try to understand the nature and expected duration of the travel differences between women and men to offer appropriate customer service options in all transport modes, to ensure safe and secure use of the transportation system, and to develop and enhance public policy in a variety of transportation and related arenas.

## ACKNOWLEDGMENTS

The author thanks Cheryl Winston-Bartlett for preparing all the 2001 NHTS data runs. The author is also

grateful for the insights and perspectives of all the participants at the conference, which provided a wonderful learning experience and greatly strengthened the writing of this paper. The guidance of three anonymous reviewers as well as that of Marty Wachs, Nancy McGuckin, and Nando Srinivasan must be acknowledged. Susan Herbel, Susan Ferguson, Susan Handy, and Mike "Susan" Myers are acknowledged for their major contributions to the conference and for their intellectual stimulation. Gloria Jeff, Miranda Carter, Elaine Murakami, Sherry Ways, Elaine King, and Kim Fisher and the support of Bob Skinner and Mark Norman are recognized for making this conference possible. Of course, all of the mistakes, errors, and inanities that remain in the paper are entirely the author's responsibility.

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# Community Design and Travel Behavior

## Exploring the Implications for Women

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In the face of growing levels of congestion and persistent air quality problems, planners increasingly see community design as a way of reducing automobile dependence. Because of growing levels of obesity and the attendant health problems, public health officials have also turned to community design as a way of increasing physical activity. Proponents from both camps argue that higher population and employment densities, greater mixes of land uses, more gridlike street networks, and better transit service contribute to lower levels of driving and higher levels of walking, and they cite numerous studies to support their cases. But most studies focus on the population as a whole, and few studies so far consider the ways in which the effect of community design might differ for particular segments of the population given their particular travel needs.

As evidence of the complexity of women's travel accumulates, researchers have begun to explore what community design means for women, both the possibility that community design adds to their travel burden and the possibility that it can help to ease that burden. Women face significant concerns related to family, health, and safety that complicate their daily lives; these concerns contribute to their need for travel and to the constraints they face in attempting to meet those needs. Communities designed so that women must drive long distances to work, to daycare, to shopping, or to medical appointments add to the time and cost of meeting their personal and household needs. In contrast, communities designed for shorter driving distances and for modes other than driving may offer women the option of reducing the time and money they spend on travel.

At this time, few questions have been answered and many questions remain, not only about the implications of community design for the travel of women but also about the relationship between community design and travel behavior more generally. As a step toward building a research agenda on the implications for women of the relationship between community design and travel behavior, the available literature is reviewed here, original data analysis is presented, and outstanding issues are discussed for the following questions:

- What is community design?
- How does community design affect travel behavior?
- How might these effects differ for women?
- Where do we go from here?

### WHAT IS COMMUNITY DESIGN?

Researchers do not always agree on a definition of community design or even on the use of this term rather than the term “built environment” or the term “physical environment” or some other term. Community design and built environment are used interchangeably here and defined as consisting of three elements: land use, the transportation system, and design (1). Land use refers to the spatial distribution of activities throughout the community, in other words, what kinds of activities are located where. The transportation system provides the physical connections between activities and determines the quality of those connections in terms of travel times, safety, comfort, and other characteristics. Design refers

to aesthetic qualities of the built environment and overlies both land use patterns and the transportation system, particularly in terms of the design of buildings and the design of streetscapes, respectively.

Other terms also need definition. Sometimes used interchangeably with the built environment, the physical environment can be defined as encompassing not just the built environment but also the natural landscape and the human use of public spaces, elements that have the potential to influence choices about travel behavior as well. Another important concept to consider is that of access. Access acts as a mediating or intervening variable between community design and travel behavior (Figure 1). In other words, community design determines levels of access to potential destinations, and the level of access then influences travel choices. Some researchers thus choose to measure access rather than community design itself in order to explain travel behavior. All of these concepts—community design, built environment, physical environment, access—can be measured at different scales, from the block to the neighborhood to the region.

The idea that community design can change travel behavior is not a new one, though it did get a boost in the 1990s with the growing popularity of the New Urbanism movement. As articulated by the Congress for the New Urbanism, this movement advocates for communities designed “for the pedestrian and transit as well as the car” where “many activities of daily living ... occur within walking distance, allowing independence to those who do not drive, especially the elderly and the young” and where “interconnected networks of streets [are] designed to encourage walking, reduce the number and length of automobile trips, and conserve energy” (2). The concept of transit-oriented development (TOD) puts forward a similar idea: “Moderate to higher density development, located within an easy walk of a major

transit stop, generally with a mix of residential, employment and shopping opportunities designed for pedestrians without excluding the auto” (3). More recently, the Active Living by Design movement has promoted “environments that offer choices for integrating physical activity into daily life” (4). Each of these movements assumes that community design can reduce driving and increase walking.

Other movements in the planning field might also work to alter community design in such a way as to decrease driving and increase walking (Table 1). A growing number of U.S. communities have adopted street connectivity ordinances, which require a more gridlike street network in new residential subdivisions (5); other communities are investing in pedestrian-bicycle bridges and tunnels to connect areas severed by freeways or divided by rivers (6). A loosely related set of programs that might be called Main Street programs aims to revitalize neighborhood commercial areas [e.g., Metro in Portland, Oregon (7)], protect local shopping areas from big-box stores [e.g., the New Rules Project (8)], and rebuild suburban strip malls as community centers [e.g., the Local Government Commission projects (9)]. Traffic calming programs, popular throughout the United States and elsewhere in the world, redesign streets to better balance the needs of pedestrians and bicyclists with the needs of vehicles (10). Safe-routes-to-school programs, such as the one funded by the California Department of Transportation (11), represent a specific form of traffic calming, one designed to increase the share of children who walk or bike to school. Finally, trails programs such as those promoted by the Rails-to-Trails Conservancy (12) have grown popular in communities of all sizes; although these trails are often best suited for recreation, they may also serve as useful routes for transportation-oriented walking or biking.

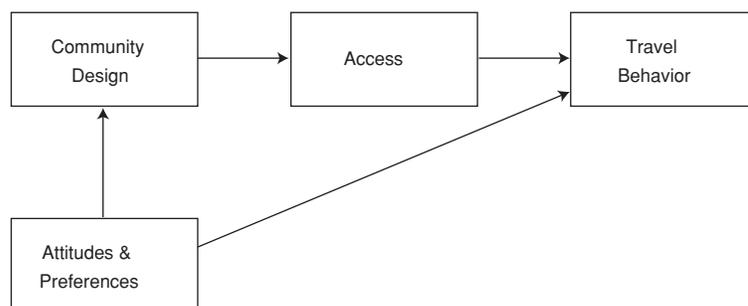


FIGURE 1 Relationships between community design, access, travel behavior, and attitudes and preferences.

**TABLE 1 Planning Movements That Improve Alternatives to Driving**

Movement	Variations	Potential Effects
Network connectivity	Street connectivity ordinances Bike/ped bridges over freeways Bike/ped bridges over rivers	Shorter distances to destinations More direct routes to destinations
Main Street programs	National, state, and local Main Street programs Anti-Big-Box ordinances Grayfield redevelopment of strip malls	Stores and services within walking distances
Traffic calming programs	City traffic calming programs Safe-routes-to-school programs	Increased safety and comfort for pedestrians
Trails programs	Transportation enhancements projects Rails-to-Trails projects	Separate facilities for bikes/peds

## HOW DOES COMMUNITY DESIGN AFFECT TRAVEL BEHAVIOR?

What effect might these changes in community design have on travel behavior? In setting out to answer this question, researchers have measured community design in various ways, most commonly as density, land use mix, distance to the nearest destination, other measures of accessibility, or neighborhood type (1). Travel behavior has also been measured in various ways, most commonly by trip frequency, trip distance, mode choice, and total vehicle miles traveled (VMT). Most (but not all) studies control in some way for sociodemographic factors that might influence travel behavior, including income, automobile ownership, household size, employment status, presence of children, and sex. Many studies compare travel behavior in neighborhoods of different types by using analysis of variance techniques. In other studies, methods for testing for an association between community design and travel behavior while controlling for sociodemographic characteristics range from simple regression models to more sophisticated discrete choice models. Differences in measures and methodologies across these studies make direct comparisons of their results difficult; nevertheless, certain patterns emerge.

After reviewing more than 50 empirical studies, Ewing and Cervero (13) concluded that trip lengths are primarily a function of the built environment, trip frequencies are primarily a function of sociodemographic characteristics, and mode choice is a function of both. Their meta-analysis of available data from these studies produced estimates of elasticities of  $-0.05$  for the relationship between density and VMT. In other words, a 100% increase in density was associated with a 5% decrease in VMT—a statistically significant though rather small relationship. In a review of studies of the link between the built environment and walking as a mode of transportation, Saelens et al. (14) concluded that “transportation and planning research supports the proposition that the physical

environment is associated with physical activity in the form of walking/cycling for transport.” In Handy’s review of this literature, strong evidence was found of an association between accessibility and frequency of walking (1).

But these studies generally assume a simple causal relationship between community design and travel behavior. A few studies have used a more complicated framework that accounts for the role of attitudes and preferences (Figure 1) and have found that attitudes and preferences play a more significant role in explaining travel behavior than community design (15, 16). These studies raise the possibility that the observed association between community design and travel behavior is spurious, that an association between attitudes and preferences and both community design and travel behavior creates the appearance of a causal relationship between community design and travel behavior that does not actually exist (17). Researchers are now taking on the “self-selection” question and testing the degree to which residents who prefer to drive less or to walk more consciously choose neighborhoods that offer such opportunities.

In studies of the link between community design and travel behavior, sex 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. In the travel behavior literature, some studies have analyzed travel at the level of the household rather than the individual (15, 18) or have used aggregate data at the level of the census tract or neighborhood (19, 20), in which case the effects of sex have not been considered. Analyses at the level of the individual show that after the effect of the built environment is accounted for, women make more trips by car (21, 22), make fewer walking trips (23, 24), are less likely to choose an alternative to driving for their trips (25, 26), but still drive less than men overall (27). These studies thus show a significant effect of sex on travel behavior but do not consider interaction effects, that is, the differential effect of community design on travel behavior for women.

## HOW MIGHT THESE EFFECTS DIFFER FOR WOMEN?

Community design might affect travel behavior differently for women than it does for men for the basic reason that women's daily lives are significantly different from men's. In particular, women face different and often more pressing concerns related to family duties, health issues, and safety threats that relate to travel behavior. Community design often contributes to these concerns but also has the potential to help alleviate them by improving alternatives to driving.

Although research on these issues is limited, data from a recent study by Handy et al. at the University of California, Davis (UC Davis), is suggestive of what further research efforts might find (28). These data, selections of which are presented in the following discussion, come from a survey of households in eight neighborhoods in Northern California, four traditional ones and four suburban ones. Community design in these two types of neighborhoods differs significantly, with traditional neighborhoods offering greater accessibility to basic services, measured both as the number of services within specified distances from home and as the distance to the nearest service establishment of each type. The survey was administered using a mail-out, mail-back approach that achieved a 25% response rate for a total sample of nearly 1,700 respondents. Categories of variables in the survey included travel behavior, perceived characteristics of the neighborhood, travel attitudes, and sociodemographic characteristics.

According to the survey results for perceived neighborhood characteristics, traditional neighborhoods offer greater accessibility to potential destinations, more social activity in the neighborhood, and a more attractive environment, thus potentially offering more opportunities for walking. Suburban neighborhoods, on the other hand, offer a greater sense of safety, another important factor influencing the potential for walking. In the following sections, simple comparisons are presented between men and women and between women with children and those without children for traditional neighborhoods and suburban neighborhoods. Though the analyses presented here do not establish a causal relationship, differences in travel behavior by type of neighborhood are suggestive of the impact of community design on travel behavior. These results point to interesting and important research questions.

### Family Concerns

Despite working outside the home at higher rates than ever, women still bear more of the responsibility for household duties. The 2003 American Time-Use Survey

showed that employed men worked about an hour more than employed women per day but that employed adult women spent about an hour more per day than employed adult men doing household activities and caring for household members (29). On an average day, 84% of women spent some time doing household activities (such as housework, cooking, lawn care, or household management), 55% reported doing housework (such as cleaning or laundry), and 66% reported doing food preparation or cleanup versus 63%, 20%, and 35% of men, respectively. Not only do these responsibilities restrict free time for women, but they are associated with additional travel needs. A report by the Surface Transportation Policy Project (30) found that two-thirds of all trips to chauffeur people around (such as driving children to soccer practice or an older parent to the doctor) are made by women. Family responsibilities are especially burdensome for women in the "sandwich generation," with responsibilities for both dependent children and aging parents.

Community design offers the possibility of easing these burdens at least a bit. If communities are designed so that necessary destinations such as schools, stores, and medical offices are closer to home, women will not need to travel so far to take care of their household responsibilities. If communities are also designed so that walking is a safe and viable option and if adequate transit service is provided, dependent children and aging parents might be able to get where they need to go by themselves, reducing the burden on women to chauffeur them. The reduced need for driving would save women time and money and, equally important, increase their flexibility. Good community design, in other words, can make it easier for women to conduct their everyday lives.

Data from the UC Davis study suggest that suburban environments put a greater driving burden on women than traditional neighborhoods do. Consistent with previous studies, the survey results show that women drive less than men—141 mi in a typical week versus 184 mi for men (Table 2). However, the differences between traditional and suburban neighborhoods are significant, with women who live in traditional neighborhoods driving 20 mi less than women who live in suburban neighborhoods, a difference of 15%. The data do not show whether this difference is a matter of choice or necessity,

TABLE 2 Vehicle Miles Driven per Week

	All Respondents	Traditional	Suburban	<i>p</i> -value
All respondents	161	148	177	0.00
Women	141	132	152	0.06
Men	184	167	202	0.01
<i>p</i> -value	0.00	0.00	0.00	
Women w/kids	161	132	180	0.04
Women w/o kids	135	132	139	0.51
<i>p</i> -value	0.03	0.82	0.01	

though the latter seems more likely given the time constraints that women face. For women with children, living in the suburbs exerts an even greater driving penalty—44 mi more per week than in traditional neighborhoods, a difference of 32%. These differences hold for nonwork driving as well (Table 3): women with children who live in the suburbs drive more for nonwork purposes than do women in the other three categories.

These results point to important questions for researchers to address: What factors contribute to higher levels of driving by women in suburban environments? To what degree do these differences reflect a causal effect and to what degree do they reflect self-selection? More specific questions are also of interest: Does the increased burden on mothers reflect a lack of independence of their children in suburban environments? Research by McDonald (31) shows no evidence that the burden on mothers declines as population densities increase, suggesting that other factors may be at play. In contrast, research by Weston (32) suggests that adolescent girls are less likely to travel independently than are adolescent boys, putting a greater burden on their parents, particularly their mothers. What about women with constrained access to a car? Is their situation mitigated or exacerbated by community design? A study in Germany by Vance et al. (33) found little impact of community design as either a mitigating or an exacerbating factor. Is the situation different in the United States, where getting around in suburban areas is largely dependent on driving?

## Health Concerns

Levels of obesity are increasing in the United States, especially for women and for older women. In 2000, 62% of U.S. women were overweight, a rate that jumped to 68% for women older than 60 (34). Being overweight contributes to numerous health effects, including cardiovascular disease, arthritis, breast cancer, gallbladder disease, and infertility, as well as stigma and discrimination. A decline in physical activity is contributing to the problem. According to the Centers for Disease Control and Prevention (CDC) (35), more than 60% of women in the United States do not engage in the recommended amount of physical activity and more than 25% are not active at

all. Even modest increases in moderate physical activity can help.

Community design can play an important role in efforts to increase physical activity for women. If community design brings destinations within walking distance, women are more likely to choose walking over driving. The CDC recommends “environmental inducements to physical activity” such as trails and sidewalks as well as neighborhood watch programs to increase safety (35). Such facilities help to encourage recreational walking as well as walking to destinations. The aesthetic qualities of the environment and amenities such as shade, benches, and drinking fountains also make walking a more attractive choice. Indeed, studies of physical activity show that enjoyable scenery is associated with more activity for women (36).

The UC Davis study reveals significant differences in walking between traditional and suburban neighborhoods for women. In traditional neighborhoods, women walk to the store more than twice as often as in suburban neighborhoods; the differences hold for men as well (Table 4). The effect of children is significant: in traditional neighborhoods, women with children walk less frequently than women without children. But they still walk more frequently than women living in suburban neighborhoods, with or without children. For strolling around the neighborhood, the differences are similar: women (and men) living in traditional neighborhoods stroll more frequently than women (and men) living in suburban neighborhoods (Table 5). However, for strolling the frequency is just 20% more in traditional neighborhoods rather than 135% more for walking to the store. For strolling, the effect of children is not significant: women living with children stroll just as fre-

**TABLE 3 Nonwork Vehicle Miles Driven per Week**

	All Respondents	Traditional	Suburban	<i>p</i> -value
All respondents	91	84	98	0.02
Women	79	76	83	0.35
Men	103	93	113	0.05
<i>p</i> -value	0.00	0.03	0.00	
Women w/kids	88	78	96	0.30
Women w/o kids	77	76	78	0.80
<i>p</i> -value	0.22	0.88	0.18	

**TABLE 4 Walks to Store per Month**

	All Respondents	Traditional	Suburban	<i>p</i> -value
All respondents	3.5	4.9	1.8	0.00
Women	3.5	4.7	2.0	0.00
Men	3.5	5.1	1.8	0.00
<i>p</i> -value	0.9	0.3	0.4	
Women w/kids	2.9	3.6	2.3	0.03
Women w/o kids	3.7	4.9	1.9	0.00
<i>p</i> -value	0.07	0.08	0.37	

**TABLE 5 Strolls per Month**

	All Respondents	Traditional	Suburban	<i>p</i> -value
All respondents	9.0	10.1	7.7	0.00
Women	9.4	10.2	8.5	0.03
Men	8.7	10.0	7.2	0.00
<i>p</i> -value	0.2	0.8	0.1	
Women w/kids	9.1	10.0	8.4	0.23
Women w/o kids	9.5	10.3	8.5	0.08
<i>p</i> -value	0.64	0.87	0.96	

quently as women not living with children, whether they live in traditional or suburban neighborhoods. Even in traditional neighborhoods, however, the average frequency is just 10 times in 30 days, or about once every 3 days, less than recommended levels for exercise. These results suggest that community design affects walking as a mode of transportation differently than it does walking for exercise.

These results raise many other questions for researchers. To what degree does community design explain levels of walking for women? The answer is not straightforward. An analysis by Clifton and Dill (37) of several different data sources finds that factors such as household responsibilities and resources, perceptions and concerns, trip purposes and comprehensive travel needs confound the relationship between community design and walking for women. Are higher levels of walking in traditional neighborhoods attributable to community design or to the preferences and attitudes of the women who live there? A study in three Maryland communities by Clifton and Livi (38) found significant differences in attitudes and perceptions about walking between men and women that helped to explain differences in walking. How does walking in the neighborhood fit into overall levels of physical activity for women? In an analysis of data from the National Household Transportation Survey, Helling (39) found that women drive to places to exercise (such as a gym or health club) less frequently than men; this result suggests the importance of walking in the neighborhood as a form of exercise for women but could also reflect more exercising within the home or less exercise overall.

### Safety Concerns

Almost every survey of fear of crime shows that women are more concerned about their personal safety and feel less safe than men (40). This difference is especially prevalent in public places, including the transportation system. Because cars represent a private and protected environment, women perceive cars to be the safest mode and transit settings, including stops and stations as well as the vehicles themselves, to be risky (40). This perception may eliminate alternatives to driving from consideration for many women and makes nondriving modes particularly burdensome for women who do not have the option to drive. Safety concerns thus compound the challenges associated with family and health concerns. For example, women who perceive neighborhoods as unsafe are less physically active (41).

Community design can help in many different ways (40). Better lighting can mean greater comfort for walking and transit, for example, as can design that eliminates dark spaces where potential attackers may hide.

Wide sidewalks with a wide grass strip can greatly improve the walking experience. Community design that encourages more people to be out and about helps to increase perceived safety; architecture that promotes “eyes on the street” also helps. The presence of certain kinds of land uses—liquor stores or bars, for example—may decrease perceived safety for women. Creating safe places for women or other groups to “hang out” can also help. Safety for pedestrians can also be affected by the volume and speed of vehicle traffic; traffic calming programs that slow speeds and discourage excess traffic can thus help to increase real and perceived safety. If women feel safer walking and riding transit, they have a greater opportunity to drive less.

In the UC Davis study, survey respondents were asked how true 34 characteristics were for their neighborhoods. Perceived characteristics related to safety that might influence walking differed between men and women and between women in traditional and those in suburban neighborhoods in interesting ways (Table 6). On average, women rated their neighborhoods higher for low crime, safety for children, neighbor interaction, and neighbors out and about; scores for safe walking, street lights, and quiet neighborhood did not differ between men and women. These results suggest that women perceive a better environment for walking than men do.

Women in traditional neighborhoods gave higher scores for neighbor interaction and neighbors out and about but lower scores for street lighting and quiet neighborhood; these results suggest that traditional neighborhoods are better for walking in some ways but not in others. Women with children gave lower scores on low crime and safety for children than did women without children, possibly owing to higher standards for these characteristics rather than actual differences in their environments. Women with children in traditional neighborhoods gave lower scores on safety for children than women with children in suburban neighborhoods; this finding is consistent with the perception that suburbs are safer places for children.

Survey respondents were also asked whether they agreed or disagreed with a series of statements related to transportation. Principal components factor analysis was used to reduce more than 30 statements to six factors, including a factor that reflects an attitude that driving is safe relative to other modes. On this factor, women scored somewhat lower on average than men. The score suggests that they feel less strongly that driving is safer than other modes (Table 7). In traditional neighborhoods, women agreed somewhat less than men that driving is safest, but both men and women in traditional neighborhoods agreed much less than residents of suburban neighborhoods that driving is safest. The effect of children was not significant: women in suburban neigh-

TABLE 6 Perceived Neighborhood Characteristics

	Low Crime	Safe Walking	Safe for Kids	Street Lights	Low Traffic	Quiet Neighborhood	Neighbor Interaction	Neighbors Out
All respondents	3.64	3.42	3.45	3.00	2.60	3.01	2.82	2.97
Women	3.78	3.44	3.53	3.03	2.58	3.00	2.90	3.02
Men	3.48	3.40	3.36	2.96	2.61	3.02	2.73	2.91
<i>p</i> -value	0.00	0.41	0.04	0.17	0.51	0.57	0.03	0.02
Women in traditional	3.75	3.43	3.50	2.94	2.57	2.91	3.01	3.17
Women in suburban	3.81	3.46	3.55	3.13	2.60	3.10	2.76	2.83
<i>p</i> -value	0.68	0.69	0.69	0.00	0.65	0.00	0.03	0.00
Women w/kids	3.51	3.46	3.24	3.03	2.60	3.07	2.84	3.06
Women w/o kids	3.86	3.44	3.62	3.02	2.58	2.97	2.92	3.01
<i>p</i> -value	0.03	0.79	0.01	0.88	0.79	0.18	0.58	.059
Women w/kids in traditional	3.46	3.44	3.10	2.92	2.48	3.00	2.95	3.21
Women w/kids in suburban	3.55	3.47	3.34	3.12	2.68	3.12	2.76	2.95
<i>p</i> -value	0.67	0.76	0.08	0.19	0.16	0.34	0.33	0.11

NOTE 4-point scale from 1 (not at all true) to 4 (entirely true).

TABLE 7 Perception That Driving Equals Safety

	All Respondents	Traditional	Suburban	<i>p</i> -value
All respondents	-0.01	-0.27	0.29	0.00
Women	-0.06	-0.33	0.29	0.00
Men	0.03	-0.20	0.30	0.00
<i>p</i> -value	0.07	0.06	0.93	
Women w/kids	-0.02	-0.34	0.22	0.00
Women w/o kids	-0.07	-0.33	0.33	0.00
<i>p</i> -value	0.60	0.93	0.26	

NOTE: Factor score based on 4 attitudinal statements; factor score has mean 0 and variance of 1.

neighborhoods agree more strongly that driving is safest than women in traditional neighborhoods, whether or not they have children. These results suggest that attitudes about the safety of driving relative to other modes are determined more by neighborhood than by sex or presence of children. It is possible that walking, biking, and transit are in fact less safe in suburban areas (making driving relatively safer), but it is also possible that residents in the two neighborhood types have different perceptions of these modes despite similar levels of safety.

Again, these results raise more questions than they answer. To what degree does perceived safety influence travel behavior for women? Do safety concerns differ depending on culture or ethnicity? How do safety concerns affect the quality of life for women, particularly those without the option to drive? To what degree do perceptions of safety match the reality of safety? What aspects of community design contribute to feelings of safety? Much of the research in this area focuses on safety concerns related to transit and explores ways of improving safety for women and others. Loukaitou-Sideris and others have studied how community design influences crime and safety in the vicinity of transit stops (42, 43) and Loukaitou-Sideris more recently offers approaches to addressing the fear of victimization that

women feel in public places (40). But much of this research focuses on strategies for improving safety other than community design. Carter (44) discusses gender-sensitive solutions to improving safety for women who use transit, including technological, staffing, and cultural approaches. Anderson Bomar (45) looks at the use of technology to address system security and evaluates the effectiveness of these approaches for addressing the safety concerns of women.

## WHERE DO WE GO FROM HERE?

On the topic of community design and travel behavior, answers are scarce and questions abundant (17). On the topic of how the relationship between community design and travel behavior differs for women, answers are rarer. Yet the questions for women are in many ways more interesting and potentially more important. Women face numerous concerns related to family, health, and safety that create significant transportation needs and contribute to critical transportation constraints (Table 8), and community design may prove important in efforts to ease these burdens. But many questions remain about the role of community design in shaping travel behavior for women in different situations and about the potential effectiveness of community design approaches to addressing their concerns.

To answer the questions outlined here, researchers need to move beyond cross-sectional designs that simply compare travel behavior in one type of community with that in another (17). Longitudinal studies that track changes in travel behavior associated with changes in community design that occur as women move from one place to another provide a more solid basis for understanding the causal effect of community design. Intervention studies that look at changes in behavior after a

TABLE 8 Summary of Research Questions

	Family Concerns	Health Concerns	Safety Concerns
Concerns for women	High levels of household work	Low levels of physical activity	Low levels of real and perceived safety in public places
Implications for travel	Dependence on driving Chauffering duties	Benefits from more walking	Transit and walking not as safe as driving
Potential role of community design	Can reduce the need for driving	Can increase opportunities for walking	Can increase safety for transit and walking
Cross-cutting questions	How important is community design relative to other factors in influencing travel choices for women? How does the role of community design differ by culture or ethnicity for women? How does community design help or hinder women without access to cars? What factors influence which communities women choose or are forced to live in? What kinds of community design policies can effectively address these concerns?		

specific change in community design, such as the implementation of a traffic calming program, are also a more effective way of establishing causality. In either type of study, attitudes and perceptions must be accounted for to establish that the causal relationship between community design and travel behavior is real. A better understanding of causal relationships is important in building the evidence base for community design policies in general and those targeted to the needs of women in particular.

To answer the questions outlined here, researchers also need to move beyond quantitative studies. Qualitative approaches can be used to explore not just travel behavior but also the travel needs, constraints, attitudes, 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. The available research on the relationship between community design and travel behavior provides a starting point for more qualitative exploration, and qualitative exploration can then provide the basis for further quantitative work focused on the ways in which community design helps to address (or to make worse) family, health, and safety concerns.

With all the questions that remain, it is not possible at this point to say that community design is either the problem or the solution. But the available research does reveal that community design increases the opportunities for alternatives to driving, for increased physical activity, and for improved personal safety. It can be said that these increased opportunities, regardless of their impact on behavior, are themselves a good thing for women.

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# Women's Issues in Highway Safety

## Summary of the Literature

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A review of research literature on passenger vehicle safety that focuses on gender differences is provided. Around the world women are licensed and driving more than in the past. The result is that more women are dying in crashes, although more men than women still die in crashes every year because men drive more miles than women and tend to take more risks (speed, driving under the influence of alcohol, less frequent use of seat belts). Men's crashes are often more severe than women's, but when crash severity is controlled for, women are more likely to be killed or injured. Evidence suggests that for the most part vehicle features designed to reduce injuries (e.g., seat belts and airbags) are as effective in protecting women as men. Sometimes they are more effective. For example, improvements to head restraints may be reducing neck injury more for women than men. There also have been changes in crash testing; dummies representing shorter women are beginning to be used. One area that has received limited attention is the safety of pregnant women and their fetuses. The development of a pregnant dummy has been under way for years, and research using both real and computer-simulated pregnant dummies is exploring how factors such as seat belts, airbags, and crash severity affect a pregnant mother and fetus in a crash. As more women drive into their later years and drive more miles, it will be important to evaluate changes in crash characteristics over time as a function of age and sex as well as the types of injuries that women and men sustain.

The overinvolvement of men, especially young men, in motor vehicle crashes has been recognized for a long time. However, the issue of gender differences in highway safety has not received as much attention as age differences. With the realization that more women are dying in motor vehicle crashes than before (Cerrelli 1994), the safety of female drivers has been the subject of reports in both Australia and the United Kingdom (Attewell 1998; Ginpil and Attewell 1994; Hill and Mackay 1997; Over 1998; UK Department for Transport 2005).

Major changes in women's roles in the United States during the past several decades have affected their use of private motor vehicles (Rosenbloom 1996). Women's activity in the labor force, type of employment, and earnings are now more equal to those of men (Hayghe 1996). Society as a whole has seen staggering growth in the dependence on automobiles, suburbanization of homes and jobs, number of single-adult and single-person households, and aging of the population, among other changes (Rosenbloom 1996). The result is that women are licensed and driving more than ever before, although still far less than men (Mayhew et al. 2003). It also has been suggested that women are driving more aggressively than they have in the past (Kostyniuk et al. 1996), which is contributing to the higher crash rates.

What is known about gender differences in motor vehicle safety is summarized here. The focus is on passenger vehicle safety rather than on bicycle, motorcycle, or pedestrian safety. In comparison of men and women,

it is important to note that although some physiological differences may account for these trends, variations in crash rates and injuries have a lot to do with when, where, how, and what women drive, as well as how much they drive.

Any discussion of gender differences also should recognize the considerable variations as a function of driver age (Evans 2004). As discussed by Rosenbloom in her plenary presentation at this conference, driving by women often is fundamentally different from that of men inasmuch as their roles as mothers and care providers affect their trips. Research also suggests that women drive older, smaller vehicles than men, which increases the likelihood of injury in the event of a crash (UK Department for Transport 2005; U.S. Department of Transportation 2003). Changing demographics should be recognized. Older women today are licensed less often than men, but this situation is likely to change. Today's baby boomers, more of whom have held licenses for much of their adult lives, likely will drive more than their predecessors as they age.

Gender differences in crash and injury rates are discussed here and how these patterns have changed over time. Also examined is whether the injuries women sustain in a given crash (e.g., frontal, side) are different in type or frequency from those of men. To the extent possible, the effectiveness of various vehicle systems designed to reduce injuries in crashes is addressed for men versus women. The general manner in which people drive and the extent to which they take risks also are examined as a function of sex. A topic that has not received much attention but has a clear gender component is the safety of pregnant women and their fetuses in motor vehicle crashes.

Studies were identified through several sources, including the Transportation Research Information Services (TRIS) database, Internet searches (e.g., [www.Google.com](http://www.Google.com), [www.Nexis.com](http://www.Nexis.com)), proceedings of scientific conferences, and backward referencing.

## MOTOR VEHICLE CRASH RATES

Only about one-third of all U.S. motor vehicle crash deaths in 2003 involved women. Women accounted for about a third of driver and pedestrian deaths, nearly half of passenger vehicle deaths, and about 10% of bicycle and motorcycle deaths [Insurance Institute for Highway Safety (IIHS) 2005a]. Gender differences in the rates of crash involvement depend on several factors including injury outcome (fatal, nonfatal injury, or all), how rates are measured (per capita, per driver, or per distance driven), and driver age.

When only fatal crashes are examined, it becomes clear that men have higher rates of driver involvement than

women. In the United States, the rate among men is about three times the rate among women per 10,000 licensed drivers (Li et al. 1998; Mayhew et al. 2003). Men also have about twice the rate of fatal crashes when measured per 1,000 crashes (Li et al. 1998) or per mile traveled (Mayhew et al. 2003). In Australia, rates of fatal crash involvement per licensed driver and per kilometer traveled show essentially the same gender disparities as those in the United States (Attewell 1998).

The picture is somewhat different when all crashes are examined. In U.S. police-reported crashes, which include predominantly nonfatal crashes, men were one-third more likely than women to crash when measured per 1,000 licensed drivers. However, per million miles traveled, women were 12% more likely than men to crash. Controlling for miles traveled does not necessarily control for gender differences in where vehicles are driven, for example, differences in the amount of urban or rural travel [unpublished analyses of data from U.S. Department of Transportation's General Estimates System, driver licensing data, and National Household Travel Survey (NHTS) 2005].

Similar results were found in western Australia. Crash rates were higher for men when measured per capita and per licensed driver but higher for women when measured per kilometer traveled (Ryan et al. 1998). Comparing results across studies is difficult because researchers often select different crash categories to analyze (e.g., injury crashes, police-reported crashes, severe crashes). Still, studies conducted during the past decade in Canada (Chipman et al. 1993), Jordan (Al-Balbissi 2003), New Zealand (Wylie 1995), and Western Australia (Ryan et al. 1998) indicate that men generally have higher crash rates than women when rates are measured per licensed driver and per capita, particularly for fatal and severe crashes.

Gender differences in crash rates vary by driver age. In the United States in 2003, crash involvements per 1,000 licensed drivers were higher for men than for women. This finding was true in all crashes and in fatal ones. For fatal crashes, the gender difference was particularly large among younger and older drivers (Figure 1). In 2001–2002, the latest year for which updated mileage data are available, driver fatal crash involvements per 100 million miles traveled were higher for men than for women through age 65. Gender differences in fatal crashes per 100 million miles traveled were greatest among people aged 16 to 24. When all crashes are considered, however, driver crash involvements per million miles sometimes were higher among men, sometimes among women (Figure 2) [unpublished analyses of data from U.S. Department of Transportation Fatality Analysis Reporting System (FARS), General Estimates System, driver licensing data, and NHTS, 2005].

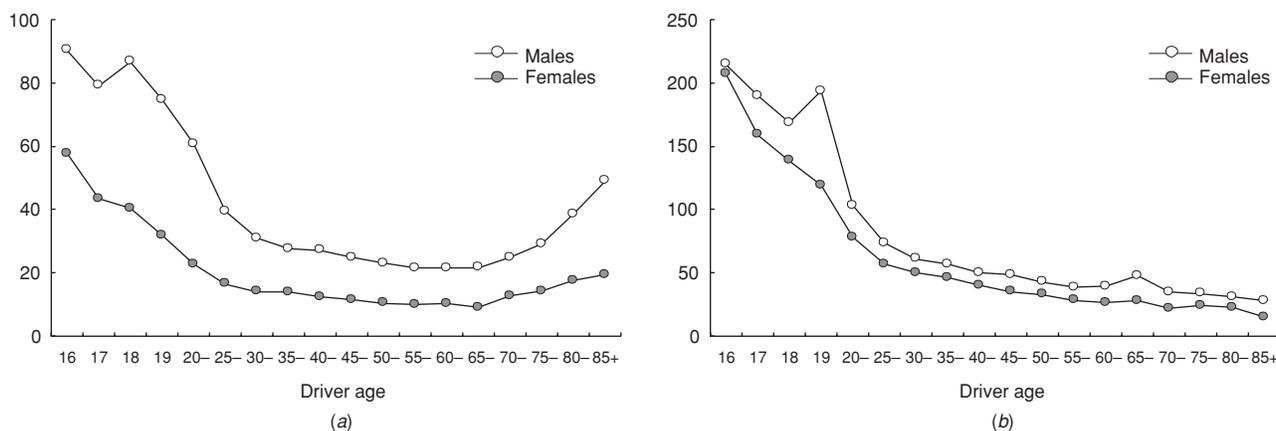


FIGURE 1 (a) Driver fatal crash involvements per 100,000 licensed drivers, 2003; (b) driver crash involvements per 1,000 licensed drivers, 2003.

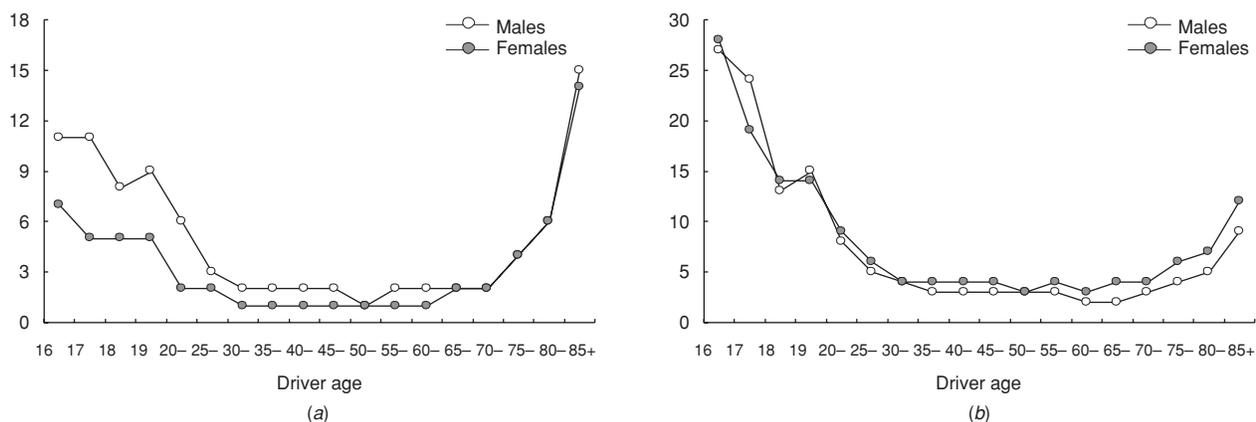


FIGURE 2 (a) Driver fatal crash involvements per 100 million miles traveled, 2001-2002; (b) driver crash involvements per million miles traveled, 2001-2002.

## RISK PERCEPTION AND RISKY DRIVING

A number of studies have shown that men rate the crash risk of driving situations lower than do women. Trankle et al. (1990) asked male and female drivers of various ages (18 to 21, 25 to 45, 65 to 75) to classify traffic scenes in terms of risk. Young men tended to rate crash risk lower relative to young women, older men, and older women. In a similar study Mundt et al. (1992) evaluated the effect of sex on risk perception of a crash in various scenarios among young college students. Women consistently rated crash likelihood higher compared with men, including when the effects of alcohol on driving were factored in.

Men also tend to rate their driving abilities more highly. Drivers of all ages tend to rate their driving as better than average, but men do so to a greater extent than women (Delhomme 1991; Sivak et al. 1989; Williams 2003; Williams et al. 1995). A national survey

of U.S. drivers found that men were more likely than women to compare themselves favorably with other drivers and to rate themselves highly on driving skill and safety (Williams 2003; Williams et al. 1995).

Men also adopt riskier driving styles than women. They are less likely to use seat belts and more likely to speed, follow too closely, and drive after drinking. U.S. surveys in 2003 reported belt use rates among front-seat occupants of 84% (women) and 77% (men) (Glassbrenner 2004). Belt use also was higher among women in an observational study of Michigan drivers during 1984-1996. However, belt use during this 12-year period increased at similar rates among men and women (Kostyniuk et al. 1996). In 2003 a higher percentage of male drivers who died in passenger vehicle crashes were unrestrained compared with female drivers (unpublished analyses of data from FARS, 2005).

Men also are more likely than women to speed. A study of U.S. fatal crashes in 2003 found that the relative

proportion of speed-related crashes to all crashes was highest among 15- to 20-year-old men (National Highway Traffic Safety Administration 2004a). The proportions were higher for men than for women across all age groups, although the magnitude of the gender gap narrowed with increasing age. Similarly, a study of young drivers in Finland during 1978–1991 found that driving too fast for the road conditions was a factor in 68% of men's fatal crashes but only 31% of those of women (Laapotti and Keskinen 1998).

An analysis of speed-related crashes in Michigan in 1994 showed that crash rates were higher for men (seven speed-related crashes per 1,000 licensed drivers) than for women (three crashes) (Kostyniuk et al. 1996). However, from 1987 to 1994 crash rates decreased by 8% for men but increased 12% for women. The increase among women was due largely to a 16% increase in speed-related crashes among young female drivers. So although men are more likely than women to speed (Kostyniuk et al. 1996; Laapotti and Keskinen 1998; National Highway Traffic Safety Administration 2004a), there is some indication that more young women are speeding than in previous years (Kostyniuk et al. 1996).

In the United States in 2003, the percentage of fatally injured drivers who were impaired by alcohol was more than twice as high among men as among women (38% compared with 18%) (IIHS 2005b). Similarly, a 1996 U.S. national breath test survey of drivers on weekend nights indicated a higher percentage of men driving under the influence of alcohol compared with women (Voas et al. 1998). Other studies confirm this pattern. In fatal two-car crashes in the United States in 1986, Pernerger and Smith (1991) found the odds of being at fault was 21% higher for men compared with women. However, in crashes in which alcohol was not involved the odds of being at fault were 17% lower for men compared with women. In a study of young drivers in Finland during 1978–1991, Laapotti and Keskinen (1998) found that alcohol was involved in 34% of men's crashes but in only 7% of women's.

Alcohol-impaired driving has decreased among fatally injured drivers, both male and female. From 1982 to 2003, the estimated reductions in crash deaths of alcohol-impaired drivers of passenger vehicles was 32% (men) and 45% (women) (IIHS 2005a). However, findings of the 1996 national breath test survey indicated that more women were driving on weekend nights than in 1986 and somewhat more of them had been drinking (Voas et al. 1998). In contrast, the percentage of alcohol-impaired male drivers decreased slightly from 1986 to 1996. Single-vehicle nighttime crashes are sometimes used as a proxy for alcohol-involved crashes. A study of such crashes in Michigan in 1994 showed higher crash rates for men (14 crashes per 1,000 licensed drivers) than for women (6 crashes) (Kostyniuk et al. 1996). However,

compared with 1987 the rates had decreased 7% for men and increased 11% for women. This finding supports the notion that in alcohol-involved nighttime crashes the gender gap may be narrowing (Voas et al. 1998).

Following other vehicles too closely is another aspect of risky driving that more often is reported among men. Evans and Wasielewski (1983) reported that in both Michigan and Ontario men generally drove with shorter following distances than women. Similarly, in a 1994 study of Michigan drivers Kostyniuk et al. (1996) found that the rates of rear-end collisions (presumably indicative of following distance) were higher for men (12 crashes per 1,000 licensed drivers) than for women (8 crashes). Compared with 1987, these rates had increased about 10% among women but only 1% among men.

As discussed earlier, men are more likely than women to speed, drive while impaired by alcohol, and drive or ride without using a seat belt. These behaviors often coexist. Belt use tends to be lower among drivers under the influence of alcohol than among those who are sober (National Highway Traffic Safety Administration 2004b), and alcohol-impaired drivers also are more likely to drive at excessive speeds (National Highway Traffic Safety Administration 2004a). All three of these factors independently increase fatality risk, and their combination may lead to even higher risks among men compared with women.

The tendency for men to drive more dangerously than women has notable effects. As mentioned earlier, women have slightly higher rates of crashes per million miles traveled, but men's crashes are more likely to be severe or fatal (Li et al. 1998). Men's risky driving also may have an effect on the type of crashes they experience. Laapotti and Keskinen (1998) examined differences in loss-of-control and non-loss-of-control fatal crashes among young, novice drivers in Finland during 1987–1991. Driving under the influence of alcohol differentiated loss-of-control crashes from other fatal crashes among young men but not women; driving under the influence played a role in 49% of men's loss-of-control crashes but only 6% of their other fatal crashes. Among women, alcohol played a role in 7% of both their loss-of-control and other fatal crashes.

These data clearly indicate that men engage in more hazardous driving compared with women, but there is some limited evidence that the gender gap may be narrowing among the youngest drivers. Young women in Michigan are more likely to speed than in the past (Kostyniuk et al. 1996). Other data suggest that women are more likely to drive on weekend nights (Voas et al. 1998) and to drive under the influence of alcohol (Voas et al. 1998). The gender gap in nighttime crashes involving alcohol also may be narrowing (Kostyniuk et al. 1996; Voas et al. 1998). However, further research is needed to confirm these findings.

## INJURY PROPENSITY IN CRASHES OF SAME SEVERITY

A paradox exists when motor vehicle injury and fatality rates among men and women are examined. Women are more prone to injury in a crash, but men sustain most of the serious injuries and fatalities because men tend to drive more miles than women and their crashes tend to be more severe (Li et al. 1998). Researchers who controlled for crash severity found that injury risk is higher among women than men, although this gender difference tends to decrease with age (Bedard et al. 2002; Evans 2001a; Evans 2001b; Evans and Gerrish 2001). When factors such as age, blood alcohol content, location of impact, restraint use, and speed are controlled for, the odds of fatal injury in a crash are 54% higher for women compared with men (Bedard et al. 2002). This effect is limited mostly to younger women. Proportionally fewer older women are fatally injured compared with men of the same age.

Using a double-pair comparison and other methods to control for crash severity, researchers estimated a 22% to 31% increase in the fatality risk for a 20-year-old woman relative to a 20-year-old man (Evans 2001a; Evans 2001b; Evans and Gerrish 2001). Evans (2001a) also showed that fatality risk increases at a slightly greater compound rate with age for men compared with women. In general, though, from the preteen years through the late 50s, women are more likely than men to sustain fatal injuries in similar crashes. These findings are seen regardless of vehicle type, seating position, occupant restraint use, and other factors such as calendar year, and suggest that the gender difference in injury propensity may be due to greater fragility among women than men.

## TRENDS IN CRASHES AND DRIVING EXPOSURE

As mentioned earlier, men historically have sustained more deaths and injuries in motor vehicle crashes, but women have been catching up. The U.S. government began keeping motor vehicle fatality records in 1975, and since then there have been a number of changes among male and female drivers in terms of licensure, mileage, and fatalities. From 1975 to 2001, driver deaths increased 80% among women but decreased 2% among men (IIHS 2005a). Driver fatalities per capita declined 26% among men during 1975–2002 while increasing 36% among women; the rate was still higher among men. Also during this period the number of licensed drivers increased at a faster rate for women compared with men; they now are equivalent. Fatalities per 100,000 licensed drivers remain higher for men than for women, but this gender difference is narrowing because the rates

are decreasing for both men and women, although faster among men (34% among men since 1975, 5% among women) (unpublished analyses of data from Census Bureau, FARS, and driver licensing data, 2005).

Given the increasing deaths among women, some have hypothesized that women may be driving more aggressively than they used to. Kostyniuk et al. (1996) provided some support for this hypothesis in a study of a limited group of young drivers in Michigan. However, when one considers women drivers of all ages combined and total miles traveled is controlled for, there is no evidence of an increase in fatal crash rates among women compared with men. Overall, men drove 65% more miles than women in 2001; yet total annual miles driven have increased more for women than men (159% for women since 1975, 60% for men). When this difference in mileage is controlled for, driver fatalities per 100 million miles traveled have decreased by similar amounts in both groups (45% for men and 48% for women during 1977–2001) (unpublished analyses of data from FARS and NHTS, 2005). These data support the notion that the increase in fatalities among women drivers is due to increased exposure, not an increase in risky driving practices.

Trends in licensure, mileage data, and fatalities per distance driven in Australia mirror the trends in the United States. Attewell (1998) reported that from 1991 to 1995 the number of licensed drivers in Australia increased more among women (15%) than among men (6%). In addition, average annual kilometers driven declined 6% among men but increased 14% among women. Similar to trends observed in the United States, fatalities per distance driven decreased by similar amounts during 1976–1995 for both men and women.

## CRASH INJURY PATTERNS AND EFFECTIVENESS OF VEHICLE COUNTERMEASURES

There is some evidence that the distribution of injuries by body region, as well as the frequency of injuries, differs among men and women in the same type of crash. For example, with 1992–1994 frontal crash data from the United Kingdom, Mackay and Hassan (2000) reported that female car occupants restrained in front seats sustained head, thorax, and lower limb injuries in lower-severity crashes than men did. Other researchers have reported gender differences in the likelihood of thorax injuries. On the basis of cadaver tests, Foret-Bruno (cited in Evans 2001b) found that women had a 20% greater risk of thorax injury compared with men. In a U.K. sample of serious injuries resulting from frontal crashes, Welsh and Lenard (2001) reported that restrained female drivers, who were far more likely than male drivers to be injured, had higher incidences of spine and leg injuries, whereas men sustained more head

injuries. These data also revealed that women have a higher propensity for skeletal chest injuries at lower crash severities.

In a sample of police-reported tow-away crashes in the United States, Crandall et al. (1996) found that female drivers and shorter occupants were at higher risk of lower limb injuries in head-on crashes. A follow-up investigation showed that this risk was due not only to occupant height but also to the types of shoes women sometimes wear; that is, high heels could affect foot and ankle stability and thereby increase the risk of lower limb injuries. It also has been reported that a higher proportion of female drivers than men sustain head, face, or neck injuries in near-side side impacts (IIHS 2003).

Ample evidence indicates that women are more likely than men to sustain neck injuries in rear-end crashes (Chapline et al. 2000; Farmer et al. 1999; O'Neill et al. 1972; States and Balcerak 1973). In the 1970s, O'Neill et al. reported insurance claim rates for neck injury among drivers of cars with head restraints: 29% of women and 22% of men reported such injuries. In the 1990s, Farmer et al. found that driver neck injury claim rates were remarkably similar to those reported in the 1970s: 30% of women and 23% of men reported such injuries. Chapline et al. (2000) surveyed drivers who had been in police-reported rear-end crashes, finding that 45% of the women and 28% of the men reported neck pain.

## CRASHWORTHINESS COUNTERMEASURES

### Front and Side Impact Airbags

Because women are more prone to injury than men in crashes of given severities, women may be differentially affected by countermeasures aimed at reducing injuries. Frontal airbags, particularly first-generation airbags, resulted in more airbag-related deaths and injuries to women than to men. The energy required to inflate frontal airbags quickly to protect occupants in crashes sometimes can cause injury as well. Many airbag-related deaths involve occupants who were unbelted or improperly belted. Improperly restrained occupants are likely to move forward during a frontal crash, especially if there is hard braking or evasive maneuvers, putting them on top of or extremely close to airbags when they deploy. Women are especially vulnerable because they are shorter and sit closer to airbags. Of the 84 drivers who died as a result of airbag deployments in low-severity crashes, 64 (three-fourths) were women.

Although the loss of life due to frontal airbag deployments has been small compared with the number of lives saved, the overrepresentation of women in airbag-related deaths warrants examination of airbag effectiveness as a function of sex. In more severe frontal crashes, Cum-

mings et al. (2002) reported that airbags reduced the risk of fatal injury about as much for women (12%) as for men (6%), although the authors did not report whether this difference was significant.

In an analysis of the lifesaving benefits of side airbags, Braver and Kyrychenko (2004) examined crashes in which vehicles were struck on the driver side. Separate analyses were conducted for airbags that protect only the torso and those that protect both the torso and the head. Side airbags that provide both torso and head protection reduced the risk of driver death by 44% for men and 33% for women, although this difference was not significant. Airbags that protect only the torso reduced the risk of death by 21% for men but had no effect for women.

### Seat Belts

Kahane (2000) reported that seat belts reduce the risk of death by the same amount for both men and women (45% when riding in passenger cars).

### Head Restraints

Improvements to head restraints may reduce the risk of neck injury more for women than for men. Farmer et al. (1999) examined the relationship between head restraint position and neck injury in rear crashes. Vehicles with head restraints rated good by IIHS were compared with those rated acceptable, marginal, and poor. Ratings are based on the position of restraints relative to the head of an average-size man; restraints that are closer to the top and back of the head earn better ratings because they are expected to protect more of the population. After controlling for the effects of driver age, direction of impact, crash location, and crash severity, the researchers found that both male and female drivers of cars with head restraints rated good were 24% less likely than drivers of cars with poor-rated restraints to sustain neck injuries in rear impacts. Significant reductions in reported neck injury also were shown for female drivers of cars with restraints rated acceptable compared with those rated poor. No similar reductions were found for male drivers. However, the restraints rated acceptable probably provide protection for more women.

Similar findings were reported by Chapline et al. (2000). In this study, head restraints were rated on the basis of measurements of the position of a driver's head relative to the restraint's position at the time of the crash. Head restraint position was significantly related to the rate of reported neck injury among women but not among men. Estimated reductions in neck injury rates for drivers with adequately positioned head restraints

relative to poorly positioned ones were similar for men and women. However, fewer men in the study had adequately positioned head restraints, so for them the effect was not significant.

One additional study reports that women benefit more from better-positioned or improved head restraints. Farmer et al. (2003) examined automobile insurance claims, finding that restraints with improved geometry reduced driver neck injury rates by about 37% for women but had little effect for men. Similarly, new head restraint designs such as active restraints that move up and closer to people's heads in rear-end crashes reduced driver neck injury rates by 55% for women (significant) and 31% for men (not significant).

### PREGNANCY AND MOTOR VEHICLE SAFETY

An understanding of pregnancy and motor vehicle safety has been hampered by the lack of relevant data. Crash databases do not consistently note whether women were pregnant. Moreover, fetal death certificates do not record maternal crash involvement as a possible cause of death, and such information typically is absent from injury surveillance systems (Weiss 2001).

Approximately 4 million women each year in the United States become pregnant, including about 10% of women ages 15 to 45 (Klinich et al. 2005). With more women in the workplace and many of them driving to work until late in their pregnancies, many women and their unborn children are at risk of crash injuries. Such injuries include placental abruption, uterine rupture or laceration, and fetal injury or death. Uterine ruptures and lacerations are fairly rare, an estimated 1% of pregnant trauma cases (Pearlman et al. 1990a). These injuries are sustained almost exclusively by women during the latter stages of pregnancy. As the uterus grows it extends beyond the pelvic cavity, and because it is filled with fluid, additional loading can more easily lead to rupture.

Weiss et al. (2001) conducted a retrospective study of fetal injury deaths (20 weeks' gestation and older) due to trauma in 16 states during 1995–1997. Information regarding crash involvement was not coded on fetal death certificates, so data were extracted from the narratives. Motor vehicle crashes were the leading cause of traumatic fetal injury death, representing about 82% of the fatalities. Extrapolating these data to the general U.S. population, the authors estimated 143 fetal deaths per year. Noting that this was conservative given a variety of factors such as the likely underreporting of fetal death by about 50%, the authors said that the estimated number of fetal deaths from crashes could be as high as 370 per year. Other crash consequences to unborn children include fetal injury or premature birth. The accompanying complications of early emergency births can lead to

long-term negative consequences for children, but estimates of the frequency of these adverse outcomes are unavailable.

Placental abruption, which involves the premature separation of the placenta from the uterus and disruption of the supply of oxygen and nutrients to the fetus, is the leading injury mechanism for fetal death in motor vehicle crashes (Lane 1989; Pearlman et al. 2000; Weiss 2001). It also is the most frequent pregnancy-related injury, estimated to occur in 1% to 5% of minor crashes and 20% to 50% of severe crashes (Klinich et al. 1998). Placental abruption is most likely to occur in severe crashes (Reis et al. 2000) but can occur with little or no injury to the mother (Agran et al. 1987; Pearlman et al. 2000).

Crash severity has been shown to be the strongest predictor of fetal outcome. In a study of 42 crashes involving pregnant occupants, Klinich et al. (2000) found that fetal loss or major fetal complications occurred in all of the crashes classified as severe (>48 km/h) regardless of restraint use or airbag deployment. In low- and moderate-severity crashes, the highest percentages of positive outcomes occurred among those restrained with either a three-point lap-shoulder belt alone or a three-point belt plus airbag. From the same data, Pearlman et al. (2000) reported that adverse fetal outcomes are less likely to occur with proper restraint use than without. The authors concluded that high-severity crashes are likely to lead to poor fetal outcome, but proper restraint use in low- and moderate-severity crashes can decrease the likelihood of fetal death and other complications.

Results of additional studies using real-world and crash test data support the findings that restraint use as well as proper restraint use reduce the likelihood of fetal injury or death. The definition of "proper" varies somewhat among researchers but generally is considered to include a lap belt positioned low and beneath the abdomen and a shoulder belt positioned between the breasts. Klinich et al. (1998) examined 120 crashes involving pregnant occupants, largely extracted from a literature review, and found that in the majority of cases (48 of 69) of placental abruption the pregnant occupant was unrestrained. In crash tests with a pregnant dummy, Pearlman and Viano (1996) found that proper belt placement, with or without airbag deployment, resulted in the lowest injury ratings compared with improper belt placement or no restraints. In fact, the authors found a three- to fourfold increase in force transmission through the uterus when the lap belt was improperly positioned across the pregnant abdomen rather than beneath it. A major limitation of this study was that the design of the pregnant dummy did not allow adequate study of placental abruption, which is widely noted as the most common injury mechanism of fetal death. Hyde et al. (2003) studied fetal deaths in police-reported crashes in Utah and found that compared with restrained pregnant

women, those who were unrestrained were at greater risk of having low-birth-weight babies and maternal bleeding. They were nearly three times more likely to experience a fetal death. More research is under way to understand better the specifics of how seat belts affect the uterus, the uteroplacental interface, and the fetus during a crash. Researchers at Volvo (Jordan 2004), Virginia Polytechnic Institute and State University (Stitzel et al. 2003) and the University of Michigan Transportation Research Institute (Rupp et al. 2001) are conducting crash tests with real and computer-simulated pregnant dummies.

In addition to crash severity and restraint use, fetal outcome also is related to maternal injury. Both Klinich et al. (2000) and Ikossi et al. (2005) reported that adverse fetal outcome was greater when maternal injury was high. However, fetal injury or death has been found to result with little or no maternal trauma, and outcomes such as placental abruption were not necessarily predictable on the basis of maternal injury (Pearlman et al. 1990b).

Less is known about the effects of airbag deployment on fetal outcome. Risk of fetal head injury due to airbag deployment may increase when occupants are unrestrained or improperly restrained. In 15 mile per hour tests with unrestrained crash dummies, Pearlman and Viano (1996) reported an increase in the risk of fetal head injury with airbag deployment. However, when occupants were properly restrained, there was little evidence of increased risk. Uterine force was relatively low in all test conditions in which an airbag deployed, with and without belt use, especially compared with test conditions with improper belt placement and no airbag. In real-world crashes involving pregnant women, Klinich et al. (1998, 2000) reported that positive fetal outcomes were highest among restrained occupants, with or without airbag deployment. Klinich et al. (2000) tentatively concluded that airbags may have a positive effect on fetal outcome but cautioned that this finding was based on a small sample. One issue among pregnant drivers is the proximity of the abdomen to the steering wheel. Regardless of airbag presence, impact with the steering wheel can result in injury. In a study of the anthropometry of pregnant women and their seating positions, researchers not surprisingly found that the distance between the steering wheel and abdomen decreased with increasing gestational age. As pregnancy progressed, subjects did not move farther away from the steering wheels because of the need to operate the pedals (Klinich et al. 1998).

### RESTRAINT USE DURING PREGNANCY

A few studies have addressed the issue of seat belt use during pregnancy. Ikossi et al. (2005) studied 1,195

injured pregnant women who were admitted to trauma centers during 1994–2001, finding reported belt use of only 66%. Surveys examining restraint use among pregnant women during prenatal visits to medical centers or health departments have determined that women need to be better informed of the benefits of proper restraint use during pregnancy and how to achieve such use. Self-reports of restraint use among survey respondents range from 42% (Schiff et al. 1992) to 98% (Johnson and Pring 2000). Restraint use also was found to be higher during pregnancy than prior to it. Restraint use reportedly increased by 9% (Tyroch et al. 1999) to 61% (McGwin et al. 2004) during pregnancy. However, 11% (Pearlman and Phillips 1996) to approximately half of those sampled (Johnson and Pring 2000; Tyroch et al. 1999) were unable to identify proper belt placement. Pearlman and Phillips reported that 23% of survey respondents said they “rarely or never” wore restraints; 11% of women who said they wore restraints also said they positioned them over the uterus. Thus, one-third of pregnant women in the sample did not routinely wear restraints or wore them improperly.

### CONCLUSIONS

There is ample evidence from the United States and around the world that women's driving habits are changing as more women transition into the workplace and become more reliant on motor vehicles. In many countries more women are holding licenses and driving more miles than in the past. Over time this increase will mean additional older women on the road. These changes have resulted in more driver deaths and injuries among women, leading people to question whether women are driving less safely than before. Looking at women drivers as a group, researchers have found little evidence of more aggressive driving (Mayhew et al. 2003), although one limited study suggests that this type of driving may be occurring among the youngest drivers (Kostyniuk et al. 1996). More research is needed to address this question.

Men, especially younger men, still lead in risky driving behaviors. They are more likely to ride unrestrained and more likely to speed, tailgate, and drive when impaired by alcohol. These risky behaviors result in higher fatal crash rates among men however the rates are measured because the crashes men typically have are more serious. When all police-reported crashes are examined, the picture changes somewhat. Crash rates per licensed driver are higher for men, but per mile driven the rates are somewhat higher for women. Women generally tend to rate safety as a more important consideration than men (Ferguson and Williams 1996). However, all other things being equal, women are more vulnerable to crash injuries. That is, when crash severity is controlled for, women are

more likely to be injured and die, although this gap narrows among older drivers.

Pregnancy has not garnered a lot of attention among highway safety researchers. One of the challenges has been estimating the magnitude of the problem because crash databases do not consistently code relevant information about maternal condition or injuries to the fetus. Another challenge in evaluating the efficacy of countermeasures or countermeasure opportunities is the limited availability of a dummy that represents a pregnant woman and fetus. The development of a pregnant dummy has been under way for some years. Additional research is being conducted with real and computer-simulated pregnant dummies to better understand how seat belts affect the uterus and the fetus in a crash. Research suggests that pregnant women in crashes are better protected by properly positioned seat belts. However, education is needed to ensure that pregnant women are aware of what to do to ensure proper belt positioning. Research should continue to explore the effects of airbag deployment in crashes involving pregnant women at various gestational stages.

Historically, government crash tests and tests conducted by consumer groups have used dummies that represent an average-size man, but there is growing recognition that in some cases it may make sense to use dummies representing women and children (of course, child restraint testing has always used child dummies). Until quite recently the U.S. government's high-speed frontal crash tests used only 50th-percentile male dummies. However, since it has been recognized that women and children are more vulnerable to airbag-related injuries, manufacturers have been required to conduct additional tests using dummies that represent both short women and children. These tests, required since September 2003, are designed to minimize the potential harm from airbags while at the same time maintaining their lifesaving benefits.

Recently the Insurance Institute for Highway Safety began evaluating the side impact performance of passenger vehicles in a crash test that represents what happens when the driver side of a vehicle is struck by a pickup or sport utility vehicle. The institute uses a side impact dummy representing a small woman or 12-year-old because the head of this shorter dummy is in the window area where people's heads are more vulnerable to being struck by the front end of a vehicle in a real-world impact (IIHS 2003). Using the smaller dummies ensures that vehicle design changes to improve side impact crash test performance are tailored to protect small as well as large occupants. For example, crash tests to date have demonstrated the overriding importance of side airbags that protect the head. No vehicles without this technology have received a good rating. However, in one crash test the head airbag was too small—it only partially covered

the window—to prevent the dummy's head from being struck by the hood of the striking vehicle.

Evaluations of countermeasure effectiveness often include analyses as a function of sex. Research to date suggests that countermeasures such as seat belts, airbags, and head restraints typically work as well or better for women. However, the experience with frontal airbag-related deaths suggests that care should be taken to include tests to ensure there are no deleterious side effects.

Is there more that can be done to better protect women in vehicles? It is likely that the amount of driving by women, especially older women, will increase. But there is little to suggest that women are becoming riskier drivers. Additional research is needed to evaluate changes in crash characteristics over time as a function of age and sex. A better understanding of the injuries men and women sustain as a function of crash type is also needed. This knowledge could provide a basis for deciding whether crash tests should employ male, female, or both kinds of dummies and whether countermeasures are protecting people of both sexes. Data such as these also may better reveal the appropriateness of existing injury criteria. Finally, continued attention needs to be given to the issue of pregnant women and their fetuses and how better to protect them.

#### ACKNOWLEDGMENT

This work was supported by the Insurance Institute for Highway Safety.

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# Women's Issues in Transportation Policy and Planning

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**T**rip-making behavior is influenced by a variety of factors, including the demographic characteristics and lifestyle choices of the traveler as well as factors associated with the transportation system itself. Many papers presented at this conference have reported on different aspects of these explanatory variables. The papers in the plenary session on policy and planning focus instead on choices made by society in the form of public policy, which can also strongly influence trip behavior, including such things as the availability of alternative modes of transportation, how transport choices are priced, the availability of lifestyle support services such as daycare centers, the manner in which communities develop, and how tax structures influence one kind of behavior over another. Three specific questions define the types of issues to be examined in this session:

- What are the implications of women's trip behavior for planning practice?
- What are the implications of women's transportation issues for policy?
- What has been international experience with respect to women's travel?

The topic of public policy and planning is so broad and encompasses so many issues that it is difficult to establish boundaries around what should be included and, perhaps more important, to know how not to cover topics that are discussed elsewhere in the conference. In some ways, all of the other sessions and papers in this conference could be placed under the broad umbrella of policy and planning because they all relate in one fashion

or another to policy and planning methods and to establishing the analysis context for policy recommendations.

The purpose of this overview is to set the context for the papers presented in the policy and planning session of the conference by establishing a conceptual framework for planning and policy development, which is used to describe current understandings and potential research needs.

## CONCEPTUAL FRAMEWORK FOR POLICY AND PLANNING IMPLICATIONS OF WOMEN'S TRAVEL BEHAVIOR

Given the breadth of issues that could be related to the policy and planning implications of women's travel, it is first useful to establish a framework of how such issues can be framed in a broader context. Figure 1 shows such a framework adopted by Meyer and Miller (1). Any planning process begins with collecting data and information on the problems being faced, a step characterized in Figure 1 as understanding the issues. Much literature on women's travel has focused on this particular aspect. This understanding of the issues feeds into a definition of a vision for the jurisdiction or community and the identification of goals and objectives and performance measures. Each of these components of a planning process is critical for establishing a particular issue on the agenda of decision makers and those who influence policy making and planning.

The next major component of the conceptual framework is analysis, which includes not only the tools and

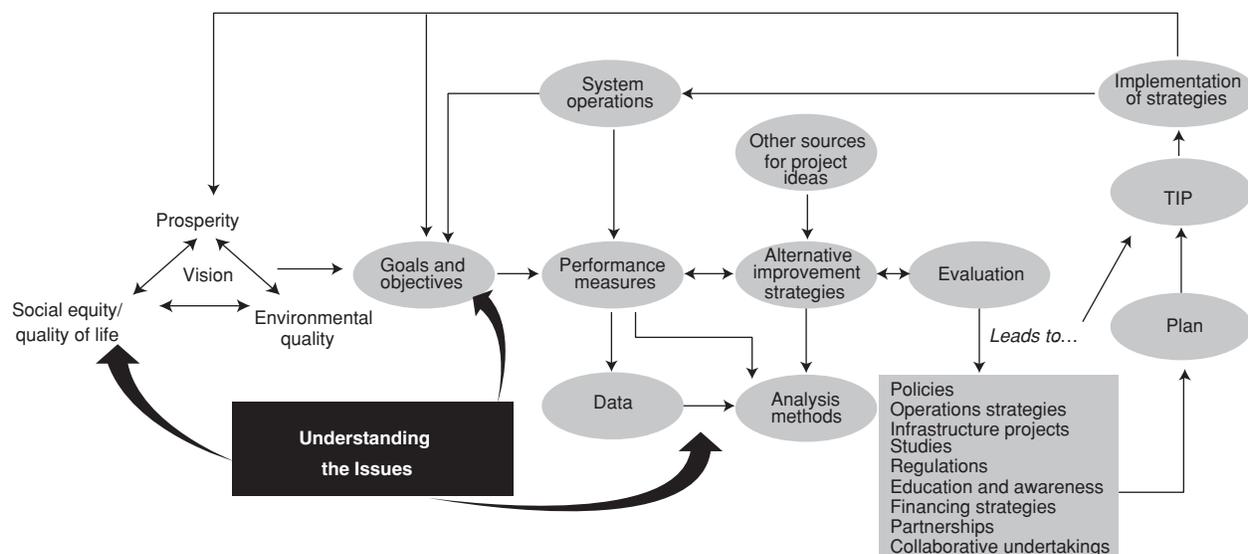


FIGURE 1 Conceptual framework for policy and planning implications of women's transportation issues [from Meyer and Miller (1)].

methods that are used to determine the consequences of alternative courses of action but also the data sources that are necessary as input into these methods. Analysis leads into the evaluation process, which synthesizes the analysis results and produces an assessment of which actions are better than others. In many cases, this assessment can include quantifiable metrics indicating how one alternative compares with another (e.g., benefit–cost analysis), whereas in other cases the assessment could be subjective.

The information produced by the evaluation process feeds into the development of the many products of the planning process, including the adoption of policies. It is important to understand that the products of the process illustrated in Figure 1 can range from project recommendations to policies to additional studies. Thus, for women's transportation issues, progress in addressing such issues will likely occur in a variety of forms, certainly by incorporating women's issues into proposed projects and services (2–6), but also by considering outreach efforts, policies, and additional studies that might promote women's issues in the decision-making process.

Although the conceptual framework up to this point could describe the planning of almost any topic, the next steps are very much related to the transportation public sector. According to federal law, every urbanized area over 50,000 population and every state must have a transportation plan, as well as produce a programming document that outlines the transportation priorities over the next 3 to 6 years. These documents are some of the most important products of the transportation planning process in that they indicate the direction in which a state or region is heading in its transportation program.

The final step is monitoring system operations. By monitoring what is happening to transportation system performance, transportation officials can provide feedback into the transportation planning process so that future planning can focus on identified deficiencies and gaps.

### Understanding the Issues

Application of this framework to the issues of women's transportation and travel behavior provides insights into research that has been undertaken in the past as well as future research needs. Much of the literature on women's transportation and indeed most of the papers submitted to this conference have focused on this point of departure for planning and policy (7–9; 10, pp. 75–85; 11–14). Most of this work has examined historical data on women's travel characteristics in order to interpret travel patterns, challenges, and behavior. Dittmar (15), however, expanded the definition of “understanding the issues” by examining the impacts of federal transportation legislation on women's travel and concluded that the most important legislative issues that might affect women's travel patterns included welfare reform, school choice, capital project emphasis, insufficient attention to social issues, travel needs of female immigrants, trends in pupil transportation, and the level to which women participate in transportation planning. He suggested that there were important issues in planning methodology as well, including activity-based travel demand modeling and better understanding of suburban travel patterns and behavior.

What are the important women-related transportation issues identified by these and other authors? In general terms, they include the following:

- Activity- and temporally oriented analysis that often misses key factors related to women's transportation issues. Much of transportation planning focuses on peak-period travel issues, which are primarily concerned with commuter trip making. Certainly, with many women in the labor force, any efforts to provide improved travel for these types of trips and during these periods would be beneficial. However, noncommute trips made during nonpeak periods (e.g., childcare-related trips) often do not receive an equivalent level of attention but are very important aspects of women's travel behavior.

- The importance of family roles and responsibilities as they relate to transportation needs and desires. Although women's role in Western societies has changed dramatically over the past several decades, women still play an important role in child rearing and household management. The travel needs in support of this role have not received much attention by researchers.

- Aging and women's travel needs. The population of many countries in the Western world is aging at a rate that is increasing the average age to significant levels. Given the life expectancy of men versus women, women make up a much larger share of this elder population than men, and this trend will likely continue in the foreseeable future. The changes in travel behavior for women who have been used to a different type of trip making in their earlier years could be one of the most important transportation challenges facing Western societies in the future.

- Cultural differences and women's travel opportunities. Much of the research that has occurred on women's transportation has focused on trip making in Western societies and has not looked closely at how cultural influences affect the challenges being faced by women in non-Western countries, or for that matter by women who have immigrated to Western societies. As is seen in papers presented at this conference, such differences can be dramatic.

Although the historical data research has been instrumental in furthering the understanding of these issues, the real challenge facing the understanding of women's transportation is not necessarily a projection of past trends but rather an increased understanding of the dynamics of future population demographics and the potential impact of technology (and other behavior-forming influences). For example, one could speculate that the following societal trends could have a fundamentally different influence on women's transportation than what has been seen in the past:

- Household mix and structure will continue to be different from what was true in the 1970s and 1980s.

- Women (and men) will live (and work) longer.

- Women, in general, will have higher incomes, but the gap between the higher- and lower-income households will continue to widen.

- As has occurred over the past 4 decades, much of the population growth will be in metropolitan areas. However, there will still be a significant number of (especially older) people living in rural areas (this trend might be particularly important for women, who tend to outlive their spouses).

- Society will continue to enjoy increasing levels of cultural diversity, leading to transportation challenges on how to provide mobility in acceptable ways to the many different groups now found in a typical metropolitan area.

- Unlike 50 years ago, when men were the predominant users of the automobile, generations of young women have grown up with driver's licenses. Thus, as women get older, their most familiar form of mobility will be the automobile.

- Societal concerns with environmental quality will continue to grow, especially among women.

- Technology will become even more prevalent for leisure and entertainment and for satisfying more of the everyday needs. Such technology could become a substitute for many travel needs experienced by women.

- Women will increasingly gain in political power, becoming more influential in determining policies and making decisions that relate directly not only to transportation but also to such issues as daycare, health provision, quality education, and environmental quality, which are affected by, and affect, the transportation system.

The foregoing list is speculative, although many of these trends are already being seen today. The research challenge is to examine these trends (and many others not listed here) and determine what impact, if any, they will have on women's transportation.

Another important concern arises when the current state of research on understanding women's transportation issues is examined. Almost all of the literature, and again most of the papers at this conference, have focused on the "what?" of women's travel behavior. What has been left out is the "why?" It is known with some level of certainty how women travel, the trip purposes associated with this travel, and the socioeconomic context of women travelers. What is left unclear is the "why?" of this travel. Why do women exhibit different travel patterns than men? Why are women seemingly more concerned about safety and personal security as they relate to trip making? Why are women not as involved in transportation decision making as their male counterparts?

These are just some of the questions that could be well served by research.

This brief overview of the initial step in the planning framework leads to the following research questions and needs:

- What do we know (and not know) about women's transportation issues and their defining parameters?
- What future societal trends might strongly influence women's transportation? What are the likely implications of these trends?
- How should one account for the effects of space, income, immigrant status, and so on, on women's transportation?
- Why do women exhibit the travel behavior they do? What are the key factors that influence women's travel decisions?
- For what is known, how should this knowledge affect societal policies and goals?
- For what is not known, what types of information and data collection are necessary to improve understanding?

### *Vision, Goals and Objectives, and Performance Measures*

The early steps in the planning process provide the foundation for many of the planning steps that follow. Not only do the vision and goals and objectives provide a statement of what is desired for a community but the public process of developing them provides an important opportunity to inform and educate the community on the key issues that could become of greater concern in the future. Although visions and goals and objectives are often community-specific, one often finds commonality among jurisdictions in the statements relating to desired transportation and related system performance. For example, goals are often found in many transportation plans relating to the following issues:

- Safety,
- Mobility,
- Community design,
- Quality of life,
- Security,
- Sustainability,
- Aging,
- Social inclusion,
- Environmental pollution,
- Public health,
- Housing, and
- Equity.

Visions and goals and objectives are not usually so detailed that one would find stated distinctions on how

they are defined or interpreted for men or women. Usually, for example, a goal statement would be simply "We want a safe transportation system." However, one can certainly speculate that each of the foregoing goal areas could have very different implications for women as compared with men. Safety might mean one thing for men (road safety, speed-related crashes, or both) and another for women (personal safety and in-vehicle child restraints). Mobility for men might very well mean ease of travel to work, whereas for women it might mean ease of travel to work as well as travel for family care reasons. Each of the goal areas has important transportation and social consequences, which might result in very different implications for men as compared with women, and vice versa.

The literature covering these issues is quite sparse. In fact, a paper presented at this conference is one of the few examinations of efforts to incorporate gender into visions and goals and objectives. Vagland (16) reports on the results of a recent transportation policy statement in Sweden that recognizes the need for equality and equity in national transportation policy making. As reported by Vagland, the Swedish policy states that "the transport system shall be designed so that it meets both men's and women's transport requirements" and that "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." This is one of the few examples where women's transportation issues have been explicitly considered in a vision and goals statement.

Performance measures are a relatively new addition to the transportation planning process. These measures or indicators provide a status report on how well the transportation system is performing at any particular point in time or, if desired, how well the system has performed over time. They are potentially very influential in that they focus on a limited number of issues that are of particular interest to decision makers.

The professional interest in performance measures has expanded in recent years. A review of one of the most complete listings of such measures, however, reveals that of the approximately 600 measures that had been identified in practice, all were defined generically, with little attempt to attach gender to any (17). Thus, for example, generic mobility and accessibility measures are used in many metropolitan areas, as are measures relating to transit ridership, road congestion, air quality, and so on. These measures generally do not target specific groups (with an important exception being low-income households) and therefore do not monitor how the transportation system is performing with respect to other important trip-making groups, such as women.

The research needs that relate to this step in the planning process include the following:

- Which goals or policy arenas are most related to women's transportation issues? Do existing typical goals and objectives provide sufficient focus on such issues?
- Where appropriate, how should women's transportation and societal issues be incorporated into a community's visions and goals and objectives? Are there sufficiently important issues relating to women's transportation that they deserve more targeted attention in this part of the planning process?
- For those women's transportation issues that are found to be most important, how can they be represented in performance measures? How do such issues or performance measures overlap with the performance measures commonly found in transportation planning?

### *Data Analysis and Evaluation*

Data analysis and evaluation are steps in the planning process most commonly found in the literature. Data, of course, are critical to the analysis of any policy topic. Many papers at previous conferences on women's transportation issues (and many of the papers submitted at this conference) focused on the analysis of data associated with women's travel as well as on the limitations of these data. In general, these papers concluded that there are not enough good quality data on women's travel patterns and behavior; that the definition and interpretation of some of the data inputs and results are unclear as they relate to women's transportation issues; that biases are often introduced into data collection by the way data are sampled and categorized, which limits their usefulness in interpreting what is being learned regarding women's transportation; and, as noted earlier, that limited data are available concerning the why of women's travel decisions.

Analysis and evaluation tools serve as the core of the investigative part of the planning process. These tools provide the information that is necessary for decision makers to understand the likely consequences of each action under consideration as well as the relative worth of one action versus another. Although important work is being done in the environmental justice community, most current approaches to analysis, evaluation, and presentation of information to decision makers seldom examine the distributional (or equity) impacts of plans, strategies, or investment actions, not only for women but also for other underrepresented groups. In many ways, doing so is a key precursor to making policies and plans more sensitive to women's transportation issues. President Clinton's Executive Order on Environmental Justice showed some level of response by the planning community in understanding the distributional impacts of proposed investments on low-income and minority households. Even here, however, the amount of progress has been limited.

What will happen in the near future for data analysis and evaluation as it relates to women's travel issues reflects observations with regard to travel modeling in general, but also captures thoughts on how deficiencies identified in this and previous conferences might now be handled given advances in modeling and data collection technologies. The following observations and predictions are perhaps a bit optimistic, but they do relate to plausible directions for improving analysis and evaluation as they relate to women's travel issues.

**Continued Linkage of Transportation Policy with Other Societal Goals and Issues** Transportation policy will continue to be linked to other societal goals and issues (e.g., public health). One of the important characteristics of transportation policy over the past 50 years has been the policy linkage between transportation investment and its desired impact on other societal goals. For example, transportation policy is often linked to economic development, economic productivity, international competitiveness, environmental quality, quality of life, and, most recently, public health. These linkages are not likely to diminish in the future and if anything could become even stronger. The important question is, how does the transportation influence on other societal activities affect different population groups? For example, a national welfare-to-work policy should have a transportation component that provides the opportunity for welfare recipients to reach jobs, but this transportation component could be different for men than for women, where the latter might also have responsibilities (requiring transportation support) for children and other family members.

**Activity-Based Travel Modeling** Activity-based modeling will provide the means by which women's travel behavior can be more effectively incorporated into travel demand models. Historically, demand modeling has focused on the trip, usually categorized by trip purpose, as the major unit of analysis and thus model output. This focus has resulted in a disconnect between what actually happens during a trip versus how a network model would represent that trip. A trip from home to a school (to drop off children) to a coffee shop to work would be modeled as three different trips: one home-to-other (or school) trip, one non-home-based-to-other trip, and one non-home-based-to-work trip. In reality, the different destinations for this home-to-work trip are really part of one trip, linked in terms of the activity undertaken by this traveler. The most recent progress in demand modeling attempts to account for the traveler's activity and the need for transportation as part of this behavior, thus resulting in activity-based modeling. With women's daily activities often different from men's, a more realistic, activity-based approach for representing trip making will

allow the model to capture women's travel behavior much better than has been done in the past.

**Better Spatial Location Technologies** Better spatial location technologies in combination with data collection methods will provide a major leap in the understanding of travel behavior. One of the important limitations of past data collection efforts has been an inability to identify easily where travel behavior was occurring on a transportation network or, in some cases, who was the actual traveler. Thus, for example, in-vehicle data collection devices that monitor vehicle speed, acceleration, and other characteristics of the vehicle's performance would often not identify where the activity occurred or who was driving. Transit riders, walkers, and bicyclists were often undercounted and their travel patterns not understood because of data collection limitations. With the Global Positioning System (GPS) and geographic information systems (GIS), transportation planners can collect a much more robust set of data that provides much more information on what is happening, how it is happening, and where it is happening. This development is important for women's travel analysis because the weakest part of transportation data collection efforts was often on phenomena such as walking and riding transit, which were very important to women's travel.

**Better Mode Analysis Models** Models will do a better job of analyzing different transportation modes. Similar in nature to the previous point, that data collection for some modes of transportation is not as good as for others, the ability of analysis tools to model adequately the different modes of transportation is a key point of departure for understanding travel behavior. In particular, improvements to the modeling of nonmotorized trips and transit trips will be important for women's travel analysis.

**Better Small-Scale Models** Better models and tools will be available for planning and analysis at smaller scales (e.g., neighborhoods). The nature of most current network models is that they aggregate model inputs and outputs at such a high level that any ability to identify impacts at a smaller scale is lost. An example is the inability of most models to analyze walk trips internal to a traffic analysis zone. In many residential communities, such trips constitute a very large proportion of trip making. Developing models and analysis tools that provide a better assessment of this level of travel and of the impacts of different strategies will be an important improvement to the profession's analysis capability.

**Better Understanding of Urban Design–Urban Travel Relationship** The impact of community development

and urban design policies on urban travel (and vice versa) will become better known and incorporated into community decision making. Many papers at this conference examine the important relationship between how communities are structured and the resulting influence on people's ability to move around. This is an important relationship, which has been examined by several researchers for many years. With women's transportation issues, because many of the nonwork trips in a community are made by women, urban design and community development patterns become a significant determinant of the quality of life they experience. The more spread-out different activities are, and especially those relating to child rearing, the more time parents (women, in particular) will spend transporting children to these locations. Many communities have begun to adopt different approaches toward urban design that better reflect the desire of community residents to spend more time enjoying activities rather than traveling to them. This action will likely continue, if not expand, in future years.

### *Consequences*

All these predictions have important consequences on how planning and policy analysis is conducted and, in particular, how women's issues are incorporated into this analysis:

- What is the current status of data as they reflect women's transportation issues? What is missing?
- What are the deficiencies in data collection strategies and methods with respect to understanding women's travel issues?
- How do state-of-the-practice models and analysis methods treat gender-related travel phenomena? What improvements are needed?
- Are evaluation methods and techniques (which are often general, e.g., benefit–cost analysis) sensitive enough to differences among travelers?
- Do commonly used evaluation criteria distinguish between impacts on different population groups, in particular, on women? If not, is this an important issue? If so, what criteria provide the best evaluation information?

### **Outputs of Planning Process**

As shown in Figure 1, the planning process can produce many important outputs. These products, along with the eventual implementation of specific actions and strategies, are the ultimate outcome of the steps that have preceded them. Thus, for example, plans, pro-

grams, projects, education strategies, additional studies, finance, and partnerships can all be possible outcomes of planning efforts. The important questions for this conference are, to what extent is women's transportation even recognized as an issue in these products? And to what extent are specific actions proposed for dealing with this issue?

One of the important issues relating to the planning results that lead to new or changed policies is the importance of scale. For example, the level of analysis and tools needed to understand the implications of national tax policy on women's transportation issues would be very different than those needed to examine a city's transit policy and its influence on women's travel decisions. To some extent this is the same issue mentioned earlier in the discussion of the desirability for tools that could operate at smaller scales of analysis. However, the analysis of policies and their impacts will likely require a flexible research framework that reflects the availability of data and the types of analysis models that are needed.

Research needs for planning outputs and outcomes include the following:

- From a retrospective perspective:
  - What have been the policies most affected by, and those most affecting, women's transportation issues?
  - To what extent have women's transportation issues been found in the products of the planning process and of policy development?
- In looking toward the future:
  - What are the implications of changing gender demographics in a range of policy areas?
  - What are the implications for transportation policies?
  - What are the best ways of integrating women's transportation issues more into planning and policy analysis processes?
- What are the supporting roles that transportation policies can play in meeting other societal goals important to women?

Finally, though not shown explicitly in Figure 1, the typical transportation planning process as practiced in the United States provides many opportunities for public involvement throughout the process. Thus, the issues associated with women's transportation could be better understood given the opportunities presented to the public to participate in the planning process. By raising women's transportation as an issue early in the planning process, the steps that follow will typically attempt to answer the questions that have been raised. Public involvement thus becomes an important opportunity to include in transportation planning the many different aspects of women's travel that are best addressed at the local or regional level.

## INTERNATIONAL PERSPECTIVES

National and cultural factors will likely have a significant effect on women's roles in society and on women's transportation issues (18, 19). This conference provided opportunities for researchers and scholars from other countries to examine women's transportation and to define some of the cultural differences that could explain women's travel behavior. This topic has not received much attention in the literature, but it is one that is certainly important from a global perspective. There will be clear differences between developed and developing countries, and even within countries there will likely be differences between women living in urban areas and those who live in rural areas. The availability of transportation for the women of the world relates not only to their economic welfare and social well-being but also to public health.

Some of the more interesting research questions on this topic include the following:

- How are women's travel needs and desires shaped by national and cultural factors?
- What has been the experience in other countries in developing national or regional transportation strategies that enhance women's mobility?
- How does transportation policy tie into other government policies (e.g., public health, economic development, education) and what has been shown to be most effective?
- How can the successful experience with women's mobility strategies in one country be transferred to others? What impediments exist to this transfer of experience?

## SUMMARY

Some planning and policy issues associated with women's transportation and travel behavior research have been examined. In each component of the planning process, as well as for the international aspects of such issues, research questions were proposed. The intent here was not to prepare an exhaustive list of such questions, but rather to establish a sense of what still needs to be examined in order to improve women's mobility. Some of these questions were examined in the papers delivered at this conference. Others were not and have not received much attention in the literature.

The challenge for the research community is not only producing a better understanding of women's transportation issues but also supporting the development of policies, plans, and actions that will ultimately enhance women's mobility. The success of such research is thus ultimately achieved when those in positions of decision making and influence understand the issues and act upon them. The research results reported at this conference

can go a long way toward providing the knowledge base for such action.

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## APPENDIX A

# Conference Committee Biographical Information

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**Sandra Rosenbloom**, *Chair*, is professor of planning and director of the Roy P. Drachman Institute for Land and Regional Development Studies at the University of Arizona. Her current research interests are the safety, transportation, mobility, and land use implications of societal changes including the changing role of women and the growth of an aging population; public transit planning; and the role of private transport options in urban and rural transportation systems. Dr. Rosenbloom has been active with the Transportation Research Board and is currently on its Women's Issues in Transportation Committee and in the American Planning Association, American Collegiate Schools of Planning, and Women's Transportation Seminar.

**Susan A. Ferguson** is senior vice president for research at the Insurance Institute for Highway Safety, where she has worked since 1991. She has conducted research in many highway safety areas, with an emphasis on child occupant protection, vehicle safety issues, young and older drivers, and alcohol and driving. Dr. Ferguson has published more than 80 scientific papers. She chairs the Blue Ribbon Panel on Advanced Airbags and serves on various advisory boards including Partners for Child Passenger Safety Advisory Board, Children's Hospital of Philadelphia, and Harvard Center for Risk Analysis Advisory Board. She serves on the Transportation Research Board Committees on Alcohol, Other Drugs, and Transportation and on Women's Issues in Transportation and on the TRB-NRC Committee for Review of the U.S. Department of Transportation's Intelligent Vehicle Initiative, Phase 2.

**Susan L. Handy** is associate professor in the Department of Environmental Science and Policy and the Institute of Transportation Studies at the University of California, Davis. She held the positions of assistant and associate professor at the University of Texas at Austin in the Community and Regional Planning Program of the School of Architecture. She is chair of TRB's Telecommunications and Travel Behavior Committee and a member of TRB's Transportation and Land Development Committee. From 1996 to 1998, she chaired the Transit Cooperative Research Program (TCRP) Project Panel H-12 on Integrated Urban Models for Simulation of Transit and Land Use Policies. Dr. Handy has conducted extensive research on a wide variety of issues relating to the social and community impacts of transportation policy, planning, and design and has authored a great many articles and research reports in these and related areas. Dr. Handy holds a bachelor of science and engineering from Princeton University, a master of science in resource planning and civil engineering from Stanford University, and a doctorate in city and regional planning from the University of California at Berkeley,

**Sara McLafferty** is professor of geography at the University of Illinois, Urbana-Champaign. Her areas of research and teaching include the geographies of health and health care, urban geography, and spatial analysis methods (geographic information systems). She has examined geographic inequalities in health and social well-being in cities in the United States and the use of spatial analysis methods in modeling and understanding such inequalities. Her research has also explored varia-

tions by race and ethnicity in women's geographical access to employment opportunities and health and social services. She was a member of the Mapping Science Committee of the National Academies.

**Michael D. Meyer** has been professor in the School of Civil and Environmental Engineering, Georgia Institute of Technology, since 1991. He has written more than 120 technical articles and has authored or coauthored numerous texts on transportation planning and policy. He has served on or chaired many TRB committees relating to public transportation, transportation planning, policy, education, environmental impact analysis, and intermodal transportation. Dr. Meyer is a current member of the TRB Executive Committee.

**Laura L. Ray**, assistant general manager of the Metropolitan Atlanta Rapid Transit Authority, has worked for the Metropolitan Transportation Authority of New York, the Metropolitan Transit Authorities of New York and Atlanta, and the National Railroad Passenger Corporation (Amtrak). She has been active for many years in the Women's Transportation Seminar (WTS) and has served as the national association's president. She has received numerous awards, including recognition from the YWCA, *Women Looking Ahead* News Magazine, and WTS-Philadelphia (Woman of the Year).

**Jane C. Stutts** is associate director for social and behavioral research at the University of North Carolina Highway Safety Research Center, in Chapel Hill. In her 28 years at the Highway Safety Research Center, Dr. Stutts has managed projects in a wide variety of highway safety areas and has authored more than 100 articles and technical reports. Recent research efforts have focused on older drivers, young drivers, driver distraction, drowsy driving, motorcyclist safety, and pedestrian and bicycle safety. Recent projects have been funded by the National Highway Traffic Safety Administration, Federal High-

way Administration, Centers for Disease Control and Prevention, and the AAA Foundation for Traffic Safety. Dr. Stutts has been an active participant in TRB activities; she has chaired the Bicycling Committee, served as a member of the Safety and Mobility of Older Persons Committee, and also served on several NRC committees dealing with health issues and aging.

**Beverly G. Ward** is research associate and director, Ethnography and Transport Systems Program, Center for Transportation Research, University of South Florida. Over the past 25 years, she has held the positions of director for special projects for Family and Child Services in Birmingham, Alabama; Social Worker for the Department of Human Resources in Birmingham; transportation director for the Office of Senior Citizens' Activities in Birmingham; and assistant director of the Alabama Transit Association. Dr. Ward has served on TRB's TCRP Project Panel B-03, Demand Forecasting for Rural Passenger Transportation, and on Project Panel J-07, Synthesis of Information Related to Transit Problems. She is also a member of TRB's Women's Issues in Transportation Committee and cochair of its Mobility Subcommittee and is a member of TRB's Community Impact Assessment Joint Subcommittee. Dr. Ward has authored and coauthored articles relating to women and minorities in the public transportation industry and how women and minorities are affected by public transit systems. She has conducted numerous transportation and transit-related research projects for a variety of state and federal agencies, including the Florida Department of Transportation, the Federal Highway Administration, the National Science Foundation, the U.S. Department of Transportation, and the Miami-Dade County Metropolitan Planning Organization. Dr. Ward holds a B.A. in psychology and film and drama from Vassar College, an M.P.A. in urban planning and design from the University of Alabama at Birmingham, and a Ph.D. in applied anthropology from the University of South Florida, Tampa.

## APPENDIX B

# Conference Participants

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ISBN 0-309-09956-0