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Research on Women's Issues in Transportation

Report of a Conference



VOLUME 1: CONFERENCE OVERVIEW
AND PLENARY PAPERS

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November 18–20, 2004
Chicago, Illinois

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

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

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.

Community Design and Travel Behavior

Exploring the Implications for Women

Susan Handy, *Department of Environmental Science and Policy,
University of California, Davis*

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 over-
lies both land use patterns and the transportation sys-
tem, 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 con-
cepts—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 com-
munities 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, employ-
ment and shopping opportunities designed for pedestri-
ans without excluding the auto” (3). More recently, the
Active Living by Design movement has promoted “envi-
ronments 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 grow-
ing 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 re-
vitalize 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 bal-
ance 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.

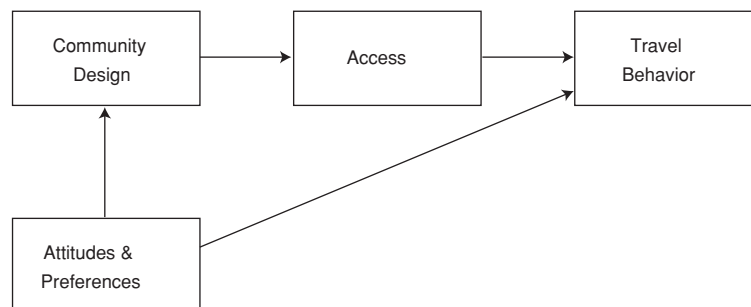


FIGURE 1 Relationships between community design, access, travel
behavior, and attitudes and preferences.

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
Women	-0.06	-0.33	0.29
Men	0.03	-0.20	0.30
<i>p</i> -value	0.07	0.06	0.93
Women w/kids	-0.02	-0.34	0.22
Women w/o kids	-0.07	-0.33	0.33
<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.

borhoods 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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