



On this road in Santa Barbara, California, motor vehicle lanes were replaced by a bidirectional bike path, separated from car traffic.



PHOTO: RALPH FERRIS

Walking and Cycling in Western Europe and the United States

Trends, Policies, and Lessons

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Walking and cycling are the most sustainable means of daily travel. They cause virtually no noise or air pollution and consume far fewer nonrenewable resources than any motorized mode of transport. The energy that walking and cycling require is provided directly by the traveler, and the use of that energy offers valuable cardiovascular exercise.

Walking and cycling require only a fraction of the space needed for operating and parking cars. Moreover, walking and cycling are economical—they cost far less than the private car or public transport, in terms of direct outlays by users and of invest-

ments in public infrastructure. Walking and cycling are affordable by virtually everyone and therefore are the most equitable of all transport modes.

Following is a brief overview of cycling and walking trends and policies in the United States and Western Europe, with a focus on the United Kingdom, Denmark, Germany, and the Netherlands, the countries for which the most comparable and detailed data are available (1–9).

Variations and Trends

The share of daily trips by walking and cycling varies greatly from country to country (see Figure

1, right). At the low end, approximately one-tenth of daily trips are by foot or bike in car-oriented countries such as Australia, Canada, and the United States. At the high end, more than half of all daily trips in the Netherlands are by walking or cycling. Most European countries have levels in between, with active travel accounting for 25 percent to 35 percent of daily trips.

Differences in national travel surveys limit the comparability of walking and cycling statistics. Nevertheless, the European countries included in Figure 1 clearly have active transport rates at least twice as high as those of North America and Australia.

Active travel generally has declined in the United States and Western Europe in the past four decades. The most dramatic change has been in trips by walking. The modal share of walking fell by roughly one-half in France and the United Kingdom, by one-third in Germany, and by one-fourth in Denmark (see Figure 2, below). Only in the Netherlands did the share of walking trips remain stable. The bike share of trips fell by one-half in the United Kingdom, by one-third in France, and by one-tenth in the Netherlands but increased slightly in Germany and Denmark.

In the five European countries in Figure 2, the combined modal shares of walking and cycling in

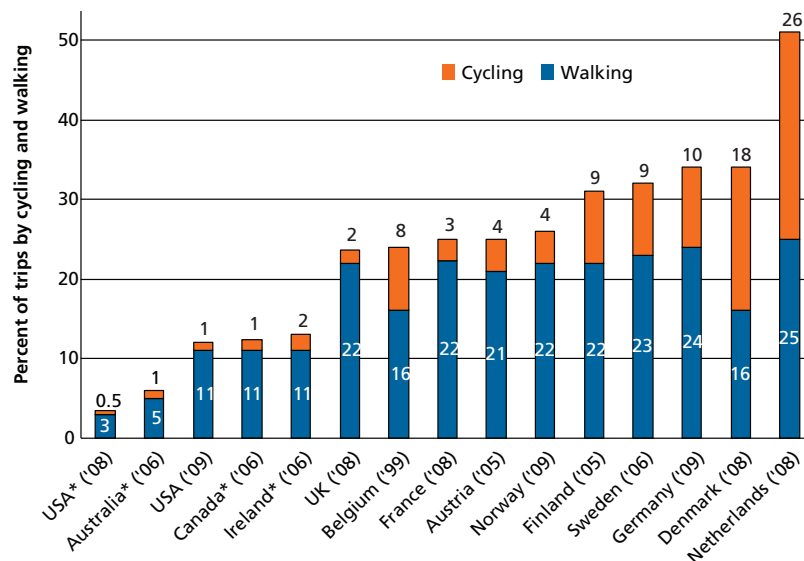


FIGURE 1 Cycling and walking share of daily trips in Europe, North America, and Australia, 1999–2009.

Note: The latest available travel surveys were used for each country; the year of the survey is noted in parentheses after each country's name. The modal shares reflect travel for all trip purposes except for those countries marked with an asterisk, which only report journeys to work derived from their censuses. Dissimilarities in data collection methods, timing, and variable definitions limit the comparability of the modal shares shown. [Sources: Danish Ministry of Transport (MOT), British Department for Transport (DfT), German MOT, Statistics Netherlands, U.S. Census Bureau, U.S. Department of Transportation (DOT), and Norwegian Institute of Economic Research.]

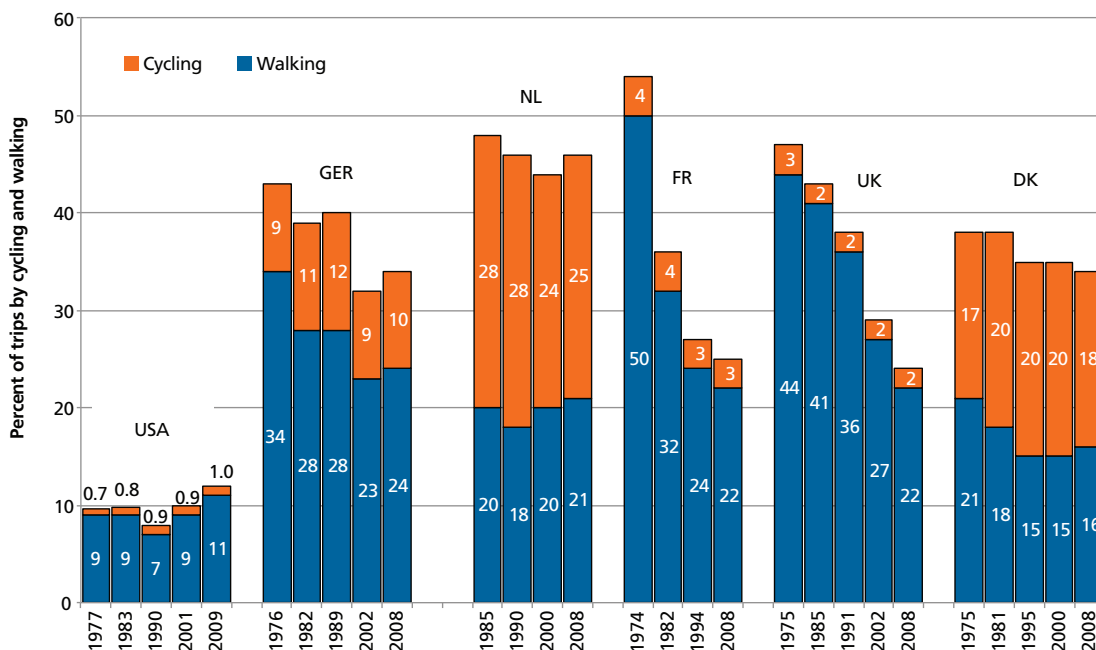


FIGURE 2 Trends in combined cycling and walking share of all daily trips in the United States, Germany (GER), the Netherlands (NL), France (FR), the United Kingdom (UK), and Denmark (DK), 1974–2009.

Note: Dissimilarities in data collection methods, timing, and variable definitions limit the comparability of the modal shares shown. The increase reported for the United States in the combined walk and bike share of trips between 1990 and 2001 probably results from a change in methodology that captured previously underreported walk trips. (Sources: Danish MOT, British DfT, French MOT, German MOT, Netherlands MOT, U.S. DOT, and Norwegian Institute of Economic Research.)



PHOTO: RALPH BUEHLER

Since the early 1970s, an increasing number of German cities have banned automobiles from the city center, as here in Freiburg, Germany.

the early 1970s were roughly comparable, at approximately 40 to 50 percent, but the most recent surveys indicate that active travel in Denmark, Germany, and the Netherlands is at a level almost twice that of France and the United Kingdom. The much smaller declines in active transport in Denmark, Germany, and the Netherlands are attributable to more car-restrictive policies since the 1970s, combined with a range of measures to encourage walking and cycling.

Walking and cycling trends in the United States are difficult to gauge, because the national travel survey methodology changed in 2001, increasing the walk mode share by capturing previously unreported walk trips. The survey results in Figure 2 suggest slight increases in walking and cycling levels in the United States in the past two decades, but in the long term, the walk mode share probably declined. The U.S. Census, which has applied a consistent methodology, reports a substantial decline in walking and cycling to work, from 7.9 percent of workers in 1970 to 3.5 percent in 2009 (10, 11).

Gender and Age Groups

Cyclists comprise virtually all segments of society in Denmark, Germany, and the Netherlands. In the United States, Canada, and the United Kingdom, women account for approximately one-fourth of all bike trips; women in Denmark, Germany, and the Netherlands make approximately half of all bike trips. Cycling is gender-neutral in Denmark, Germany, and the Netherlands but dominated by men in the United States, Canada, and the United Kingdom. In contrast, the share of walk trips made by women shows little variation among countries.

Walking and cycling levels vary significantly by age, but the variation is much less in some countries than in others. The combined share of walking and

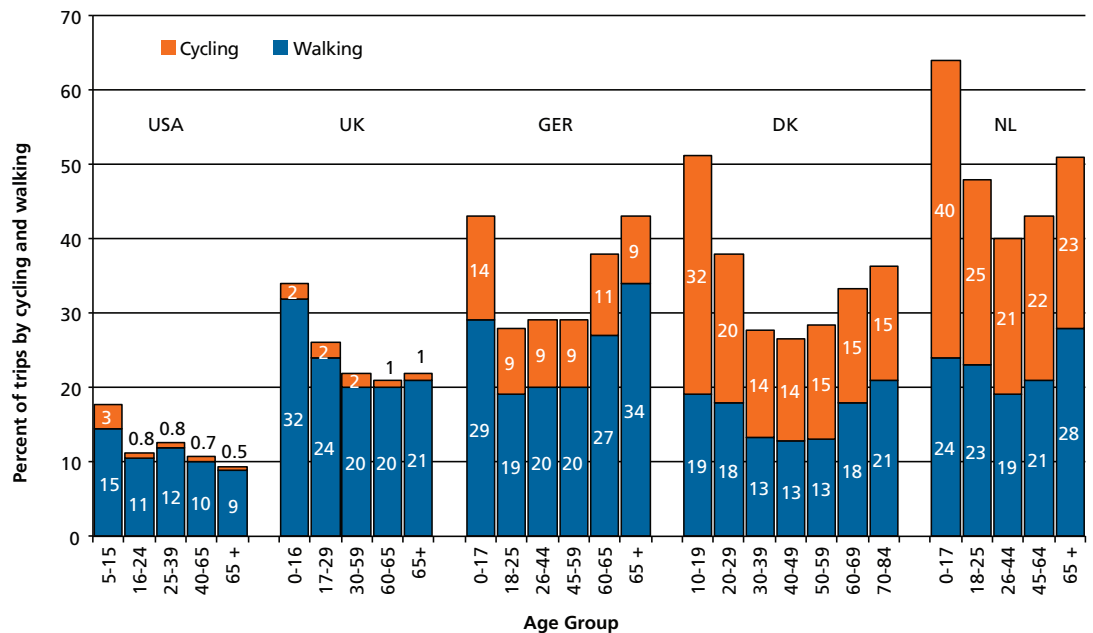


FIGURE 3 Cycling and walking share of trips within each age group in the Netherlands, Denmark, Germany, the United Kingdom, and the United States, 2009, as percent of trips by all modes for all trip purposes.

Note: Each country uses somewhat different age categories in travel surveys. The percentages shown refer to the walking and cycling share of all trips made by persons within each age category. (Sources: Danish MOT, British DfT, German MOT, Netherlands MOT, and U.S. DOT.)

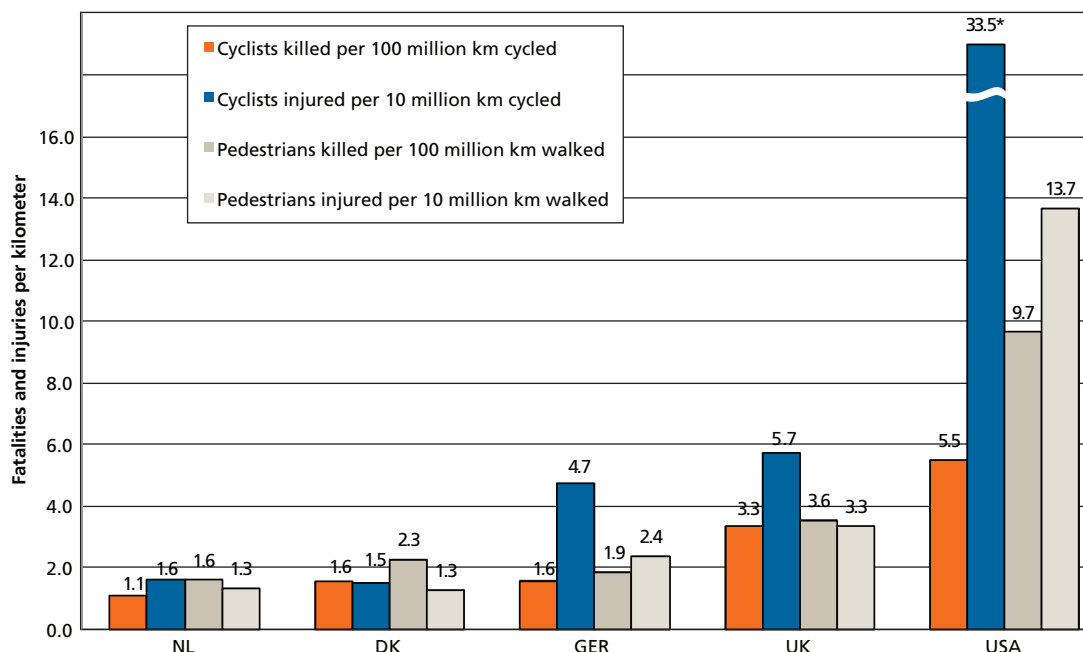


FIGURE 4 Cyclist and pedestrian fatality rates and nonfatal injury rates in the Netherlands, Denmark, Germany, the United Kingdom, and the United States, 2004–2009.

Note: To control for annual fluctuations, a 5-year average (2004–2008) was used for pedestrian and cyclist injuries and fatalities. Trips and kilometers for cycling and walking exposure levels derive from 2008 travel survey data.

* Cyclist injury rate for the United States is off the chart and is shown with a discontinuous bar. (Sources: Danish MOT, British DfT, German MOT, Netherlands MOT, U.S. DOT.)

cycling trips increases with age in Denmark, Germany, and the Netherlands (see Figure 3, page 36). Walking and cycling account for roughly half of all trips by Danish, German, and Dutch elderly, compared with one-fifth of the trips by British elderly and one-tenth of trips by U.S. elderly.

Differences among countries in rates of cycling are striking. The cycling share of trips made by the elderly is 23 percent in the Netherlands, 15 percent in Denmark, and 10 percent in Germany but 1 percent in the United Kingdom and 0.5 percent in the United States.

Safety Issues and Trends

Studies show that traffic danger deters walking and cycling, especially by women, children, and the elderly (12–14). The lower rates of walking and cycling in the United States may be attributable to greater dangers faced by pedestrians and cyclists. Cyclist fatalities per kilometer are 3 to 5 times higher in the United States than in Denmark, Germany, and the Netherlands (see Figure 4, above).

Walking in the United States is even more dangerous, with pedestrian fatalities per kilometer 5 to 6 times higher than in Denmark, Germany, and the Netherlands. Walking and cycling are about twice as dangerous in the United Kingdom as in Germany, but still much less dangerous than in the United States. Nonfatal injury rates for pedestrians and cyclists also are much higher in the United States.

Walking and cycling were not always as safe in Northern Europe as they are today. Annual cyclist fatalities in Denmark, Germany, the Netherlands,

and the United Kingdom declined by 60 to 80 percent between 1970 and 2008. By comparison, cyclist fatalities in the United States fell by less than 10 percent, mainly reflecting a sharp decline in cycling by children (15, 16). Similarly, part of the decrease in cyclist fatalities in the United Kingdom was attributable to a decrease in the number of bike trips. In Denmark and Germany, by contrast, cycling fatalities fell although the number of bike trips increased.



A bicyclist crosses a roundabout in the Netherlands. Bicycling rates of the elderly reach 10 percent in Germany, 15 percent in Denmark, and 23 percent in the Netherlands, compared with 1 percent in the United Kingdom and 0.5 percent in the United States.

This cycle track in New York City features priority traffic signals for cyclists and physical separation from motor vehicles.



PHOTO: NEW YORK CITY DOT

Bike paths in the Netherlands are designed for safety and comfort for all, including women, children, and seniors. Wide paths enable cyclists to ride two or three abreast, making cycling more sociable.

In all five countries, pedestrian fatalities have declined more than cyclist fatalities. Walking levels fell in most countries over this period, however, so that part of the reduction is attributable to reduced exposure rates. The number of annual pedestrian fatalities dropped more sharply in Europe—by between 80 percent and 90 percent—than in the United States, with a decline of 50 percent. Germany and the Netherlands recorded an impressive 90 percent decline in pedestrian fatalities between 1970 and 2008.

These statistics suggest that traffic safety affects walking and cycling and that greater safety in Denmark, Germany, and the Netherlands has contributed to the higher rates of walking and cycling. The theory of safety in numbers also suggests that more walking and cycling may help improve safety (17).

Walking and cycling levels correlate strongly with safety rates. More and safer walking and cycling in Denmark, Germany, and the Netherlands result from a range of programs and policies designed to encourage walking and cycling while restricting car use.



PHOTO: WARREN SALOMON

Promoting Walking and Cycling

Danish, German, and Dutch transportation policies have emphasized improvements in the transportation infrastructure for walking and cycling. For pedestrians, measures include extensive auto-free zones in much of the city center; wide, well-lit sidewalks on both sides of every street; pedestrian refuge islands for crossing wide streets; clearly marked zebra crosswalks, often raised and with special lighting; and pedestrian signals at intersections and mid-block crosswalks with ample crossing times.

From the mid-1970s to the mid-1990s, separate bicycling facilities—such as bike paths and lanes—expanded in most Northern European countries. In Germany, the bikeway network more than doubled in length, from 12,911 km (8,070 mi) in 1976 to 31,236 km (19,522 mi) in 1996. In the Netherlands, the bikeway network doubled in length, from 9,282 km (5,801 mi) in 1978 to 18,948 km (11,843 mi) in 1996 (3).

Comparable nationwide aggregate statistics for the period since the mid-1990s are not available, but data for individual cities suggest continued expansion, although at a slower rate. The current focus is on improving the design of cycle paths and lanes to improve safety, especially at intersections.

Various other measures complement separate rights-of-way: special bike lanes leading directly to and through intersections; separate bike traffic signals with advance green lights for cyclists; bicyclist-activated traffic signals at key intersections; and modification of street networks to create dead ends and slow, circuitous routing for cars but direct, fast connections for bikes.

Danish, German, and Dutch bikeway systems serve practical destinations for everyday travel. By comparison, most separate bike paths in the United States are located in parks or along rivers, lakes, or harbors and are mainly for recreation.

Traffic Calming

Traffic calming in residential neighborhoods in Western Europe limits the volume and the speed—usually to less than 30 km/h (20 mph)—of motor vehicle traffic, both by law and by physical barriers, such as raised intersections and crosswalks, traffic circles, road narrowing, zigzag routes, curves, speed humps, and artificial dead ends created by street closures at midblock. Traffic calming is less common in the United States and is usually limited to isolated streets.

The most extreme form of traffic calming—the *woonerf*, home zone, or *Spielstrasse*—imposes additional restrictions, requiring cars to travel at walking speed—7 km/h (4 mph) in Germany—and to yield to nonmotorized users.

Reduced speeds are crucial in enabling motorists to avoid crashes with pedestrians and bicyclists and in increasing the likelihood of a nonmotorist's survival in a crash. The World Health Organization (18), for example, found that the risk of pedestrian death in crashes rose from 5 percent at 30 km/h (20 mph) to 45 percent at 50 km/h (30 mph) and to 85 percent at 65 km/h (40 mph). In Denmark, Germany, the Netherlands, and Great Britain, a comprehensive review found that traffic injuries fell by an average of 53 percent in neighborhoods with traffic calming measures (19).

Integration with Transit

Coordinating walking and cycling with public transport enhances the benefits of all three modes, encouraging more walking and cycling, as well as more use of public transport. In most countries, trips by public transport usually start and end with walks

PHOTO: JOHN PUCHER



Many bikeway facilities in Europe have parallel walkways for pedestrians, such as here in Münster, Germany.

to and from bus or rail stops.

Bicycling extends the catchment area of transit stops beyond the range of walking and at a much lower cost than neighborhood feeder buses or park-and-ride facilities for cars. Access to public trans-

Many German cities have introduced home zones or *Spielstrassen*, an advanced form of traffic calming, with a speed limit of 7 km/h on neighborhood streets; cars are required by law to yield to cyclists, pedestrians, and children.

PHOTO: PETER BERKELEY



Münster offers secure and sheltered parking for 3,300 bikes at its main train station and bus terminal.



PHOTO: PETER BIRKLEY

port helps cyclists make longer trips than are possible by bike alone. Therefore the design of public transport stations should offer safe, convenient, and comfortable pedestrian and cycling facilities, both in the stations themselves and on routes leading to the stops.

Four main categories of measures assist in coordinating cycling with public transportation (20):

1. Bike parking at rail stations and bus stops;
2. Provisions for taking bikes aboard trains and buses;
3. Bike rental facilities near public transportation stops; and
4. Coordination of bike routes with public transportation.

Even inexpensive and easily implemented traffic-calming measures can reduce car speeds in residential neighborhoods, as here in Freiburg.



PHOTO: CITY OF FREIBURG

Compact Development

Trip distance affects levels of walking and cycling. Most walking trips are 1 km (0.6 mi) or shorter, and most bike trips are 3 km (1.8 mi) or shorter. Land use is crucial in determining average trip distances. By promoting or requiring compact, mixed-use development and discouraging low-density sprawl, land use policies in Denmark, Germany, and the Netherlands have established a long-term framework for walkable and bikeable communities.

In the past two decades, many Danish, German, and Dutch cities have revised their land use and transport plans to strengthen neighborhood commercial and service centers. The plans encourage more variety in neighborhood land use by mixing housing with stores, restaurants, offices, schools, and services. The plans emphasize development in the neighborhood centers, not on the suburban fringe; this keeps trip distances short and assures local accessibility by foot and bicycle.

Many European cities have implemented people-friendly urban design to create a safe, convenient, and attractive environment that facilitates cycling and walking into city centers. Wide sidewalks and pedestrian plazas can encourage walking, particularly facilities that are well maintained and include attractive paving, comfortable benches, shade trees, outdoor cafes, public art, and fountains. Short city blocks, pedestrian passageways within longer blocks, narrow streets, midblock crosswalks, and median refuge islands facilitate pedestrian access and safety. Pedestrian-scale signage and lighting also are necessary (21).

Some European countries have improved suburban design as well. Many new suburban developments in Denmark, Germany, and the Netherlands

provide safe and convenient pedestrian and cycling access. European suburbs almost always include sidewalks for pedestrians and often bikeways or bike lanes for cyclists.

Training and Regulations

Driver training is much more rigorous in Denmark, Germany, and the Netherlands than in the United States and pays special attention to avoiding collisions with pedestrians and cyclists (12). Traffic education of children is a priority. By the age of 10, most schoolchildren in Denmark, Germany, and the Netherlands have received extensive instruction about safe walking and cycling—not only in traffic regulations but in walking and bicycling defensively, anticipating dangerous situations, and reacting appropriately.

Traffic regulations in Denmark, Germany, and the Netherlands favor pedestrians and bicyclists. When a crash involves children or the elderly, the police and the courts almost always find that the motorist was at fault and should have anticipated irregular moves by children or seniors.

In addition, Danish, German, and Dutch police are strict in ticketing motorists, pedestrians, and cyclists who violate traffic regulations. Penalties for motorists in particular can be high for minor violations. Not stopping for pedestrians at crosswalks is considered a serious offense. Red traffic signals are strictly enforced, and many intersections in Danish, German, and Dutch cities have cameras that automatically photograph cars running red lights and stop signs.

Complementary Policies

These measures make walking and cycling safer and more convenient in Europe. Many other government policies indirectly encourage walking and cycling—for example, road capacity and car parking facilities are far less generous than in American cities. Many Danish, German, and Dutch cities have reduced roadway and parking supply in the past few decades to discourage car use in the city center. These restrictions reduce the relative speed, convenience, and flexibility of car travel compared with walking and cycling.

Moreover, sales taxes on gasoline and on new car purchases, import tariffs, registration fees, license fees, driver training fees, and parking fees are generally much higher in Europe than in the United States (22, 23). The costs of car ownership and use are two to three times higher in Europe as a result and discourage car use, indirectly promoting alternative, less expensive modes, including walking and cycling.



PHOTO: CURRAN KELLNER

Climate, Topography, and Culture

Climate, topography, and culture also influence cycling and walking levels but are beyond the control of policy makers and planners; nevertheless, inclement weather conditions and hilly topography do not necessarily prevent walking and cycling. For example, the Netherlands and Denmark have high rates of cycling despite rainy climates, and cities such as Helsinki, Finland; Stockholm, Sweden; Montreal, Canada; and Minneapolis, Minnesota, have high cycling rates despite harsh winters. San Francisco, California, and Seattle, Washington, are among the hilliest U.S. cities but also two of the most bike-oriented.

Culture and habit tend to foster cycling in cities and countries with high levels of cycling, but where cycling levels are low, and where cycling is viewed as a fringe mode, culture and habit can deter cycling—especially among noncyclists (24). Nevertheless, culture and habit can change over time.

Some traditionally car-oriented and sprawling U.S. cities have promoted cycling successfully with the same sorts of measures used in Danish, German, and Dutch cities. For example, Portland, Oregon, and Minneapolis raised cycling levels more than five-fold from 1990 to 2010 (10, 11).

History and culture therefore are not insuperable obstacles to increasing walking and cycling but do not guarantee continued high levels of walking and cycling, either, as shown by the sharp declines in active travel in France and the United Kingdom. Policies appear far more important than history and culture in explaining trends in walking and cycling.

Fuel prices and costs of car ownership are far higher in Europe than in the United States and indirectly contribute to higher rates of active transportation.

On-street bike corrals in Portland offered more than 1,425 parking spaces for bikes in 2012.



PHOTO: RALPH BUEHLER

Comprehensive Approach

The infrastructure, programs, and policies needed to increase walking and cycling are well known and tested, with decades of successful experience in many European cities. One key lesson is that no single strategy is sufficient (25). Communities must implement a fully integrated package of measures like those discussed in this article.

A comprehensive approach has a much greater impact on walking and cycling levels than several individual measures that are not coordinated. The impact of any particular measure is enhanced by the synergies with complementary measures in the same package.

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References

1. Buehler, R., and J. Pucher. Sustainable Transport in Freiburg: Lessons from Germany's Environmental Capital. *International Journal of Sustainable Transport*, Vol. 5, No. 1, pp. 43–70 (2011).
2. Buehler, R., J. Pucher, and U. Kunert. *Making Transportation Sustainable: Insights from Germany*. Brookings Institution, Washington, D.C., 2009.
3. Pucher, J., and L. Dijkstra. Making Walking and Cycling Safer: Lessons from Europe. *Transportation Quarterly*, Vol. 54, No. 3, pp. 25–50 (2000).
4. Pucher, J., and R. Buehler. Why Canadians Cycle More Than Americans: A Comparative Analysis of Bicycling

Trends and Policies. *Transport Policy*, Vol. 13, No. 1, pp. 265–279 (2006).

5. Pucher, J., and R. Buehler. Making Cycling Irresistible: Lessons from the Netherlands, Denmark, and Germany. *Transport Reviews*, Vol. 28, No. 1, pp. 495–528 (2008).
6. Pucher, J., and R. Buehler. Walking and Cycling for Healthy Cities. *Built Environment*, Vol. 36, No. 4, pp. 391–414 (2010).
7. Pucher, J., R. Buehler, D. R. Bassett, and A. L. Dannenberg. Walking and Cycling to Health: Recent Evidence from City, State, and International Comparisons. *American Journal of Public Health*, Vol. 100, No. 10, pp. 391–414 (2010).
8. Buehler, R., J. Pucher, D. Merom, and A. Bauman. Active Travel in Germany and the USA: Contributions of Daily Walking and Cycling to Physical Activity. *American Journal of Preventive Medicine*, Vol. 40, No. 9, pp. 241–250 (2011).
9. Pucher, J., and R. Buehler, eds. *City Cycling*. MIT Press, Cambridge, Mass., 2012 (in press).
10. *American Community Survey 2009–2010*. U.S. Census Bureau, Washington, D.C.
11. *United States Census, 1980–2000*. U.S. Census Bureau, Washington, D.C.
12. *TRB Special Report 300: Achieving Traffic Safety Goals in the United States: Lessons from Other Nations*. Transportation Research Board of the National Academies. Washington, D.C., 2010.
13. International Transport Forum. *IRTAD Road Safety 2010*. International Traffic Safety Data and Analysis Group, Paris, 2010.
14. *The World Health Report, 2002*. World Health Organization, Geneva, Switzerland.
15. *The National Walking and Bicycling Study: 15-Year Status Report*. Federal Highway Administration, Washington, D.C., 2010.
16. *National Household Travel Survey, 2008–2009*. Federal Highway Administration, Washington, D.C., 2010.
17. Jacobsen, P. Safety in Numbers: More Walkers and Bicyclists, Safer Walking and Bicycling. *Injury Prevention*, No. 9, pp. 205–209 (2003).
18. *Core Health Indicators, 2008*. World Health Organization. www.who.int/whosis/database/core/core_select.cfm.
19. Preston, B. Cost-Effective Ways to Make Walking Safer for Children and Adolescents. *Injury Prevention*, No. 1, pp. 187–190 (1995).
20. Pucher, J., and R. Buehler. Integrating Bicycling and Public Transport in North America. *Journal of Public Transportation*, Vol. 12, No. 3, pp. 79–104 (2009).
21. Ewing, R. *Pedestrian- and Transit-Friendly Design: A Primer for Smart Growth*. Smart Growth Network, Washington, D.C., 1999.
22. *Special Report 257: Making Transit Work: Insight from Western Europe, Canada, and the United States*. Transportation Research Board, National Research Council, Washington, D.C., 2001.
23. Buehler, R. Transport Policies, Automobile Use, and Sustainable Transport: A Comparison of Germany and the United States. *Journal of Planning Education and Research*, Vol. 30, No. 1, pp. 76–93 (2010).
24. Gatersleben, B., and K. M. Appleton. Contemplating Cycling to Work: Attitudes and Perceptions in Different Stages of Change. *Transportation Research Part A: Policy and Practice*, No. 41, pp. 302–312 (2007).
25. Pucher, J., J. Dill, and S. Handy. Infrastructure, Programs, and Policies to Increase Bicycling: An International Review. *Preventive Medicine*, No. 50, pp. S106–S125 (2010).