Photo: Dan Burden

Policy makers are looking to research findings for ways to address the causes of the comparatively low rates of walking and bicycling in the United States for utilitarian purposes, such as getting to work or school and completing daily errands.

Walking and Bicycling in the United States

The Who, What, Where, and Why

J. RICHARD KUZMYAK AND JENNIFER DILL

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Concerns about health and obesity have directed attention to the possible link between physical exercise levels and the built environment. In the United States, development in the past 60 years has turned away from the traditional compact, walkable city or town toward a more dispersed, automobile-centric pattern that makes travel by any means except private vehicle impractical and inconvenient.

People living or working in these automobile-oriented environments may still walk or bicycle, but generally for exercise or recreation and not for utilitarian purposes such as travel to work or school, shopping or running errands, visiting a friend or going to a restaurant, or accessing public transit. This raises the question of whether—and to what extent—people would choose to walk or bicycle for these routine travel purposes under the proper conditions.

According to the latest National Household Travel Survey (NHTS), fewer than 11 percent of daily trips in the United States are made by walking and about 1 percent by bicycle. This is in marked contrast to the rest of the world. Although the high rates of nonmotorized travel in many Asian and third world countries may be explained by the intensely populated cities and poor economic conditions, different reasons are needed to explain the major differences between the United States and other Western nations. In Switzerland, for example, 45 percent of trips are made by walking and 5 percent by bicycle; in Spain, Germany, and Sweden, the amounts are 23 percent and 9 percent; and in the United Kingdom, 24 percent and 3 percent (*1*).

What makes the United States so different? Does the design of modern U.S. cities and neighborhoods discourage walking and bicycling? Or is it the lack of facilities to assure safe and efficient travel by foot or bicycle, or the array of incentives for driving—such as low fuel prices, free parking, abundant and unpriced road capacity, and subsidized mortgages for housing at the urban fringe? Or does the Ameri-

can lifestyle inherently find driving more pleasurable and convenient? To plan sustainable—and healthful—human environments, and to determine the most cost-effective measures to encourage more walking and bicycling, more must be known about the various influences on bicycling and walking behavior.

Data and Planning Tools

In the past decade, interest in walking and bicycling has elevated so that travel surveys and transportation plans are addressing these modes. A major contributor to this interest is the link between exercise and public health. Transportation and community planners, however, also envision walking and bicycling as key elements in development patterns and transportation systems that offer more travel choices and that reduce vehicle demand, congestion pressure for new highways, and environmental impacts.

Conventional data sources and travel models, however, have constrained planners and decision makers from fully incorporating bicycle and pedestrian policies, programs, and outcomes into the planning process. The standard travel forecasting models used by metropolitan planning organizations (MPOs) fail to incorporate bicycling and walking as modes in the planning process, and the traffic analysis zone (TAZ) geography is too coarse to relate to the shorter distances associated with walking and bicycle travel or with the relevant characteristics of the built environment.

Photo: Colin Bogart, Los Angeles County Bicycle Coalition

A bicycle count in Glendale, California, under the Safe and Healthy Streets project provided city officials with information on walking and biking trends and laid the groundwork for improvements.

New techniques incorporating geographic information system tools and parcel-level data are beginning to isolate and quantify the role of land use attributes such as density, mix of uses, multimodal accessibility, and urban design on travel behavior, particularly on walking and bicycling. Many MPOs are upgrading their models to work with smaller TAZs and to include measures of the built environment, with walking and bicycling as explicit travel modes. An emerging class of activity- and tour-based models enables analysis at the level of parcel points but may not be available nationally for many years.

Photo: Ted Sweeney

In the Netherlands, 25 percent of errands and other daily trips are made by bicycle and 22 percent are made by walking.

Photo: Steve Pinkus

Walking rates for many Europeans steadily increase until age 75; in the United States, walking rates remain stable until age 65 and then drop off.

The most comprehensive data on walking and bicycling are from the household travel surveys used in regional models. These surveys obtain full sociodemographic and travel diary information from a large sample of households, selected and weighted to represent the region.

In the past five years, surveys have improved at capturing walk and bicycle trips, with better techniques and stratified sampling approaches that are likelier to include candidate households. Many of these surveys follow the pattern of the NHTS, conducted nine times since 1969 by the U.S. Department of Transportation (DOT). The NHTS documents trends in travel, although subtle changes in the survey approaches make direct comparisons of walk and bicycle activity levels difficult.

Many research studies have collected data on bicycle and pedestrian travel with a range of methods from user intercept surveys to national surveys to special panels. The National Bicycle and Pedestrian Documentation Project, initiated in 2002, has attempted to systematize data collection and create a national repository for planning use; the data, however, are principally from counts.

Although counts are the most common type of data for bicycle and pedestrian planning—particularly for facilities—their value for understanding bicycle and pedestrian travel behavior is limited. Counts record activity levels at a particular location but yield little or no information about who is making the trip, for what purpose, from what origin to what destination, or what alternative routes were available. Without this information, building realistic estimates of demand from count data alone is difficult.

The following sections highlight factors that research has shown to be important in bicycle and pedestrian travel behavior. This in turn suggests the types of data that are most needed for bicycle and pedestrian demand analysis.

Collecting Bicycle and Pedestrian Data

The lack of data on pedestrian and bicycle volumes hampers transportation agency efforts to plan more effective facilities and to improve safety for pedestrians and bicyclists. As noted in the article by Aultman-Hall et al. (page 8), transportation agencies have well-established procedures for collecting, summarizing, and disseminating motor vehicle traffic volumes, but these procedures do not generally include systemwide pedestrian and bicycle volume data. This limits the ability of transportation agencies to provide or improve pedestrian and bicycle facilities to meet needs; moreover, the lack of data impedes the development of improved methods for predicting pedestrian and bicycle crashes.

Under National Cooperative Highway Research Program Project 07-19, a research team led by Paul Ryus of Kittelson & Associates will assess current and innovative technologies and methods and will provide guidance for transportation practitioners on how best to collect pedestrian and bicycle volume data. The project began in April 2012 and is scheduled for completion in spring 2014.

The assessment will consider the feasibility, availability, quality, reliability, cost, and compatibility of volume data. The guidance will include methods to (*a*) mine and manage data sources efficiently; (*b*) acquire and use data from new and innovative technologies; and (*c*) summarize and disseminate pedestrian and bicycle volume data for site-specific, local, and systemwide needs assessments, project development, and safety management.

Walking and Bicycling Data

Demographics

According to the 2009 NHTS, the most frequent travelers by nonmotorized modes are children under 16 years of age who depend on others for motorized travel (Figure 1). Among walkers, the next most active age group consists of adults 25 to 34 years old. Walking rates remain stable until the age 65 group and then decline. In many European countries, by contrast, the walking rates steadily increase until age 75.

Among those more than 24 years old, domestic bicycling rates are low and relatively flat. Gender differences are most pronounced for bicycling—across all age groups, males are two to four times more likely to have made a bicycle trip than females.

Walking—but not bicycling—appears to be linked to income (Figure 2, page 7). People in the lowest income category made 16.9 percent of their trips on foot and another 4.8 percent on foot to access transit. The share declines to 8.9 percent for

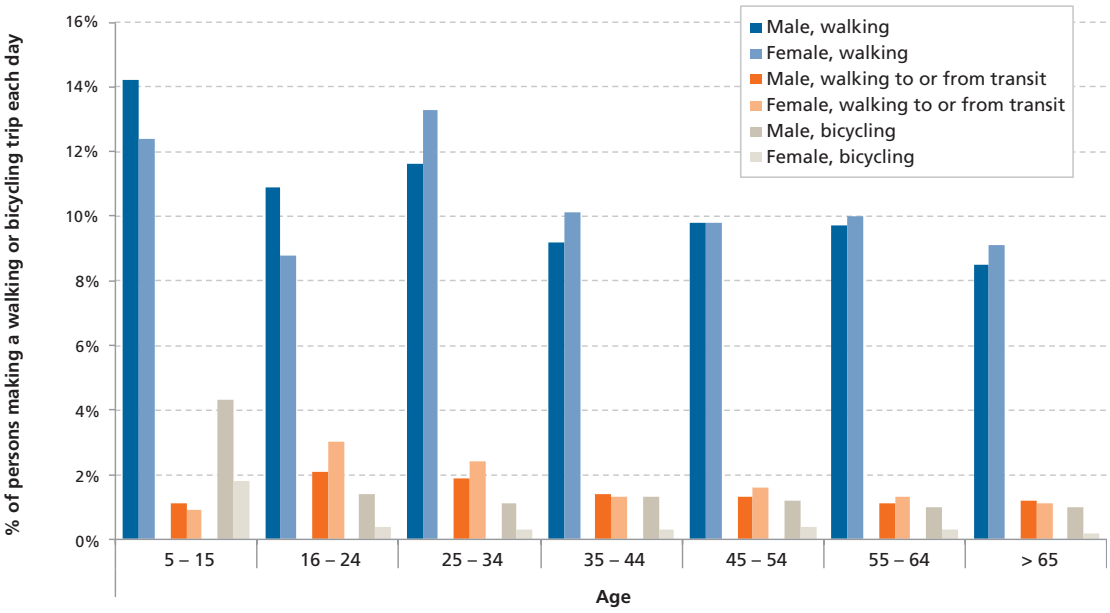


FIGURE 1 Percent of daily trips made by bicycling or walking, by age and gender. (Source: 2009 NHTS.)

people with annual incomes between $40,000 and $99,999 and rises to 10.1 percent for people with annual incomes of more than $100,000.

Bicycling is more consistent across income classes, with the highest rate—1.3 percent—in the $20,000 to $40,000 range, 0.9 percent in the $75,000 to $99,000 range, and 1.1 percent for all other groups.

The relationship to education differs (Figure 3, below right)—the highest rates of walking and bicycling are among people without a high school diploma, with 16.7 percent of trips on foot, including access to transit, and 1.1 percent on bicycles; the next highest rates are among people with graduate or professional degrees—13.9 percent on foot and 1.1 percent on bicycle. The lowest rates of both walking and bicycling are among people with only a high school diploma or GED and some college or an associate degree.

Automobile ownership and availability is perhaps the most telling demographic measure. Persons in households with fewer vehicles than licensed drivers averaged 12.3 percent of daily trips by walking and 1.6 percent by bicycling, in comparison with 7 percent and 0.8 percent when vehicles outnumbered drivers.

(continued on page 10)

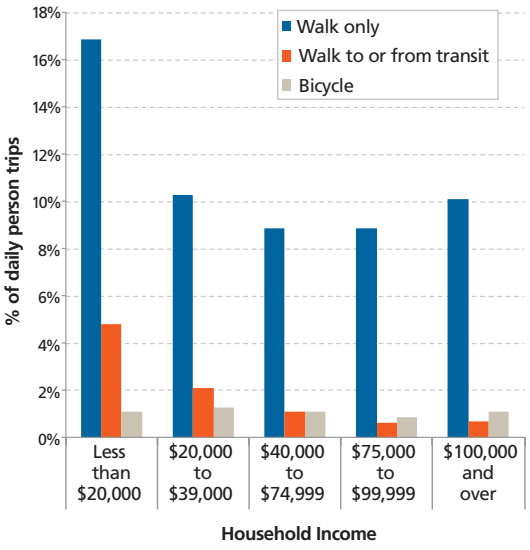


FIGURE 2 Percent of daily person trips, by income.

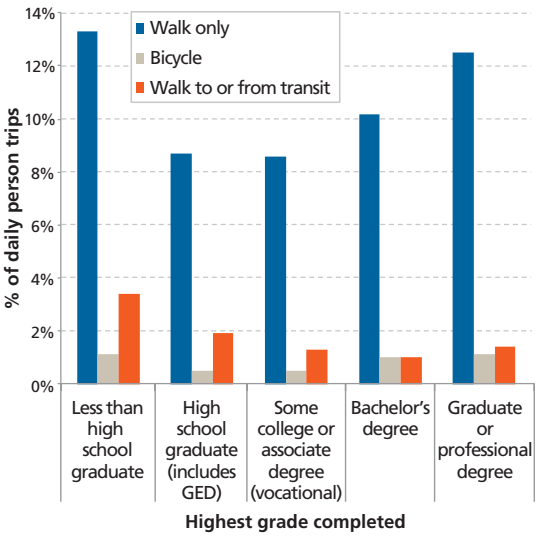


FIGURE 3 Percent of daily person trips, by education.

Innovative Data Collection for Pedestrians, Bicycles, and Other Non–Motor Vehicle Modes

LISA AULTMAN-HALL, JONATHAN DOWDS, AND BRIAN H. Y. LEE

The transportation community has long recognized the need for improving pedestrian and bicycle volume counts. The collection of nonmotorized travel data under a consistent, systematic methodology is a priority for improving research, planning, and policy making for pedestrian and bicycle travel. Volume data are needed for safety and risk assessments, new infrastructure evaluations, travel model inputs, and estimations of miles of travel.

One of the most significant concerns about the lack of data for nonmotorized transportation is that decisions based on judgment may lead to a less efficient use of limited funds. Data scarcity and poor data quality remain challenges for all modes, but with recent technological innovations and widespread advances, the scarcity of bicycle and pedestrian data could be disproportionate.

Although poorly quantified, pedestrian and bicycle activity increasingly is recognized as a vital component of the transportation system, spurring solutions to the data gap. These nonmotorized modes have specific infrastructure and safety requirements that must be met to maximize the utility they provide and to minimize associated safety risks. Successful infrastructure planning relies on accurate volume data by facility and location type, with adjustments for the time of day and year. These data are not widely available for pedestrians and bicyclists. The lack of data—and the resultant lack of informed decision making about facilities and other programs—is a significant reason these modes continue to have limited trip shares nationwide.

Volume collection processes should reflect the unique physical characteristics of pedestrian and bicycle travel. Adding to the complexity is the increasing recognition of the variety of nonmotorized modes in the transportation system, such as skateboards, strollers, rollerblades, and scooters, which provide mobility with differing levels of benefits and risks and also require documentation. Some devices, although motorized, are legitimately considered within pedestrian planning, including wheelchairs of various designs and other assistive devices. Consideration of these modes is important because they are disproportionately used by the most vulnerable populations: seniors, youth, and the physically and mentally challenged.

PHOTO: JODY CIANO, UNIVERSITY OF VERMONT TRANSPORTATION RESEARCH CENTER

Successful infrastructure planning requires data that accurately represent an area, whether urban or rural.

PHOTO: ED YOURDON

Other nonmotorized forms of transportation—such as skateboards, scooters, and strollers—can complicate the task of collecting volume data.

Flawed Programs

Transportation agencies have well-established, systemwide programs for collecting, summarizing, and disseminating data on motor vehicle traffic volumes, but most do not require pedestrian and bicycle volume data, which may be collected on a project-by-project basis at a few isolated locations. The limited scope of the data collected precludes extrapolation systemwide to uncounted sites.

Volume count programs for nonmotorized travel typically have a small extent—for example, at major intersections or specific points of particular facilities and for limited periods during select times and days. The dissemination and use of the collected data are often constrained, and the count locations rarely are selected to allow statistically valid extrapolation, even for total miles of travel within the jurisdiction, because typically only the highest-volume locations are counted. Programs often are strictly urban, although the authors recently have collected data to measure the volumes of bicycles and pedestrians in rural areas in relation to neighborhood activities and tourism.

Technology to the Rescue?

Some of the most advanced pedestrian- and bicycle-counting technologies are available commercially, each with different capabilities and limitations. These tools include microwave and infrared sensors, active and passive; pneumatic and pressure-sensitive devices; inductive loops; piezoelectric counters; and video-image processing equipment. Several groups have compared the

accuracy of these technologies and have found the same range of accuracy as that of the methods used for motorized transportation modes. Costs are becoming reasonable and are not the main barrier to widespread use.

The literature and recent experience suggest that commercial devices have trade-offs in terms of the accuracy, the setting, and the duration at which they are effective in distinguishing between pedestrians and bicyclists and other users. Many infrared devices, for example, do not distinguish between pedestrians and bicycles or other moving objects and can be recommended only for settings that have a physical separation between the count target and motor vehicle traffic. The devices therefore are not suitable for counts of mixed traffic. As another example, some pressure-sensitive devices may not be suitable for winter conditions if snow and ice reduce the sensitivity or if snow removal equipment can damage the device.

Some of the shortcomings of individual devices may be surmountable, however, by combining multiple devices or by deploying them in innovative ways. Siting infrared sensors at locations with a traffic loop that is insensitive to bicycles and taking the difference between the counts from each device, for example, may offer one approach for capturing bicycle volumes on a roadway.

In addition to commercial products, other emerging methods and technologies hold promise for counting pedestrians and bicyclists or for extracting count data from current data sources. These include

- Passive signal-processing from the mobile devices of pedestrians and bicyclists—that is, extracting the locations of pedestrians and bicyclists by tracking their mobile phones or other digital signals;
- Active route- and behavior-logging applications—such as tracking registered users through web-based social media applications; and
- Passive video-image processing—using image processing software to analyze video from existing cameras.

Video-image processing is appealing because video cameras are becoming ubiquitous for traffic monitoring and security. Nonetheless, the approach raises challenges, particularly the practitioner's level of control over the placement and direction of the cameras. If the camera is not installed to include pedestrian and bicycle activities, then the angle of view or the lighting can make it inaccurate for comprehensive, accurate count data.

Call to Action

An assessment of the factors affecting counting technology feasibility, availability, quality, reliability, cost, and compatibility reveals significant but surmountable technical barriers. Available technology can allow for systematic, methodologically consistent data collection for nonmotorized travel. Effective widespread counting programs for nonmotorized transportation are achievable with off-the-shelf technologies, within the specific needs and budgetary constraints of a variety of practitioners.

PHOTOS COURTESY JOAN HUDSON, TTI

*A pedestrian and bicycle traffic counter is installed in Austin, Texas (*above*), and a newly placed counter is tested (*below*). The Texas Transportation Institute and the Capital Area Metropolitan Planning Organization handled the installations and conducted research on bike and walking paths throughout the city in 2011.*

Because of the proliferation of new data collection technologies and the unique capabilities and challenges associated with these technologies, the need is urgent to develop uniform guidelines for nonmotorized travel data collection and data management and to create policies mandating the collection of these data, modeled on the data collection methods for other modes. Management and planning systems now are the main obstacles to action, and coordinated leadership is needed to overcome this barrier.

Acknowledgment

The authors acknowledge valuable discussions with James Sullivan, University of Vermont, and Wesley E. Marshall and Krista Nordback, University of Colorado, Denver.

The authors are with the Transportation Research Center at the University of Vermont, Burlington.

TABLE 1 Proportions, Distance, and Duration of U.S. Walking and Bicycling Trips by Purpose

Trip Purpose	Walk Only — Total Trips: 40,962 million			Bicycle — Total Trips: 4,082 million		
	Percent of Trips	Average Trip Length (miles)	Average Travel Time (minutes)	Percent of Trips	Average Trip Length (miles)	Average Travel Time (minutes)
To or from work	4.5	1.0	16.2	10.9	3.8	21.2
Work-related business[a]	1.7	1.1	14.0	1.8	3.3	21.7
School or church[b]	8.6	0.6	14.5	6.0	1.6	15.2
Shopping[c]	14.7	0.6	12.7	9.8	1.3	14.0
Other family or personal business[d]	21.5	0.5	11.2	8.2	1.4	15.5
Medical or dental	0.9	0.7	16.1	0.2	2.2	26.0
Vacation[e]	1.9	0.8	22.5	2.1	2.4	21.0
Visit friends or relatives[f]	8.7	0.6	11.7	13.0	1.0	13.9
Other social or recreational[g]	35.4	0.8	18.3	47.3	2.6	22.5
Other	1.4	1.2	13.1	0.1	2.3	16.0
Refused or not available	0.8	0.8	22.0	0.8	2.7	25.7
All purposes	**100.0**	**0.7**	**14.9**	**100.0**	**2.3**	**19.4**

SOURCE: 2009 NHTS.

[a] Includes business meetings and other work-related activity.

[b] Includes going to school, religious activity, school or religious activity, and library for school purposes.

[c] Shopping, buying goods, and buying gas.

[d] Includes day care, buying services, family or personal business, wedding or funeral, grooming, pet care or dog walk, civic meeting, transporting someone, meals, social event, getting a meal, and getting snacks.

[e] Includes rest and relaxation or vacation.

[f] Visit only.

[g] Includes social or recreational; exercise (e.g., walking and jogging); playing sports; going out for entertainment; visiting a public place; eating a meal; social event; getting or eating a meal, coffee, or snacks.

(continued from page 7)

The National Household Travel Survey revealed that walking in the United States is linked closely to metropolitan areas and the presence of transit.

Frequency of Travel

Because bicycle or walk trips are made less frequently than might be registered in a one-day travel diary, the 2009 NHTS asks about the use of these modes in the past week. The data reveal that 87 percent of Americans had not made a bicycle trip during the past week, and 32 percent had made no walk trips.

Travel Distance

The NHTS showed that average distance for a walk trip was 0.7 miles, for a travel time of less than 15 minutes. The average for bicycling was 2.3 miles and approximately 19 minutes. Only 12 percent of all walk trips were 1 mile or longer, and only 13 percent were for 30 minutes or longer; 54 percent of all bicycle trips were 1 mile or more, with 26 percent more than 2 miles, but only 12 percent were longer than 30 minutes.

PHOTO: LARRY LEVINE, WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

Travel Purpose

Walking and bicycling destinations differ from those by other modes (Table 1, above). Only a relatively small percentage of walking and bicycling trips are to or from work—4.5 percent and 10.9 percent, respectively—but 8.6 percent of walking trips and 6 percent of bicycling trips are to or from school, reflecting higher use among children.

The single largest purpose for both modes was for social or recreational travel, comprising 35.4 percent of walk trips and 47.3 percent of bicycle trips, suggesting a goal of exercise or relaxation without a particular destination. By contrast, two-thirds of bicycle travel in Europe is for utilitarian purposes (2). Travel to work was associated with the longest trips for walking, at 1.0 mile, and for bicycling, at 3.8 miles, in the United States; in contrast, trips for nonwork utilitarian travel—for example, shopping, family or personal business, and visiting friends or relatives—were shorter, at 0.5 to 0.6 mile for walking and 1 to 1.4 miles for bicycling.

Geographic Location

The highest rates of walking, 19.2 percent, are found in metropolitan areas with populations of 1 million or more that have rail transit. The rate falls to approximately 10 percent for areas of the same size without rail transit and to slightly more than 8 percent in smaller urban and nonmotorized areas.

Bicycling is not as sensitive to urban setting, registering 1.3 percent in areas with populations of 200,000 to 500,000 and averaging 1.1 percent in other areas. Among U.S. regions, the mid-Atlantic

states have the highest rates of walking at 15.8 percent, with the Pacific and New England states at a midrange of 10.3 to 10.6 percent, and the lowest rates in the East and West South Central states at 6.0 to 6.3 percent.

Influence of Environment

Price can influence the choice of travel mode. Increases in the direct costs of driving—gasoline, tolls, and parking, for example—may make walking or bicycling more attractive for more travelers, despite the extra time required. Differences in the price of gasoline and parking may explain some of the differences between mode choices in Europe and the United States. Nevertheless, these costs do not differ much between U.S. cities, yet different rates prevail for walking and cycling to work among the largest cities (Figures 4 and 5, right).

The differences perhaps stem from characteristics of the physical environment—the natural and man-made. In the natural environment, hills and other features affect the directness of travel or the amount of effort required of the walker or cyclist, and weather and climate affect levels of comfort. The man-made, or built, environment, determines the location and proximity of origins and destinations and the characteristics of the environment between.

Travelers respond differently to these influences. Research under National Cooperative Highway Research Program (NCHRP) Project 8-78, Estimating Bicycling and Pedestrian Demand for Planning and Project Development, is investigating the relationships between the built environment and walking and bicycling (see sidebar, page 12).

Two basic research techniques can gauge the importance of particular environmental features in the decision to walk or bicycle to a particular location or via a particular route:

1. The stated-preference approach presents the subject with a range of choices, described in terms of key attributes, and asks for a ranking of the alternatives by personal preference. Statistical analysis of the data from a diverse sample can quantify the relative importance of each attribute.

2. Geographic Positioning System (GPS) devices can trace travel as it occurs, recording actual behavior instead of subjective information. Statistical techniques identify and quantify sensitivities to particular environmental characteristics that influence the travel choices.

In both cases, the sensitivities link to the characteristics of the traveler, which is important for planning.

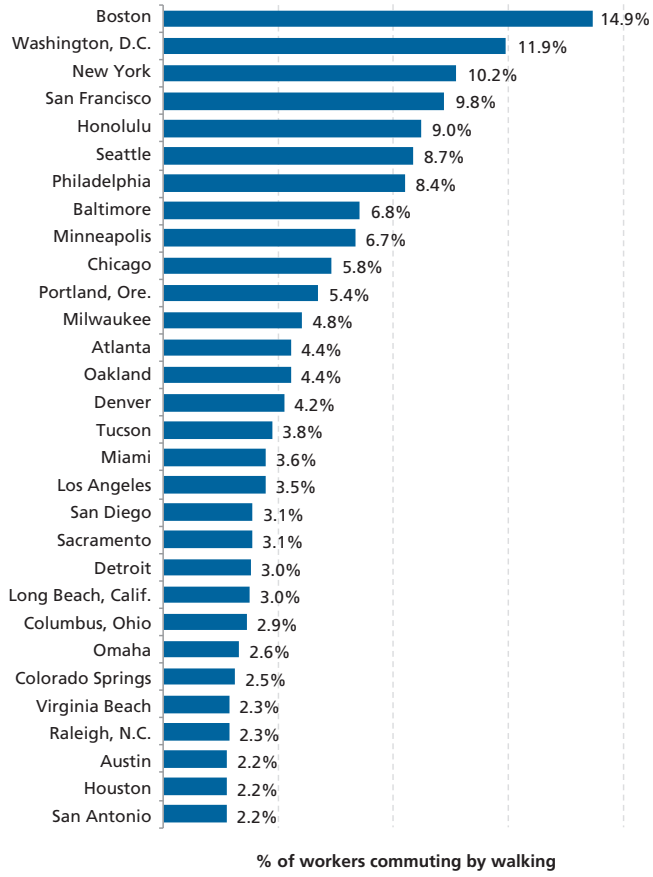


FIGURE 4 Top large cities for commuting by foot. (Source: American Community Survey, 2006–2010, 5-year average; top 30 cities among the largest 50 cities.)

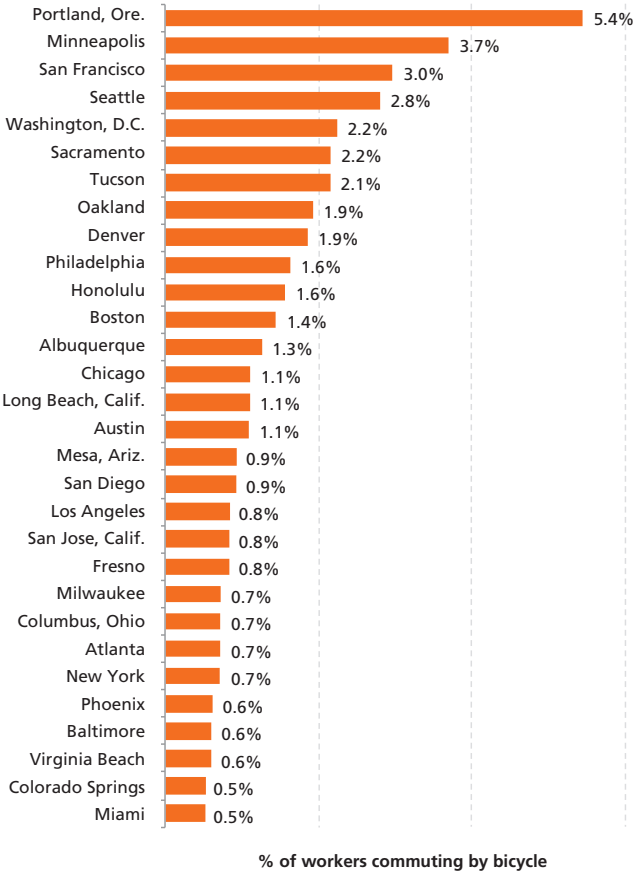


FIGURE 5 Top large cities for commuting by bicycle. (Source: American Community Survey, 2006–2010, 5-year average; top 30 cities among the largest 50 cities.)

PHOTO: DAN BURDEN

The effects of seasonal weather on pedestrian and bicycle activity are difficult to distinguish from the effects of acute weather events such as heavy rainfall.

Natural Environment

Topography

Several studies have demonstrated that hills and steep grades have a negative impact on walking or bicycling. A stated preference approach determined that slope was extremely important in walk and bicycle route decisions in San Francisco but was almost twice as important for bicycling (*3*). GPS data from 166 cyclists in the Portland, Oregon, region indicated that the typical utilitarian cyclist would travel 27 percent farther to avoid each 1 percent of additional average upslope (*4*). The same study found that the effect of slope was much more significant for women than for men and for infrequent or inexperienced cyclists than for experienced bicyclists.

Climate and Weather

Walkers and cyclists are exposed to the elements; sensitivity to major changes in temperature and precipitation is expected. Distinguishing between climate effects that involve seasonal variations in atmospheric conditions—for example, hot summers, cold winters, or rainy seasons—and the shorter-cycle events of weather—like a snowfall, heavy rain, or uncommonly hot or cold days—is difficult. Although research has documented a decline in bicycle activity in areas with strong climate differences, the most pronounced variations in bicycle or walk activity are most closely tied to acute weather events.

Built Environment

Land Use

Walking and bicycling are easier and more relevant in compact, mixed-use settings, which register much higher rates for both modes, particularly for utilitarian purposes. Households in mixed-use areas own fewer vehicles, make more trips to nearby destinations, and are more likely to use transit for trips outside the community.

As a destination, a compact mixed-use setting is more likely to attract trips by nonautomobile modes. Cyclists tend to be less sensitive than pedestrians to immediate surroundings, particularly at the origin of a trip.

Facilities

Planners and engineers have focused on facilities for walking and bicycling. Pucher and Buehler (*2*) and others who have compared the U.S. bicycling and walking experience with that of Europe have emphasized the high-quality, coordinated travel networks for cyclists and pedestrians as a key influence on the high rates of walking and bicycling.

The effectiveness of European walk and bicycle networks is the result of a high level of connectivity; in conjunction with the compact mixed-use design of communities, this allows for direct, convenient paths. Also evident are public policies and attitudes that support walking and bicycling as modes of transportation—for example, traffic calming measures are widely applied and enforced in urban settings, allowing motorized and nonmotorized traffic to coexist. In addition, vehicle parking is much more limited and expensive in urban areas.

In the United States, if the objective is to create a safe and pleasant recreational environment for walking

Answering the Demand for Bicycling and Walking

NCHRP Project 8-78 is developing a guidebook on methods for Estimating Bicycling and Pedestrian Demand for Planning and Project Development. The project is responding to a long-recognized need for robust methods that can measure bicycle and walking activity accurately in relation to the contexts of land use, infrastructure, sociodemographics, and environment—including motor vehicle traffic, hills, and climate and weather—that are uniquely important to nonmotorized travel.

The project has completed an extensive review and synthesis of international research on this topic and has summarized what is known and what is uncertain, identifying important needs for clarification and for integration into reliable tools. An interim report, released in April 2011, documents this research.

The project team is progressing with primary research, using data from Seattle, Washington, and metropolitan Washington, D.C., to develop and test model formulations for a new, more comprehensive set of relationships to support analyses at the regional, subarea or corridor, and project levels. The work is scheduled for completion in September 2012. For additional information, visit http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=2707.

and bicycling—and perhaps for some long-distance commute travel—then a network of exclusive off-road trails may be the priority. If the objective is to integrate walking and bicycling into the community design and daily transportation, then the focus may fall on the shared use of roads and streets, emphasizing features that allow for safe shared use, such as sidewalks, bicycle lanes, and convenient signalized crossings. In both cases, the aspects of accessibility and connectivity are critical to network design.

Urban Design

Walking for utilitarian purposes probably is influenced most by urban design—having interesting and relevant destinations that can be accessed efficiently via minimum-distance paths and with minimal direct contact with vehicle traffic.

Planning bicycle networks, in contrast, is complicated and technical. Cyclists are much more likely to share facilities and interact with motor vehicles. Building separate off-road facilities can be expensive, and the availability of land can produce paths that do not go where most travelers want to go. Much less expensive—and more conducive to everyday use of bicycles for a range of travel purposes—are shared-use facilities such as striped bicycle lanes or signed bicycle routes on low-volume, residential streets.

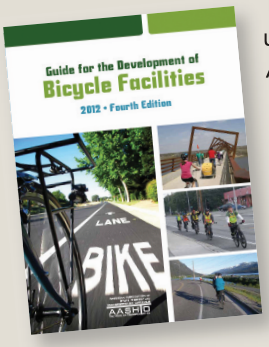
Improving Designs

Research has found that the factors most important to cyclists planning a route include separation from traffic, the steepness of grades, crossings or turns at arterial intersections, and surface type and quality; these factors vie in importance with the shortest path and minimum travel time to the destination; moreover, the effects vary with the type of traveler and the purpose of the trip. Stated preference surveys and GPS monitoring have allowed researchers to begin to

Bringing Bicycle and Pedestrian Guidelines Up to Speed

The American Association of State Highway and Transportation Officials (AASHTO) has released the *Guide for the Development of Bicycle Facilities, 4th Edition*, an update of the 1999 guide, incorporating results from a National Cooperative Highway Research Program (NCHRP) project.[a]

A scoping study in 2005 by Sprinkle Consulting, Inc., conducted the initial research, interviews, and a literature review to determine the focus and content of the revisions to the bicycle facilities guide. Under the subsequent NCHRP project, a team led by Jennifer Toole of Toole Design Group, with additional input from the Midwest Research Institute, developed new recommended guidelines applying findings from research, as well as from practical experience in the design and construction of bikeways throughout the United States.



Another NCHRP project is starting up this summer to update the 2004 AASHTO *Guide for the Planning, Design, and Operation of Pedestrian Facilities*. Toole Design Group completed a scoping study in late 2010, identifying pedestrian issues and treatments that were not included or that were not covered in sufficient detail in the 2004 guide. Changes at the federal and state levels—such as the imminent adoption of new accessibility standards and the adoption of the 2009 *Manual on Uniform Traffic Control Devices*—have rendered the current guide obsolete.

PHOTO: NICK JACKSON, TOOLE DESIGN GROUP

For the revised AASHTO bicycle facilities guide, NCHRP reviewed design practices in cities and states nationwide, including approaches to signing and marking bike lanes. The City of Boston, Massachusetts, has installed more than 50 miles of new bike lanes in the past three years.

In addition, pedestrian planning and design is advancing at a rapid rate in response to widespread concerns among government agencies and citizens that the transportation system does not adequately meet the needs of pedestrians. NCHRP Project 15-45, Proposed Update of the AASHTO *Guide for the Planning, Design, and Operation of Pedestrian Facilities*, has been contracted to a team led by Theo Petritsch of Sprinkle Consulting; the project is slated for completion in 2014.[b]

[a] For more information about the revised AASHTO bicycle facilities guide or to place an order, go to https://bookstore.transportation.org/item_details.aspx?ID=1943.

[b] http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3175.

PHOTO: JEF NICKERSON

Striped bike lanes and other shared-use facilities provide a cost-effective, efficient way to incorporate bicycle networks into urban design.

quantify the relative importance of these attributes to particular populations, which will improve designs.

Experienced cyclists making a trip to work or school are more concerned about minimizing travel time, are less sensitive about proximity to traffic, and are more comfortable with on-road bicycle lanes. Less experienced cyclists and those making nonessential trips, however, may be more concerned about ambience, comfort, and ease of travel than with time or distance and are more likely to favor separate facilities to reduce interactions with motor vehicles. Because this group of less experienced cyclists represents the market with the greatest potential for utilitarian cycling, solutions are needed to make bicycling as safe, convenient, and attractive as it is in most European cities.

A combination of good urban design, traffic calming, and efficient, connected networks of bicycle-only and joint-use local streets is needed. Cities such as Portland, Oregon; Minneapolis, Minnesota; New York; and Washington, D.C., are investing in facility designs borrowed from European counterparts, such as cycle tracks, traffic-calmed bicycle boulevards, and bike boxes; each of these cities has recorded increases in bicycling rates.

Attitudes and Perceptions

Many other influences on the choice to walk or bicycle are rooted in attitudes and perceptions that are difficult to gauge. Safety concerns and self-selection are prominent among these.

PHOTO: DAN BURDEN

Traffic calming measures in European neighborhoods, like these speed bumps in Cologne, Germany, allow for the coexistence of motorized and nonmotorized vehicles.

Safety

Safety concerns are twofold: travel safety during exposure to traffic and personal safety from crime or when passing through uncomfortable surroundings. Facilities planning and traffic management can address concerns about traffic safety, but personal safety is a different matter.

Public health researchers at the Centers for Disease Control and Prevention found strong relationships between physical inactivity and perception of neighborhood safety, with older adults and racial and ethnic minorities demonstrating the greatest sensitivity (5). This finding, confirmed in many other studies, stresses the importance of street lighting, landscape maintenance, and crime control in overcoming resistance to walking or bicycling.

Self-Selection

Perhaps most befuddling to planners of new urban places and bicycle and pedestrian environments is the role of self-selection. Some researchers have asked if the difference in travel behavior in different settings is attributable to the physical characteristics of the setting or to the tendencies and preferences of the people who live there. In other words, people who want to walk or bicycle self-select to live in neighborhoods that are more bikeable and walkable. Therefore building places that are friendly to walking or bicycling will only attract people who are favorably disposed to walk or bicycle.

This conundrum of nature versus nurture has been the subject of many studies. A review of 11 studies found that two concluded that self-selection was present, five found self-selection and the built environment equally important, and four found the effects of built environment most important (6). A definitive answer may never emerge; nevertheless, the demand for housing in walkable areas continues to be a strong market trend (7).

Future Research

Even with the new NHTS data, much remains to understand about bicycle and pedestrian travel. This is partly the result of how travel surveys are conducted. When an activity is rare—such as bicycling—a random sample of households and single-day trip diary methods will not capture a sufficient amount of information to address the behavioral questions important for planning.

The physical environment more emphatically influences the decision to walk or bicycle than the decision to drive or take transit. Therefore, detailed route information is important in understanding individual decisions. Travel surveys rarely collect these data, although GPS tracking is a promising technique.

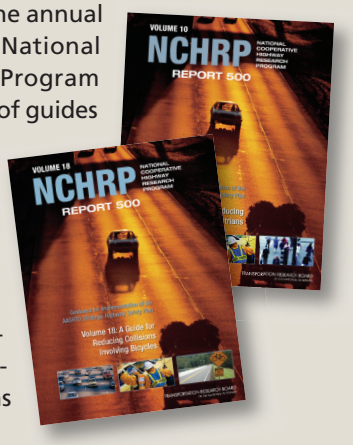
Many cities are conducting regular counts of bicycles and pedestrians. But these efforts often rely on manual counts that require staff expenditures or many volunteers, and the results are not comparable to counts of motor vehicle traffic. Advances in technology are likely to solve this problem but will require investments in counting equipment and software. Nevertheless, activity counts do not provide insight into the types of trips being made, the characteristics of the travelers, and the reasons for their choice of mode, destination, or path.

Even if quality data on travel behavior were available, accurate and comprehensive information is lacking about the physical environment, including the presence of bicycle and pedestrian infrastructure. This limits understanding of the interrelationships. Several recent studies have shown that attitudes and other psychological factors also play a significant role in travel decisions, particularly for walking and bicycling. Data on these factors are also rare and are not collected in a consistent way to allow comparisons.

Finally, much of the data is generated from people who already walk or bicycle. If the objective is to increase the use of these modes for transportation, more needs to be known about the people who do not walk or bicycle or who do so only for recreation. These people are likely to differ from current cyclists and pedestrians, and encouraging them to change modes will likely require a different approach.

Although the gaps in knowledge about walking and bicycling are great, the prospects for filling these gaps are equally great. The number of papers reviewed by the TRB Pedestrians Committee and the Bicycle Transportation Committee has been increasing steadily. NCHRP has several related projects under way and nearing completion. TRB's Research in Progress database lists 67 projects with "pedestrian" in the title and 52 with "bicycle," "bicycling," or "bicyclist," sponsored by U.S. DOT, state DOTs, University Transportation Centers, and other agencies.

Implementing Safety Measures for Pedestrians and Bicyclists



To advance the goal of reducing the annual number of highway deaths, a National Cooperative Highway Research Program (NCHRP) project has produced a series of guides for state and local agencies. Each title corresponds to one of 23 emphasis areas outlined in the American Association of State Highway and Transportation Officials plan for highway safety. Published as volumes of NCHRP Report 500, the implementation guides cover topics from seatbelt use to unsignalized intersections to pedestrians and bicycles.

Volume 10 of NCHRP Report 500, *A Guide for Reducing Collisions Involving Pedestrians*,[a] offers research findings and proactive strategies to address pedestrian safety. Types of pedestrian crashes, victims, and precipitating events are examined, as well as a list of measures categorized by implementation timeframe and relative cost. Measures include minimizing pedestrian exposure to vehicular traffic, improving sight distance and visibility between motor vehicles and pedestrians, reducing vehicle speeds, and improving pedestrian and motorist safety awareness.

Characteristics of bicycle crashes and strategies for bicycle safety are explored in Volume 18, *A Guide for Reducing Collisions Involving Bicycles*.[b] Safety objectives presented include reducing bicycle crashes at intersections, along roadways, and at midblock crossings; lowering vehicle speeds; raising safety awareness and encouraging safer behavior; increasing the use of bicycle safety equipment; and reducing the effect of potential hazards.

For more information on the NCHRP Report 500 series, see www.trb.org/Main/Public/Blurbs/152868.aspx.

[a] http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v10.pdf.
[b] http://onlinepubs.trb.org/onlinepubs/nchrp/nchrp_rpt_500v18.pdf.

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