

Cycling for Everyone: Lessons from Europe

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Abstract

This paper investigates how bicycling can be promoted as a safe and feasible means of transport for everyone and for all trip purposes. The policies and programs needed to encourage a broad spectrum of social groups to cycle are the same policies and programs that encourage high overall levels of cycling: extensive systems of separate cycling facilities, intersection modifications and priority bicycle traffic signals, traffic calming of neighborhoods, safe and convenient bike parking, coordination and integration of cycling with public transport, traffic education and training for both cyclists and motorists, and traffic laws that favor cyclists and pedestrians. To show how this multifaceted, coordinated approach actually works, we focus in this paper on cycling trends and policies in the Netherlands, Denmark, and Germany. We supplement our national level comparative analysis with case studies of large and small cities in each country.

Introduction

The European Union has officially recognized the importance of cycling as a practical mode of urban transport, generating environmental, economic, and health benefits (1). The United States Department of Transportation emphasizes the same benefits and sets the specific goal of doubling the percentage of trips made by cycling and walking (2).

Unfortunately, cycling levels in the USA lag far behind those in most European countries. Cycling here is primarily for recreation and not for daily, utilitarian travel. Equally important, from a social perspective, cycling is limited mainly to young men. In sharp contrast, cycling in northern Europe is as common for women as for men, and declines only slightly with age. In short, cycling in northern Europe is a normal way of getting around cities—for everyone and for all trip purposes.

If cycling is ever to become a viable way of getting around American cities, it must be made safe, convenient, and feasible for all ages and for women as well as men. Cycling remains a marginal mode of transport in most American cities because it is

widely viewed as requiring special equipment and training, physical fitness, and the courage and willingness to battle with motor vehicles on streets without separate bike lanes or paths. Cycling is a mainstream mode of urban travel in northern Europe precisely because it does **not** require any of those things. For example, most northern European cyclists ride on simple, inexpensive bikes, almost never wear special cycling outfits, and rarely use safety helmets.

The Netherlands, Denmark, and Germany have been especially successful in promoting safe and convenient cycling. Despite high rates of car ownership, these three countries have achieved high overall bike shares of urban travel, ranging from 9% in Germany to 19% in Denmark and 27% in the Netherlands, far higher than the 1% bike share of travel in the USA (3, 4, 5, 6). Equally impressive, German, Danish, and Dutch women cycle as often as men, and all age groups make a considerable percentage of their daily trips by bike.

Several studies have examined a variety of policies and programs intended to encourage more cycling in Europe by making it safer and more convenient (1, 6, 7, 8, 9, 10). This paper updates those studies and supplements their information with new data from the Netherlands, Denmark, and Germany, including both aggregate national data and city case studies. The main objective is to identify and categorize the policies and programs successful cycling cities have in common with each other, and to provide a thematic framework for implementation.

The paper begins by documenting differences among countries in their overall levels of cycling, bike trip purposes, and the gender, age, and income characteristics of cyclists. Differences in cycling safety help explain some of the difference in cycling levels among

countries; thus, there is an entire section devoted to international comparisons of cycling fatality and injury rates and trends over time.

The subsequent sections of the paper summarize the wide range of coordinated policies and programs used in the Netherlands, Denmark, and Germany to promote cycling by everyone and at the same time improve cycling safety. The paper concludes with an overall assessment of the lessons that can be learned from northern Europe to move cycling more toward the mainstream here in the USA.

Variations among Countries in Overall Cycling Levels

As shown in Figure 1, there are large differences between Australia, the United States, Canada, and European countries in the bike share of trips, ranging from a low of only 1% in Australia and the USA to 27% in the Netherlands. These differences in the bike share of trips roughly parallel differences in the average distance cycled per person per day, an alternative way of measuring and comparing cycling levels among countries. The European Conference of the Ministers of Transport estimated that per capita cycling per day ranges from a high of 2.5km in the Netherlands to a low of only 0.1 km in Spain, Greece, and Portugal (1). The USA is also at the low end of the spectrum, averaging 0.1 km of cycling per person per day. Germany (0.9km) and Denmark (1.6km) are near the top, immediately following the Netherlands in distance cycled per inhabitant.

These statistics on cycling levels reflect data provided directly by federal ministries of transport and central statistical bureaus in each country. They are not entirely comparable because national travel surveys vary somewhat according to variable definitions, data collection method and frequency, target population, sample size, and response rates (11). At the very least, however, the national travel surveys facilitate

approximate comparisons of different levels of cycling among countries, and whatever their limitations, they are the best available sources of information.

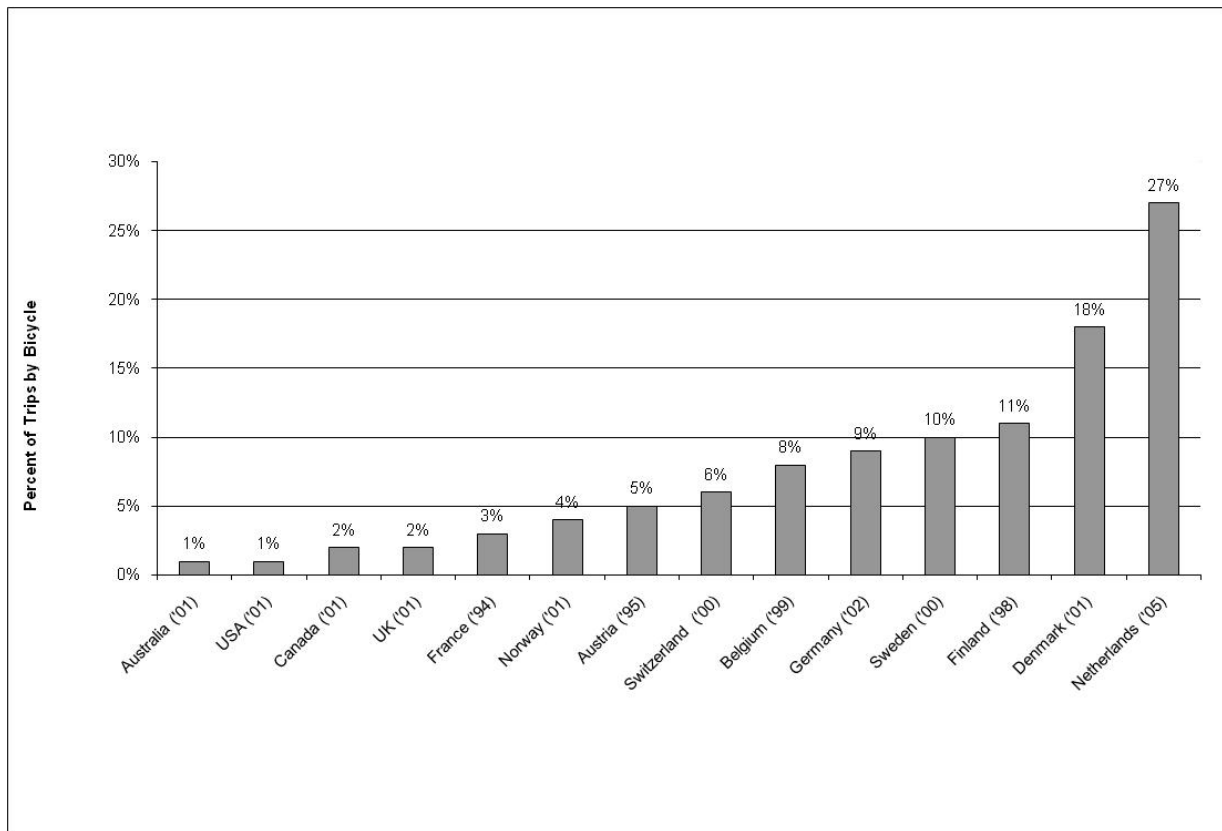


Figure 1. Bicycle Share of Trips in Europe, North America, and Australia (percent of total trips by bicycle) (1), (2), (3), (5)

One might expect that Europeans cycle more than Americans due to shorter trip lengths in European cities. In fact, a considerably higher percentage of all trips in European cities are shorter than 2.5km: 44% in the Netherlands, 37% in Denmark, and 41% in Germany, compared to 27% in the USA (1, 3, 4, 5, 12, 18). Even controlling for trip distance, however, northern Europeans make a much higher percentage of their local trips by bike. For example, Americans cycle for only 2% of trips shorter than 2.5km, compared to 37% in the Netherlands, 27% in Denmark, and 14% in Germany.

Not only do northern Europeans cycle more than Americans at every trip distance, but they are far more likely to cycle for practical, utilitarian purposes. Travel to work or school accounts for only 11% of all bike trips in the USA, compared to 22% in Germany, 32% in the Netherlands, and 38% in Denmark. Similarly, shopping trips account for only 5% of all bike trips in the USA, compared to 20% in Germany, 22% in the Netherlands, and 25% in Denmark (3, 4, 5, 12). Roughly three-fourths of all bike trips in the USA are for recreation, compared to 35% in Germany, 27% in the Netherlands, and 24% in Denmark.

Those large differences in trip purpose suggest that the much higher levels of cycling in northern Europe are due to the use of bikes for a wide range of trip purposes, especially for daily utilitarian travel. Conversely, the very low levels of cycling in the USA might be due to mainly recreational cycling here, which is far less frequent. If that is true, then efforts to increase cycling in the USA should perhaps focus more on utilitarian, daily travel within cities as opposed to the recent emphasis on recreational cycling facilities in parks and rural areas.

Some readers might assume that bicycling levels in Western Europe have been consistently high. In fact, cycling in Western Europe fell sharply during the 1950s and 1960s, when car ownership increased rapidly and cities started spreading out. A Dutch study showed that, from 1950 to 1975, the bike share of trips fell by roughly two-thirds in a sample of Dutch, Danish, and German cities, from 50-85% of trips in 1950 to only 14-35% of trips in 1975 (6). Similarly, a study by the City of Berlin (13) found that the number of bike trips there fell by 78% from 1950 to 1975. During that 25-year period, cities throughout the Netherlands, Denmark, and Germany focused on accommodating

and facilitating increased car use by vastly expanding roadway capacity and parking supply, while largely ignoring the needs of pedestrians and cyclists (14).

In the mid-1970s, transport and land use policies in all three countries dramatically shifted to favor walking, cycling, and public transport over the private car. To some extent, this was a reaction to the increasingly harmful environmental, energy, and safety impacts of rising car use (1, 6, 14, 15, 16). Most cities vastly improved their bicycling infrastructure while imposing ever more restrictions on car use and making it more expensive. That policy reversal led to turnarounds in the previous decline of bike use. From 1975 to 1995, the bicycling share of trips in the previously cited sample of Dutch, Danish, and German cities rose by roughly a fourth, resulting in 1995 bike shares of 20-43%. In Berlin, the total number of bike trips quadrupled from 1975 to 2001 (increasing by 275%), reaching 45% of the 1950 bicycling level (13). The rebound in cycling from 1975 is especially impressive given the continuing growth in per-capita income, car ownership and suburban development in all three countries over the past three decades.

Analysis of nationwide aggregate data (as opposed to only a few sampled cities, as above) confirms a rebound in cycling since the 1970s. Average daily km cycled per inhabitant rose in all three countries over the period 1978 to 2005: from 0.6 to 1.0 in Germany, from 1.3 to 1.6 in Denmark, and from 1.7 to 2.5 in the Netherlands (1, 5, 17, 18).

Not only do these three countries have high and growing levels of cycling, but cyclists comprise virtually all segments of society. For example, women are just about as likely to cycle as men. Women make 45% of all bike trips in Denmark, 49% in

Germany, and 55% in the Netherlands (17, 18, 19). That compares with only 24% in the USA (3).

Another dimension of cycling's universality in northern Europe is the representation of all age groups. Children and adolescents have the highest rates of cycling in almost every country. As shown in Figure 2, however, cycling levels in northern Europe remain high even among the elderly.

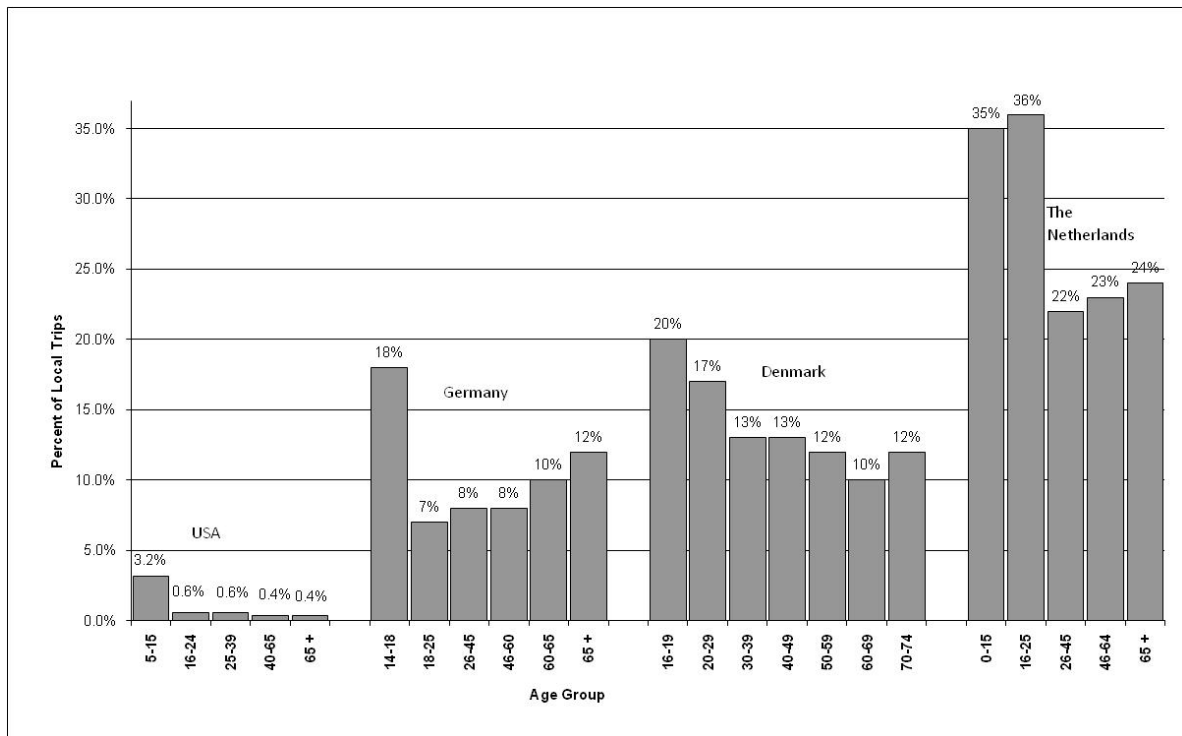


Figure 2. Bicycling Share of Trips by Age Group in the Netherlands, Denmark, Germany, and the USA (2000-2002) (3), (4), (17), (18)

In northern Europe there are no significant differences in cycling rates among income classes. For example, the 2002 national travel survey in Germany revealed that the lowest-income quartile was only slightly more likely to travel by bike (10% of trips) than the highest-income quartile (8.3%). Similarly, cyclists are distributed evenly among income classes in the Netherlands and Denmark (5, 17).

The remainder of this article examines possible reasons why cycling in Germany, the Netherlands, and Denmark is truly for everyone.

Trends in Cycling Safety

Perhaps the most important reason for the higher levels of cycling in northern Europe—especially among women, children, and the elderly—is that cycling is much safer there than in the USA. Both fatality and injury rates are much higher for cyclists in the USA compared to Germany, Denmark, and the Netherlands. Averaged over the years 2002 to 2005, the number of American bicyclist fatalities per 100 million km cycled was 5.8, compared to 1.7 in Germany, 1.5 in Denmark, and 1.1 in the Netherlands (see Figure 3). Thus, cycling is over five times as safe in the Netherlands as in the USA, which probably explains why the Dutch do not perceive cycling as a dangerous way to get around. Cycling in Germany and Denmark is not quite as safe as in the Netherlands, but still 3-4 times safer than in the USA.

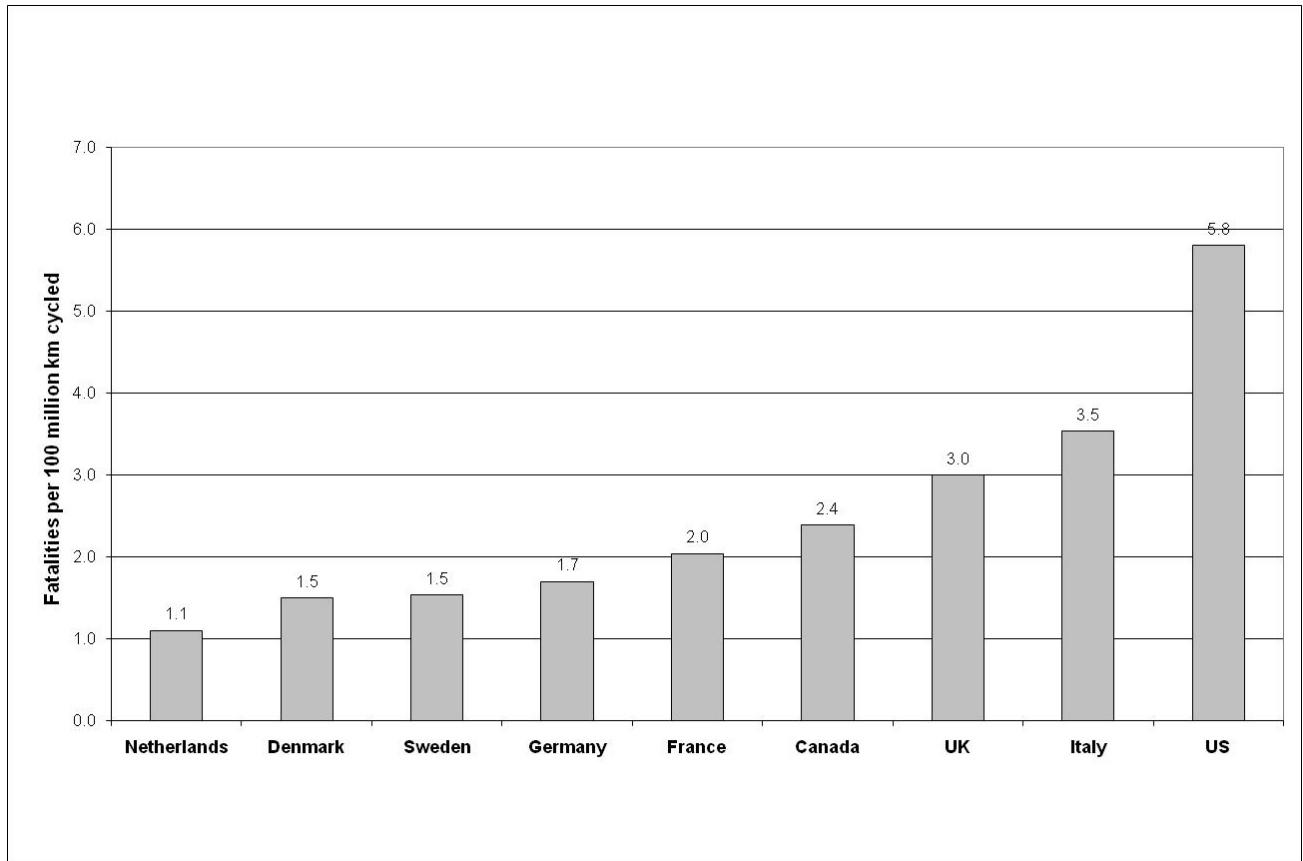


Figure 3. Cycling Fatality Rates in Europe and North America, 2002/2005 (Cyclist deaths per 100 million km cycled) (1), (2), (5), (9), (17)

Germany, Denmark, and the Netherlands have greatly improved cycling safety since 1970. Although levels of cycling have increased in all three countries over the past 35 years, the total number of cycling fatalities has declined by over 70% (5, 12, 17, 18). By comparison, cycling fatalities have fallen by less than 30% in the USA over the same period (2). These trends in cycling safety correspond to overall traffic safety trends. Thus, total traffic fatalities for all modes have also declined much more in Europe than in the USA (19).

While safer cycling clearly encourages more cycling, there is also reason to believe that more cycling facilitates safer cycling. The phenomenon of ‘safety in numbers’ has been consistently found to hold over time and across cities and countries.

Fatality rates per trip and per km are much lower for countries and cities with high bicycling shares of total travel, and fatality rates fall for any given country or city as cycling levels rise (20).

The perceived traffic danger of cycling is an important deterrent to more widespread cycling (1, 2, 5, 6, 17, 21, 22, 23). Women and the elderly appear to be especially sensitive to such traffic danger. Many American parents do not allow their children to cycle for the same reason. Thus, making cycling safer is surely one of the keys to increasing overall cycling levels in the USA, particularly among women, the elderly, and children.

It is important to emphasize that the much safer cycling in northern Europe is definitely *not* due to widespread use of safety helmets. On the contrary, in the Netherlands, with the safest cycling of any country, less than one percent of adult cyclists wear helmets, and even among children, only 3-5% wear helmets (5, 6). In 2002, 33% of German children aged 6-10 years wore helmets while cycling, compared to only 9% of adolescents aged 11-16, and only 2% of Germans aged 17 or older (17). In 2006, 66% of Danish school children aged 6-10 wore helmets, compared to 12% among school children 11 years or older, and less than 5% among adults (22).

Government Roles in Funding and Planning Cycling Facilities and Programs

Due to the mostly local, short-distance trips made by bike, policies and programs to promote safe and convenient cycling are usually carried out at the municipal level (1). Local governments in the Netherlands, Germany, and Denmark have been planning, constructing, and funding bicycling facilities for many decades, at least since the 1970s but much earlier in some cities.

Cycling training, safety, and promotional programs are usually carried out at the local level as well, even if they are mandated and funded by higher levels. At the intermediate level, states, counties, and regional governments provide additional policy guidance, coordination, and funding, as well as some direct planning and construction of cycling facilities that serve rural areas or link different municipalities.

Central government involvement in cycling has been more recent, evolving gradually since about 1980 and providing overall goals, design guidelines, research support, model projects, coordination, and funding. The Netherlands, Denmark, and Germany all have official National Bicycling Master Plans (17, 21, 22). Each of these plans sets forth the overall goal of raising levels of cycling for daily travel while improving cycling safety. They also propose various strategies to achieve these dual goals: better design of lanes, paths, and intersections; more and better bike parking; coordination with public transport; and cycling safety and promotion campaigns.

Federal governments usually bear the cost of bicycling facilities built along national highways and contribute significantly to financing long-distance bicycling routes that cross state boundaries (1). In Germany, for example, the federal government contributed over €1.1 billion to doubling the extent of bikeways along federal highways from 1980 to 2000, and is now devoting €100 million per year for further bikeway extensions, cycling research, and demonstration projects. In addition, about €2 billion a year in revenues from the motor fuel tax are earmarked for a special urban transport investment fund, which provides 70-85% federal matching funds for state and local governments wanting to build cycling facilities (paths, lanes, bridges, traffic signals, signs, parking, etc.) (17). From 1990 to 2006, the Dutch Central Government contributed

an average of €60 million per year to various cycling projects, including €25 million per year specifically for bike parking at train stations. In addition, the Dutch Central Government provides €1.8 billion a year for provinces to spend on transport projects, including cycling facilities (5). By comparison, the Danish Central Government has no regular funding for cycling projects but since 2000 contributed about €5 million year to various demonstration projects (1, 24).

The European Union (EU) has been playing a modest but increasing role in promoting cycling (1). It provides funding, for example, for transnational and cross-border bikeway projects through its EU Interreg Funding. The European Cycling Federation (ECF) has already established a system of European-wide bicycling routes, and the EU contributes toward the funding of missing bike route connections between countries and of cycling facilities in underdeveloped regions.

How to Make Cycling Safe and Convenient for Everyone

Many policies and programs are necessary to make cycling safe and feasible for a broad spectrum of the population. We describe below eight categories of measures that have been widely adopted in Dutch, Danish and German cities. Their success in making cycling possible for everyone is largely attributable to the coordinated implementation of all of these measures, so that they reinforce the impact of each other in promoting cycling. Indeed, that is perhaps the key lesson to be learned: the necessity of a coordinated, multi-faceted approach.

Due to space limitations, we can only provide a few representative examples that illustrate the nature and extent of the eight types of measures.

Bike Paths and Lanes. Especially from the mid-1970s to the mid-1990s, separate facilities such as bike paths and lanes expanded greatly in all three countries. In Germany, for example, the bikeway network almost tripled in length, from 12,911km in 1976 to 31,236km in 1996. In the Netherlands, the bikeway network doubled in length, from 9,282km in 1978 to 18,948km in 1996 (25). Nationwide, aggregate statistics for the period since the mid 1990s are not available, but data for individual cities suggest continued expansion, albeit at a much slower rate than previously. The main focus now appears to be on improving the specific design of cycle paths and lanes to improve safety.

In 2004, for example, Berlin (3.4 million inhabitants) had 1140km of separate bike paths and lanes (26). By comparison, Amsterdam (735,000 inhabitants) and Copenhagen (504,000 inhabitants) each have roughly 400km of completely separate bike paths and lanes (27, 31). Even much smaller cities, however, have extensive cycling facilities. For example, there are 320km of bike paths and lanes in Muenster, Germany (278,000 inhabitants), over 500km in Odense, Denmark (185,000 inhabitants), and over 420km in Groningen, Netherlands (181,000) (27, 28, 29, 30). The bicycling networks in all these cities include numerous off-street short cut connections for cyclists between streets and traversing blocks to enable them to take the most direct possible route from origin to destination. The result of all these facilities is a truly complete, integrated system of bicycling routes that permit cyclists to cover almost any trip either on completely separate paths and lanes or on lightly traveled, traffic-calmed residential streets.

Not only has the network of separate cycling facilities greatly expanded since the 1970s, but their design, quality, and maintenance have continually improved to ensure

safer, more convenient, and more attractive cycling with each passing year. In addition, most cities have established a fully integrated system of directional signs for cyclists, color-coded to correspond to different types of bike routes. All large cities and most medium-sized cities provide detailed maps of their cycling facilities. Some cities have recently introduced internet bike route planning to assist cyclists in choosing the route that best serves their needs. In Berlin and Odense, for example, cyclists can enter not only their origin and destination but also a range of personal preferences, such as speed, on-street or off-street facility, avoiding intersections and heavy traffic, etc. The internet program shows the optimal route on a map and provides all relevant information about time, average speed, bike parking, and public transport connections (26, 29).

The provision of separate cycling facilities is the cornerstone of Dutch, Danish, and German policies to make cycling safe and attractive to everyone. They are designed to feel safe, comfortable, and convenient for both young and old, for women as well as men, and for all levels of cycling ability. Virtually all studies of the impacts of separate facilities confirm that most cyclists prefer them (1, 7, 8, 32). Separate paths, in particular, are perceived as being much safer and more pleasant than cycling on the roadway, thus leading to significant growth in cycling volumes when such facilities are expanded.

Traffic Calming. It is neither possible nor necessary to provide separate bike paths and lanes on lightly traveled residential streets, but they constitute an important part of the overall cycling route network. Thus, Dutch, Danish, and German cities have traffic-calmed most streets in residential neighborhoods, reducing the legal speed limit to 30km/hr (19mph) and often prohibiting any thru traffic (6). In addition, many cities—

especially in the Netherlands—introduced considerable alterations to the streets themselves, such as road narrowing, raised intersections and crosswalks, traffic circles, extra curves and zigzag routes, speed humps, and artificial deadends created by mid-block street closures. Cycling is almost always allowed in both directions on all such traffic-calmed streets, even when they are restricted to one-way travel for cars. That further enhances the flexibility of bike travel. In the Netherlands, Denmark, and Germany, traffic calming is area-wide and not for isolated streets.

Related to traffic calming, almost every city has created extensive car-free zones in their centers, mainly intended for pedestrian use but generally permitting cycling during off-peak hours. In some Dutch cities, these car-free zones specifically include cycling facilities such as bike lanes and parking. The combination of traffic calming of residential streets and prohibition of cars in city centers makes it virtually impossible in some cities for cars to traverse the city center to get to the other side.

Another kind of traffic calming is the so-called “bicycle street,” which has been increasingly adopted in Dutch and German cities. These are narrow streets where cyclists are given absolute traffic priority over the entire width of the street. Cars are usually permitted to use the streets as well, but they are limited to 30km/hr (or less) and cannot rush bicyclists or otherwise interfere with them (28).

Traffic calmed residential neighborhoods, car-free city centers, and special bicycle streets all greatly enhance the overall bicycling network in all Dutch, Danish, and German cities. Most importantly, they offer much safer, less stressful cycling than streets filled with fast-moving motor vehicles. Since most bike trips start at home, traffic calming of neighborhood streets is crucial to enabling bike trips to start off in a safe,

pleasant environment on the way to the separate bike paths and lanes that serve the rest of the trip.

All available evidence shows that traffic calming improves overall traffic safety. The benefits tend to be greatest for pedestrians, but serious cyclist injuries also fall sharply. Moreover, all studies report large increases in overall levels of walking and cycling. There are, of course, many different kinds of traffic calming. It is conceivable that one or another specific kind of traffic calming measure (perhaps traffic circles or speed humps) might detract from cycling safety in some circumstances. Overall, however, the evidence is overwhelming that traffic calming enhances both pedestrian and cyclist safety by reducing speeds on secondary roads (33, 34, 35, 36).

Intersection modifications. While bike paths and lanes help protect cyclists from exposure to traffic dangers between intersections, they can pose safety problems when crossing intersections. Thus, Dutch, Danish, and German planners have worked continuously on perfecting the designs of intersections to facilitate safe cyclist crossings. The extent and specific design of intersection modifications vary, of course, from city to city, but they generally include most of the following:

- Special bike lanes leading up to the intersection, with advance stop lines for cyclists, far ahead of waiting cars
- Advance green traffic signals for cyclists, and extra green signal phases for cyclists at intersections with heavy cycling volumes
- Turn restrictions for cars, while all turns allowed for cyclists
- Highly visible, distinctively colored bike lane crossings at intersections
- Special cyclist-activated traffic lights

- Timing traffic lights to provide a “green wave” for cyclists instead of for cars, generally assuming 14-22km/hr bike speed
- Moving bike pathways a bit further away from their parallel streets when they approach intersections to help avoid collisions with right-turning cars

Given the very nature of roadway intersections, it is virtually impossible to avoid all conflicts between motor vehicles and cyclists, but Dutch, Danish, and German planners have done a superb job of minimizing these dangers.

Bike Parking. Extensive bike parking of various sorts is available throughout most Dutch, Danish, and German cities. Local governments and public transport systems themselves directly provide a large number of bike parking facilities (6, 28, 29, 30). Moreover, private developers and building owners are required by local ordinances to provide specified minimum levels of bike parking both within and adjacent to their buildings.

Aside from the large number of bike racks throughout these cities, the most visible and most innovative aspect of bike parking policy is the provision of state-of-the-art parking facilities at train stations. Immediately adjacent to Muenster’s main train station, for example, there is a modern, attractive “bike station” (built in 1999) that offers secure parking for 3,300 bikes as well as bike repairs, bike rentals, and direct access to all train platforms (28). Amsterdam, Groningen, Odense, and Copenhagen offer similar, high-capacity bike parking facilities at their main train stations. Moreover, virtually every train station throughout Dutch, Danish, and German metropolitan areas offer bike parking of some sort (6). In the Berlin region, there were 24,600 bike-and-ride parking

spots at train stations in 2005 (including metro, suburban rail, and regional rail), with 7,000 additional bike parking spots planned by 2010 (26).

Many city centers also offer special bike parking facilities. The City of Odense, for example, recently added 400 sheltered bike racks near its main shopping area as well as a state-of-the-art automatic, secure parking station (30). Groningen offers 36 major bike parking facilities in its town center, including seven that are guarded to prevent bike theft (6). In 2007, Muenster added a secured, sheltered parking facility for 300 bikes adjacent to its main shopping district (28). The City of Copenhagen has 3,300 bike parking spaces in its center and added 400 between 2000 and 2002 (26). Amsterdam has 15 guarded bicycle parking facilities in its downtown area (27). The current policy focus in Dutch, Danish, and German cities is to increase the security of bike parking, since bike theft is a major problem.

Integration with Public Transport. Most Dutch, Danish and German cities have integrated cycling with public transport (1, 6, 17, 21, 22). Public transport systems and city planners in northern Europe have increasingly recognized the key role that bicycling plays as a feeder and distributor service for public transport. Thus, copious bike parking is provided at train stations in the city center as well as at outlying stations along the rail network. In cities such as Muenster, many suburban residents use a bike to reach the nearest suburban rail station, park it there, and then take the train to the city center, where they continue their trip with another bike they have parked at the main train station (28). Most rail systems permit bikes to be taken on vehicles only during off-peak hours and require an additional fee. Another form of bike-transit integration is the

provision of bike rentals at virtually every major Dutch, Danish, and German train station and many suburban stations as well (6).

Most Dutch, Danish, and German cities we surveyed do not permit bikes to be taken onboard regular city buses, and most buses do not come equipped with bike racks (6, 26, 27, 28). That contrasts starkly with the USA, where over 50,000 urban transit buses in 2007 had bike racks to facilitate bike and ride (37). It appears to be the one area where American transit systems do a better job of coordinating cycling with transit. The European approach is to provide bike parking facilities at major bus terminals, bus route interchanges, and even some suburban bus stops.

Training and Education. Dutch, Danish, and German children receive extensive training in safe and effective cycling techniques as part of their regular school curriculum (6, 17, 21, 22). Most children complete such a course by the fourth grade. It includes both classroom instruction and “on the road” lessons, first on a cycling training track just for children, and then on regular cycling facilities throughout the city. Real police officers test the children, who receive official certificates, pennants, and stickers for their bikes if they pass the test. Since many children get to school by bike, training in safe cycling is considered essential to ensure their safety. But it also gets kids off to a lifetime of safe cycling skills. And since all schoolchildren are included, it means that girls as well as boys start cycling at an early age.

Another crucial element in cyclist safety is training motorists to be aware of cyclists on the roadway and to avoid endangering them (6, 17, 21, 22). In general, motorist training in the Netherlands, Denmark, and Germany is far more extensive, more thorough, and more expensive than in the USA. By law motorists are required to

anticipate and avoid situations that would endanger cyclists or pedestrians. Motorists are assumed to be responsible for any collisions with children, elderly, or disabled cyclists or pedestrians, even if they are jaywalking, cycling in the wrong direction, ignoring traffic signals, or otherwise behaving contrary to traffic regulations.

How do these training programs promote cycling for everyone? They ensure that by the age of 10, most children have the basic skills to cycle safely, and that drivers of motor vehicles give special consideration to cyclists. Moreover, since motorists had to take the safe cycling lessons during their early school years, and since many of them still cycle, they are more likely to drive with respect and consideration for cyclists. Cyclist and motorist training together enhance cycling safety, which has a major impact on cycling levels, especially among children, the elderly, and women.

Promotional Events. Although the provision of safe and convenient cycling facilities is the key approach to promoting cycling, virtually all Dutch, Danish, and German cities have various programs to stimulate interest and enthusiasm for cycling by all groups. Below is a list of selected promotional measures used by six cities we specifically surveyed: Amsterdam, Groningen, Copenhagen, Odense, Berlin, and Muenster (26, 27, 28, 29, 30, 31).

- Well signed and maintained bike routes both in the city and the surrounding countryside, with connections between different routes, color-coded, systematic numbering of paths for improved guidance
- Comprehensive bike maps for every part of the city and the surrounding region
- Bicycling websites with extensive information for cyclists on bicycling routes, activities, special programs, health benefits of cycling, bike and bikes and bike accessories, etc.
- Improved lighting and security of bike parking facilities, especially important for women concerned about their personal safety, often featuring priority bike parking exclusively for women

- Cycling ambassador programs that send well-trained cyclists to residential neighborhoods to serve as role models of safe cycling and help with cycling promotion, distributing newsletters and information about cycling events
- Annual bicycling festivals and car-free days that promote the environmental advantages of bicycling, display the latest bike models and accessories, disseminate various other relevant information for bike enthusiasts, and offer a range of bike races and mass bike rides
- Wide range of cycling competitions for different ages and skill levels
- Annual awards to firms that do the most to increase bicycling among their employees by providing showers, lockers, bike parking, bikes to borrow, and a flexible dress code
- Focus on health benefits of cycling
- Regular surveys of cyclists to assess their satisfaction with cycling facilities and programs and to gather specific suggestions for improvement

These sorts of promotional activities tend to be more extensive in Denmark and Germany than in the Netherlands, where cycling levels are already so high that the focus is more on safer cycling than on more cycling, although the two are directly related, as noted earlier.

Complementary taxation, parking, and land-use policies

Most of the above policies refer to measures that make cycling safer and more convenient. But there are other important factors that encourage cycling indirectly (1, 6, 7, 8). For example, sales taxes on petrol and new car purchases, import tariffs, registration fees, license fees, driver training fees, and parking fees are generally much higher in Europe than in the USA (38, 39, 40, 41, 42). That results in overall costs of car ownership and use two to three times higher in Europe. That higher cost discourages car use to some extent and thus promotes alternative ways of getting around, including cycling, which is surely one of the cheapest of transport modes. In addition, there are many restrictions on car use and parking that reduce the relative speed, convenience, and flexibility of car travel compared to cycling.

Finally, land use and urban design policies in Dutch, Danish, and German cities are generally much stricter than in the USA and provide more government controls on

low-density sprawl and the long trip distances that usually generates (38, 39, 40, 43). Moreover, mixed-use zoning and transit-oriented developments have a long history in Europe. They facilitate the proximity of residential areas to commercial establishments, schools, churches, and a range of services. For the most part, these complementary taxation, parking, and land use policies are not specifically intended to promote cycling. Nevertheless, they provide dramatically more favorable pre-conditions for cycling than in the USA. Thus, one way that European cities promote cycling for everyone is by making car use more expensive, less convenient, and less necessary for everyone.

Conclusions: Policies to Make Cycling Possible for Everyone

It is impossible to provide rigorous, statistical proof that the eight categories of measures discussed above, either individually or in combination, lead to more and safer cycling. The available data do not permit multivariate analysis, and even if data were available, such analysis cannot determine direction of causation. Nevertheless, the aggregate national data and specific case study data presented in this paper strongly suggest an important link between the eight categories of measures and the desired outcomes of more and safer cycling.

The most important approach to making cycling safe, convenient, and attractive for everyone in Dutch, Danish, and German cities is the provision of separate cycling facilities along heavily traveled roads and at intersections, combined with extensive traffic calming of residential neighborhoods. Safe and relatively stress-free cycling routes are especially important for children, the elderly, women, and for anyone with special needs due to any sort of disability. Providing such separate facilities to connect practical, utilitarian origins and destinations also promotes cycling for work, school, and

shopping trips, as opposed to the mainly recreational cycling in the USA, where most separate cycling facilities are along urban parks, rivers, and lakes or in rural areas.

As noted in this article, separate facilities are only part of the solution. Dutch, Danish, and German cities reinforce the safety, convenience, and attractiveness of excellent cycling rights of way with extensive bike parking, integration with public transport, comprehensive traffic education and training of both cyclists and motorists, and a wide range of promotional events intended to generate enthusiasm and wide public support for cycling.

At the same time, car use is made expensive, less convenient, and less necessary through a host of taxes and restrictions on car ownership, use, and parking. And land use policies foster relatively compact, mixed-use developments that generate more bikeable, shorter trips.

The key to the success of cycling policies in northern Europe is the coordinated implementation of this multi-faceted, self-reinforcing set of policies. Precisely because the policies are sensitive to the very different needs of different social groups, they also succeed in making cycling possible for virtually everyone. It is a lesson still to be learned in the USA.

References

- (1) European Conference of the Ministers of Transport. *National Policies to Promote Cycling*. Paris, France: Organisation for Economic Cooperation and Development, 2004.
- (2) U.S. Department of Transportation. *National Bicycling and Walking Study: Ten Year Status Report*. Washington, DC: Federal Highway Administration, 2004.
- (3) U.S. Department of Transportation. *National Household Travel Survey, 2001*. Washington, DC: Federal Highway Administration, 2003.
- (4) German Federal Ministry of Transport. *German Federal Travel Survey 2002 (MiD)*. Berlin, Germany: German Federal Ministry of Transport, 2003.

- (5) Dutch Ministry of Transport. *Cycling in the Netherlands*. Rotterdam: Ministry of Transport, Public Works, and Water Management, 2006.
- (6) Dutch Bicycling Federation. *Continuous and Integral: The Cycling Policies of Groningen and other European Cities*. Amsterdam, NL: Fietsberaad, 2006.
<http://www.fietsberaad.nl>. Accessed 20 October 2007.
- (7) Tolley, R., Ed. *Sustainable Transport: Planning for Walking and Cycling in Urban Environments*. Cambridge, UK: Woodhead Publishing Ltd, 2003.
- (8) McClintock, H., ed. *Planning for Cycling: Principles, Practice, and Solutions for Urban Planners*. Cambridge, UK: Woodhead Publishing Ltd, 2002.
- (9) European Cycling Federation. *Bicycle Research Reports*.
http://www.ecf.com/37_1. Accessed 20 October 2007.
- (10) Zegeer, C., Ed. *FHWA Study Tour for Pedestrian and Bicyclist Safety in England, Germany, and the Netherlands*. US Department of Transportation, Washington, D.C., 1994.
- (11) Kunert, U., Kloas, J., and H. Kuhfeld. Design Characteristics of National Travel Surveys. Internationals Comparison for 10 countries. *Transportation Research Record 1804*. TRB 2002.
- (12) National Statistical Office of Denmark. *National Travel Statistics*. Copenhagen, Denmark: National Statistical Office. 2005.
- (13) City of Berlin. *Urban Transport in Berlin: Focus on Bicycling*. Berlin: Senatsverwaltung fuer Stadtentwicklung. 2003.
- (14) Hass-Klau, C. *The Pedestrian and City Traffic*. New York: Belhaven Press, 1990.
- (15) Pucher, J. Bicycling boom in Germany: A revival engineered by public policy. *Transportation Quarterly* 51, 4: 31-46, 1997.
- (16) Langenberg, P. *Cycling in Amsterdam. Developments in the City*. Amsterdam, The Netherlands: Velo Mondial, 2000.
- (17) German Federal Ministry of Transport. *Ride Your Bike: National Bicycle Plan*. Berlin, Germany: German Federal Ministry of Transport, 2002.
- (18) Statistics Netherlands. *Transportation Statistics*. Amsterdam, NL: Statistics Netherlands, 2005.
- (19) Organisation for Economic Cooperation and Development. *International Road Traffic Accident Database*. Paris, France: OECD, 2007.
www.bast.de/htdocs/fachthemen/irtad. Accessed 20 October 2007.
- (20) Jacobsen, P. Safety in numbers: more walkers and bicyclists, safer walking and bicycling. *Injury Prevention* 9: 205-209, 2003.
- (21) Dutch Ministry of Transport. *The Dutch Bicycle Master Plan*. The Hague: Ministry of Transport, Public Works, and Water Management, 1999.
- (22) Danish Ministry of Transport. *Promoting Safer Cycling: A Strategy*. Copenhagen: Danish Ministry of Transport, 2000.

- (23) Noland, R. B. Perceived risk and modal choice: Risk compensation in transportation systems. *Accident Analysis and Prevention* 27: 503–521, 1994.
- (24) Andersen, T. Odense: The National Cycle City of Denmark. Annual Conference of the Bicycling Federation of Australia, Brisbane, Australia, Oct 6, 2005.
- (25) Pucher J. and L. Dijkstra. Promoting Safe Walking and Cycling to Improve Public Health: Lessons from the Netherlands and Germany. *American Journal of Public Health* 93:1509-1516, 2003.
- (26) City of Berlin. *Fahrradverkehr*. Berlin, Germany: Senatsverwaltung fuer Stadtentwicklung, 2007.
<http://www.stadtentwicklung.berlin.de/verkehr/radverkehr/index.shtml>
- (27) City of Amsterdam. *The Amsterdam Bicycle Policy*. Amsterdam, the Netherlands: Dienst Infrastructuur Verkeer en Vervoer. Gemeente Amsterdam, 2003.
- (28) City of Muenster. *Verkehrsplanung in Muenster*. 2007.
http://www.muenster.de/stadt/stadtplanung/index_verkehr.html
- (29) City of Groningen. *Key Figures*. 2007.
http://www.groningen.nl/assets/pdf/kerncijfers_2006_engels.pdf
- (30) City of Odense. *National Cycle City (Cycleby)*. 2007.
<http://www.cykelby.dk/eng/index.asp>
- (31) City of Copenhagen. *Cycle Policy*. Copenhagen, Denmark: City of Copenhagen, 2002.
- (32) Jensen, S, Rosenkilde, C, and Jensen, N. *Road safety and perceived risk of cycle facilities in Copenhagen*. Copenhagen: Trafitec Research Center. www.Trafitec.dk. 2007.
- (33) Webster, D.C., Mackie, A. M. *Review of Traffic Calming Schemes in 20mph zones*. TRL Report 215. Transport Research Laboratory. Crowthorne, UK, 1996.
- (34) Morrison, D, Thomson, H, and Petticrew, M. *Journal of Epidemiology and Community Health* 58: 837-840, 2004.
- (35) Herrstedt, L. Traffic calming design—a speed management method: Danish experiences on environmentally adapted through roads. *Accident Analysis and Prevention* 24: 3-16, 1992.
- (36) Transport for London. *Impacts of 20 mph Zones in London Boroughs*. TfL, London, UK, 2003.
- (37) American Public Transportation Association. *Public Transportation Fact Book*. Washington, D.C.: APTA. 2007.
- (38) Nivola, P.S. *Laws of the Landscape. How policies shape cities in Europe and America*. Washington D.C.: Brookings Institution Press, 1999.
- (39) Pucher, J. Urban passenger transport in the United States and Europe: A comparative analysis of public policies. Part 1. Travel behavior, urban development and automobile use. *Transport Reviews*. Vol. 15: 99-117, 1995.
- (40) Banister, D. *Unsustainable Transportation*. New York: Routledge, 2005.

- (41) Bratzel, S. Conditions of success in sustainable urban transport policy - Policy change in 'relatively successful' European cities. *Transport Reviews*. Vol. 19: 177-190, 1999.
- (42) Transportation Research Board. *Making Transit Work: Insights from Western Europe, Canada, and the United States*. TRB Special Report 257. Washington, DC: National Research Council. 2001.
- (43) Schmidt, S. and R. Buehler. The Planning Process in the US and Germany: A Comparative Analysis. *International Planning Studies*. Vol. 12: 55-75, 2007.