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Walking, Cycling, and Obesity Rates in Europe, North America, and Australia

David R. Bassett, Jr., John Pucher, Ralph Buehler, Dixie L. Thompson, and Scott E. Crouter

Purpose: This study was designed to examine the relationship between active transportation (defined as the percentage of trips taken by walking, bicycling, and public transit) and obesity rates (BMI $\geq$ 30 kg $\cdot$ m^{-2}) in different countries. ***Methods:*** National surveys of travel behavior and health indicators in Europe, North America, and Australia were used in this study; the surveys were conducted in 1994 to 2006. In some cases raw data were obtained from national or federal agencies and then analyzed, and in other cases summary data were obtained from published reports. ***Results:*** Countries with the highest levels of active transportation generally had the lowest obesity rates. Europeans walked more than United States residents (382 versus 140 km per person per year) and bicycled more (188 versus 40 km per person per year) in 2000. ***Discussion:*** Walking and bicycling are far more common in European countries than in the United States, Australia, and Canada. Active transportation is inversely related to obesity in these countries. Although the results do not prove causality, they suggest that active transportation could be one of the factors that explain international differences in obesity rates.

Keywords: active transportation, bicycling, walking, commuting, transportation, physical activity, exercise, travel, obesity

Walking and bicycling are far more common in Europe than in North America and Australia.[1] The use of public transit, which normally requires walking or cycling to reach the transit stop,[2,3] is also more common in Europe. Travel-related walking, bicycling, and use of public transit are collectively referred to as active transportation. Active transportation is common in Europe because of several factors[1,3,4]:

1. Compact, dense cities with mixed land uses that generate short trips;
2. Restrictions on car use such as car-free zones, low speed limits, and prohibitions of through traffic;

Bassett and Thompson are with the University of Tennessee Obesity Research Center, The University of Tennessee, Knoxville, TN 37996. Pucher and Buehler are with the Urban Planning and Policy Development Program, Bloustein School of Planning and Public Policy, Rutgers University, New Brunswick, NJ 08901. Crouter is with the Dept of Exercise and Health Sciences, University of Massachusetts, Boston, MA 02125.

3. Extensive, safe, and convenient facilities for walking and cycling;
4. Traffic calming of residential neighborhoods;
5. Coordination of public transit with walking and cycling to transit stations and stops, including bike parking, as well as safe sidewalks and bikeways;
6. Traffic regulations and enforcement policies that favor pedestrians and cyclists over motorists; and
7. High cost of owning and operating a car resulting from expensive driver licensing, high gasoline prices, and high taxes on car purchases.

Some researchers have suggested that the physical activity generated by active transportation is helpful in weight control.[5,6] Walking and bicycle commuting usually fall into the moderate-intensity range, and if performed regularly, can result in substantial amounts of energy expenditure.[7] In addition, the use of public transit (trains, subways, and buses) usually involves walking or cycling to and from transit stops and, hence, would also be expected to promote weight control, as well as a host of other physical and mental health benefits.[8,9]

The purpose of this study was to determine if variations in active transportation (defined here as the percentage of trips taken by walking, bicycling, and public transit) are related to international differences in obesity prevalence. It was hypothesized that developed nations where active transportation is common would have lower obesity rates than those with high automobile dependency. We limited our comparison to Europe, North America, and Australia because industrialized countries on those continents have similar, high levels of income and standards of living.[10,11] This reduced the likelihood that obesity rates would be influenced by food availability, as is the case for developing nations.[11]

Methods

To be able to draw valid conclusions, representative data on active transportation and obesity prevalence in different nations were needed. The approach we used was to synthesize data from various sources. This included both raw data from national surveys of travel behavior and health indicators obtained from government agencies (which were then analyzed by our colleagues or ourselves), as well as summary data obtained from published reports.

Transportation Data

At this time, there are no standardized travel surveys that gather data for the purpose of allowing international comparisons.[12] However, in many countries, national travel surveys are conducted by, or under the direction of, national or federal authorities. An article by Pucher,[4] cited by the Transportation Research Board of the National Academy of Sciences,[3] compiled data on the percentage of trips in the mid 1990s taken by various transportation modes in 10 countries of Europe and North America. We expanded this data set by including more countries and updated travel data for most of the 10 previously included countries by using the most recent national transportation studies conducted between 1994 and 2006. We consulted a review of short-distance travel patterns in Europe[12] and gathered additional data from ministries of transportation in various countries. By using this combination of all available data sources, we produced a synthesis of the best and most recent information on the percentage of trips taken in each country by walking, cycling, public transit, and automobiles. All of these studies attempted to obtain a representative sample of the residents of that country. The age of eligible participants was usually 6 years and older, but in the United States, it was 5 years and older and in Denmark, 10 years and older. The data in these travel surveys did not include long-distance trips and were restricted mostly to daily travel.[4]

Most travel surveys use an additional diary in which the respondent records each place visited during the course of a day, the starting and ending time of each trip, transportation mode, and trip distance.[13] In some countries, the travel diary is supplemented by a computer-assisted telephone interview (CATI) to enable interviewers to verify and edit the individual's responses. This combined method (diary + CATI) has been reported to increase the numbers of respondents who made trips by 7%.[14] Germany, the Netherlands, Norway, Switzerland, and the United States are examples of countries that use this technique.[14] Other factors limiting comparability between surveys are the response rate, method of survey administration, and the inclusion/exclusion of weekend travel.[14,15] Despite some inconsistencies, it is still possible to obtain a rough estimate of active transportation in different countries by using data from national surveys.

Further information on the specific design characteristics of various national transportation surveys is available in several reviews. For instance, Schafer[14] reported on the comparability of travel surveys from 11 industrialized countries between 1981 and 1995. More recently, Kunert et al[13] published an international comparison of travel surveys from 10 countries in Europe and North America conducted between 1988 and 2000.

Obesity Prevalence Data

We examined obesity rates in selected European nations, the United States, Canada, and Australia for the period of 1995 to 2005 using several sources of data. To identify primary sources of data, we conducted Medline searches to identify the obesity prevalence in various countries during this time period. In addition, we consulted the International Association for the Study of Obesity,[16] the Organization for Economic Co-operation and Development (OECD) Health at a Glance report,[17] and the World Health Organization (WHO) Web site. We included studies on obesity prevalence if they (1) defined obesity as a body mass index (BMI) ≥ 30 kg $\cdot$ m^{-2}, (2) included nationally representative data, and (3) had fieldwork periods ending between 1995 and 2005. (Because published studies of obesity prevalence are not published annually in all countries, we searched for ones that were conducted within the same approximate time period as the transportation surveys.)

Data Analysis

The obesity prevalence studies were grouped into 2 categories, those using self-report data and those using measured data. Because BMI values computed on the basis of self-reported height and weight usually underestimate BMI values determined from measured height and weight,[18] it was necessary to consider these separately. One study obtained both self-report and clinical measurements of height and weight in the Netherlands.[19]

The data on active transportation and obesity rates were graphed to show the relationship between these variables. Two separate graphs were constructed, one for studies using self-report data and the other for studies using clinical measurements.

Results

Data on travel behavior and health indicators were used to construct 2 figures showing the modal shares of walking, bicycling, and public transit as a percentage of the total number of trips for 17 countries (Figure 1). The lowest rate of active transportation was seen in the United States (only 8% of trips by walking + cycling + public transit), whereas the highest rate was seen in Latvia (67% of trips by walking + cycling + public transit). The main characteristics of the national travel surveys are shown in Table 1.

The obesity rates in different countries, based on self-reported height and weight, are shown in Table 2. These national health interview surveys tended to yield lower obesity prevalence values than those based on clinical measures. Based on these self-report data, the lowest rates of obesity were seen in Switzerland (8%), the Netherlands (8.1%), and Sweden (9.4%). The United States (23.9%) had the highest rate of obesity using self-report data. The Pearson correlation coefficient between active transportation and obesity rates (based on self-report data) was $r = -.86$ ($P < .001$).

The obesity rates in different countries, based on measured height and weight, are show in Table 3. Based on anthropometric measurements, the lowest rates of obesity were seen in the Netherlands (11.2%) and Latvia (13.7%). The United States had the highest rate of obesity (34.3%). The Pearson correlation coefficient between active transportation and obesity rates (based on measured height and weight) was $r = -.76$ ($P < .05$).

There are large differences between nations in their use of active transportation and obesity rates (Figures 2 and 3). European countries that rely heavily on walking and cycling have lower rates of obesity. In contrast, the United States, Australia, and Canada demonstrate extreme automobile dependence and have the highest rates of obesity.

Discussion

The main finding of this study is that countries in Europe, North America, and Australia where active travel is most common have the lowest obesity rates, whereas those countries with the highest rates of car use for travel have the highest obesity rates. The data are cross-sectional, and we did not adjust for possible confounders such as energy intake; hence, causality cannot be shown. However, consideration of the causes for this inverse association between active transportation and obesity rates is warranted.

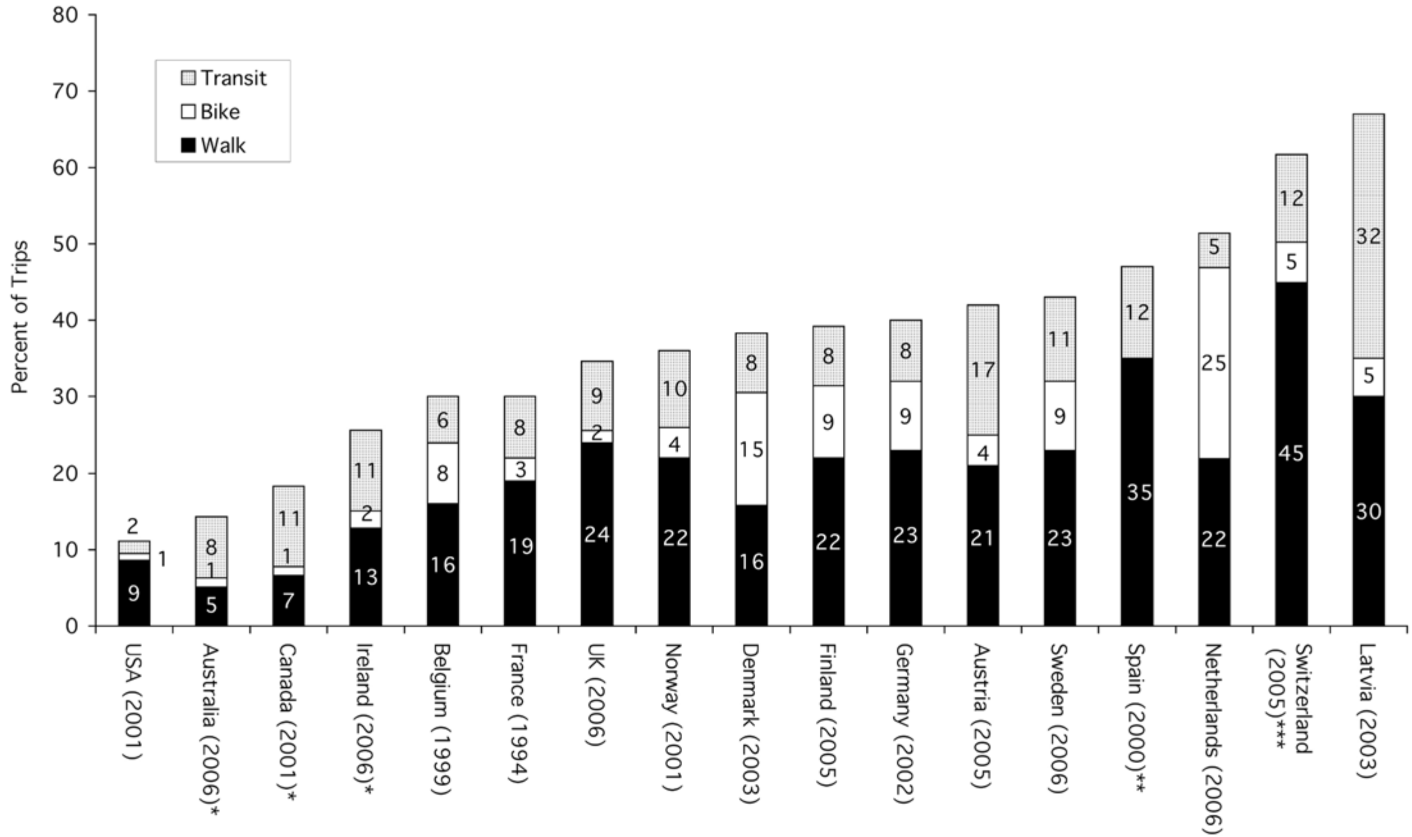

Figure 1 — Percentage of trips taken by walking, bicycling, and public transit in countries of Europe, North America, and Australia. For data sources, see Table 1. * Work trips only. ** Walk and bike trips combined for Spain. *** Special focus on short trips for Switzerland (any trip of 25 m or more was included).

Table 1 Characteristics of National Travel Surveys in Europe, North America, and Australia

Country	Agency responsible for the survey	Survey	Period of data collection	Age Range (y)	Sample Size	Source
Australia	Australian Bureau of Statistics	Census of Population[a]	2006	15+	20,000,000 persons	Australian Bureau of Statistics[35]
Austria	Austrian Ministry of Transport, Innovation and Technology	National Travel Survey	2005	6+	12,400 households	Austrian Ministry of Transport[36]
Belgium	Federal Office for Academic, Technical and Cultural Affairs	National Travel Survey	1998–99	6+	9459 households	Eurostat[12]
Canada	Statistics Canada	Census of Population[a]	2001	employed persons	census of population	Statistics Canada[37]
Denmark	Danish Ministry of Transport	National Travel Survey	2003	10–84	25,000 persons	Danish Ministry of Transport[38]
Finland	Ministry of Transport and Communications Finland, Finnish National Road Administration	National Travel Survey	2004–05	6+	18,250 persons	Ministry of Transport and Communications Finland[39]
France	INSEE	National Travel & Communication Survey	1993–94	6+	20,002 households	Eurostat[12]
Germany	Federal Ministry of Transport and Spatial Development	National Travel Survey	2001–02	all ages	25,000 households, 62,000 persons	Federal Ministry of Transport and Spatial Development[40]
Ireland	Central Statistics Office	Census of Population[a]	2006	15+	census of population	Central Statistics Office[41]

(continued)

Table 1 ***(continued)***

Country	Agency responsible for the survey	Survey	Period of data collection	Age Range (y)	Sample Size	Source
Latvia	Central Statistical Bureau of Latvia	National Travel Survey—short trips	2003	6+	2476 households, 6208 persons	Eurostat[12]
Netherlands	Ministry of Transport, Public Works, and Water Management	National Travel Survey	2006	all ages	34,454 households, 77,317 persons	Statistics Netherlands[42]
Norway	Institute for Transportation Research	National Travel Survey	2001–02	13+	20,752 persons	Eurostat[12]
Spain	Ministry for Public Works and Economy	National Travel Survey—short trips	2000	all ages	24,000 households, 39,981 persons	Eurostat[12]
Sweden	Swedish Institute for Transport and Communications Analysis (SIKA)	National Travel Survey	2005–06	6–84	41,000 persons	SIKA[43]
Switzerland	Federal Office for Spatial Development and Federal Statistical Office	Micro Census/Travel Behavior[b]	2005	6+	31,950 households, 33,930 persons	Federal Office for Spatial Development and Federal Statistical Office[44]
United Kingdom	Department for Transport	National Travel Survey	2006	all ages	8300 households, 19,350 persons	Department for Transport[45]
United States	Federal Highway Administration	National Travel Survey	2000–01	all ages	26,083 households	US Department of Transportation[46]

[a] Work trips only; overestimates trips by public transportation and underestimates trips by bike and on foot.

[b] Special focus on short trips (any trip of 25 m or more is included); this overestimates walk trips.

Table 2 Obesity (BMI ≥ 30 kg · m^{-2}) Prevalence Determined From National Health Interview Surveys in Which BMI Was Computed From Self-Reported Height and Weight

Country	Reference	Survey	Years of data collection	Sample size (men; women)	Age range (y)	Obesity prevalence in men (%)	Obesity prevalence in women (%)	Obesity prevalence combined (%)[a]
Australia	Brown et al[47]	2001 National Health Survey	2001	7600; 8646	18+	16.6	15.8	(16.2)
Canada	Vanasse et al[48]	2003 Canadian Community Health Survey	2003	130,000 total	20+	NA	NA	15.2
Denmark	Bendixen et al[49]	Trends in Food Habits in Denmark, Nutrition Council	2001	10,094; 9897	16–98	11.8	12.5	(12.2)
Finland	Tikkinen et al[50]	Danish Prostatic Symptom Score Questionnaire	2003–04	1663; 1897	18–79	13.5	13.2	(13.3)
France	INSERM[51]	ObEpi 2003	2003	25,770 total	15+	NA	NA	11
Germany	Federal Statistical Office, Germany[52]	Telephone Survey	2005	25,873 total	18+	NA	NA	12.1
Italy	Gallus et al[53]	National Multipurpose Surveys	2004	1407; 1525	18+	7.4	8.9	8.2
Ireland	McCarthy et al[54]	North/South Ireland Food Consumption Survey	1997–99	1379 total	18–64	20	16	(18)

(continued)

Table 2 *(continued)*

Country	Reference	Survey	Years of data collection	Sample size (men; women)	Age range (y)	Obesity prevalence in men (%)	Obesity prevalence in women (%)	Obesity prevalence combined (%)[a]
Netherlands	Schokker et al[55]	Health Interview Survey	2001	1809; 1882	20–59	8.5	7.7	(8.1)
Spain	Martinez et al[56]	National Health Survey (ENS)	2001	21,120 total	>16	11.9	13.6	12.8
Sweden	Sundquist et al[57]	Swedish Annual Level of Living Survey (SALLS)	2000–01	5515; 5838	16–84	9.6	9.3	(9.4)
Switzerland	Eichholzer et al[58]	Swiss Health Survey	2002	19,706 total	15+	NA	NA	8
United States	Ni et al[59]	National Health Interview Survey (NHIS)	2002	31,044 adults	20+	NA	NA	23.9

Abbreviations: BMI, body mass index; NA, not available.

[a] Obesity rates in parentheses were calculated from a weighted average of the published obesity rates for men and women.

Table 3 Obesity (BMI $\geq$ 30 kg $\cdot$ m^{-2}) Prevalence Determined From National Health Examination Surveys in Which BMI Was Computed From Measured Height and Weight

Country	Reference	Survey	Years of data collection	Sample size (men; women)	Age range (y)	Obesity prevalence in men (%)	Obesity prevalence in women (%)	Obesity prevalence combined (%)[a]
Australia	Dalton et al[60]	The Australian Diabetes, Obesity, and Lifestyle Study	2000	11,247	25+	19.3	22.2	20.8
Canada	Luo et al[61]	Canadian Community Health Survey	2004	18,668	20+	22.9	22.5	22.7
Great Britain	Rennie and Jebb[62]	Health Survey for England	2002	Not specified		23	25	(24)
Latvia	Pomerleau et al[63]	Not specified	1997	1062; 1230	19–64	9.5	17.4	(13.7)
Netherlands	Visscher et al[19]	Health Interview Survey & Health Examination Survey of the Risk Factors and Health (REGENBOOG)	1998–2002	1809; 1882	20–59	11.5	11.0	(11.2)
Norway	Anderssen et al[64]	National Health Screening Service Survey	1995–2002	10,690; 12,654	20–70	15.4	13.3	(14.3)
United States	Ogden et al[65]	National Health and Nutrition Examination Survey (NHANES)	2005–2006	US Census Bureau	20+	33.3	35.3	(34.3)

Abbreviations: BMI, body mass index; NA, not available.

[a] Obesity rates in parentheses were calculated from a weighted average of the published obesity rates for men and women.

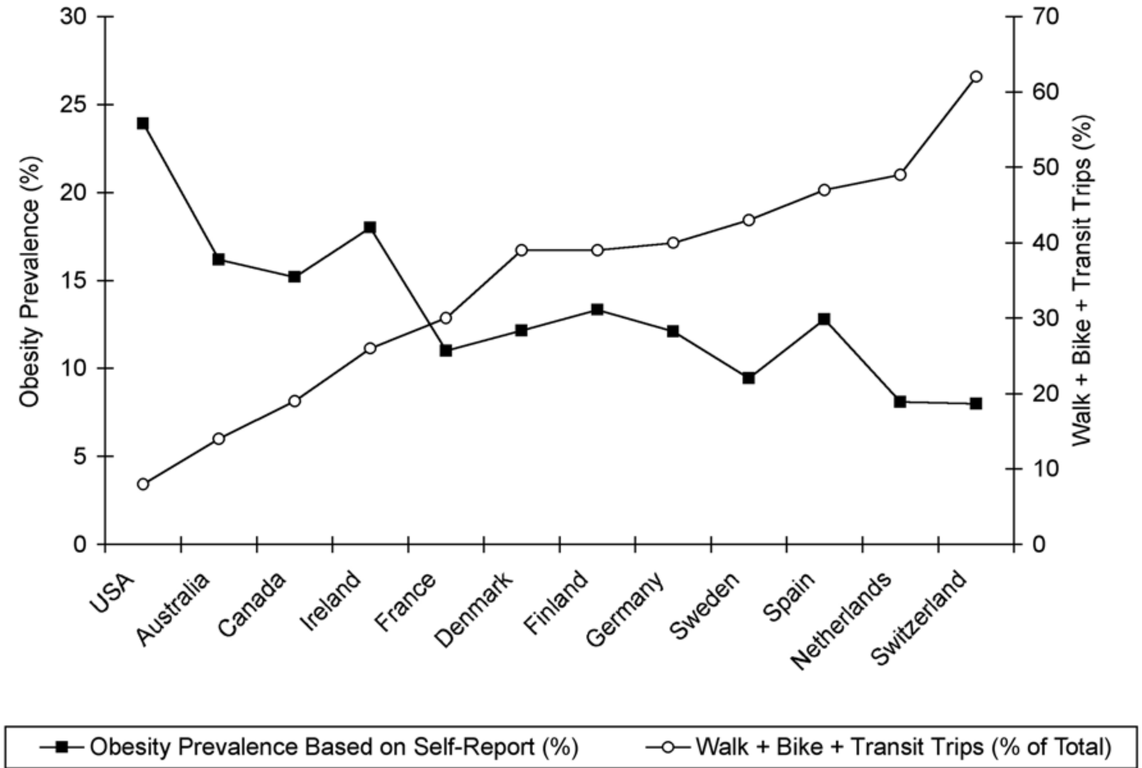

Figure 2 — Obesity (BMI ≥ 30 $kg \cdot m^{-2}$) prevalence and rates of active transportation (defined as the combined percentage of trips taken by walking, bicycling, and public transit) in countries of Europe, North America, and Australia. BMI was computed from self-reported height and weight. Data were obtained from national surveys of travel behavior and health indicators conducted between 1994 and 2006 (see text for details).

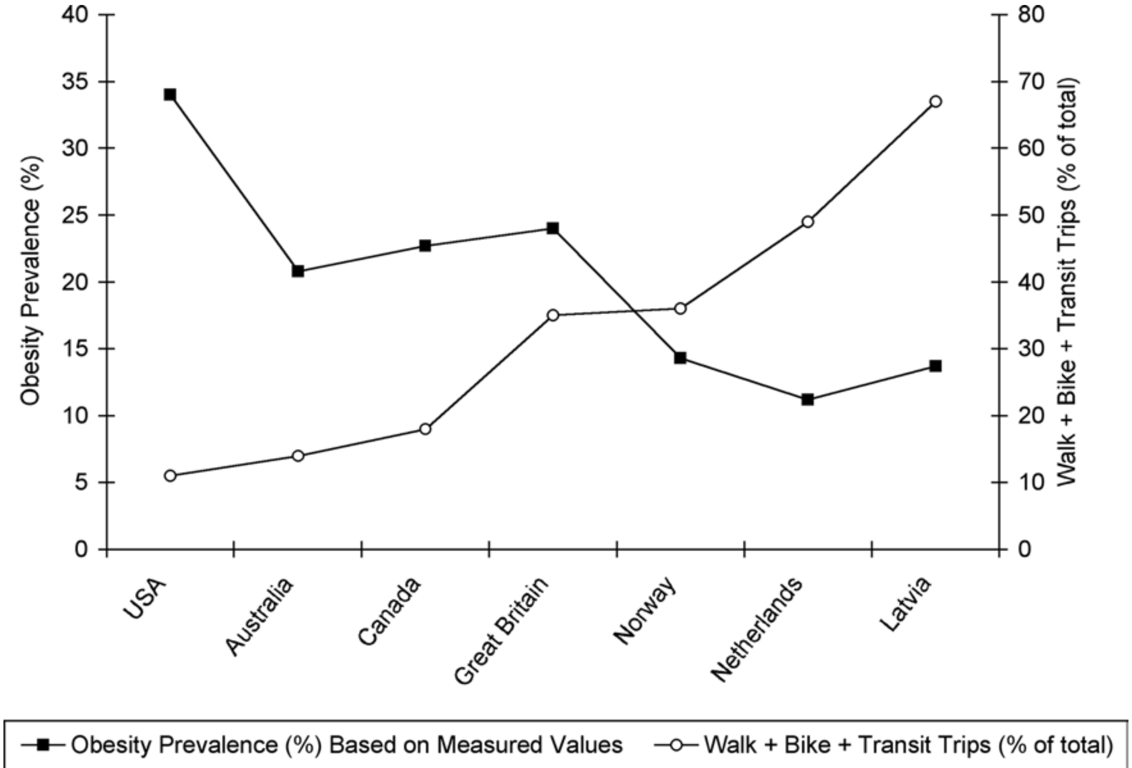

Figure 3 — Obesity (BMI ≥ 30 kg · m^{-2}) prevalence and rates of active transportation (defined as the combined percentage of trips taken by walking, bicycling, and public transit) in countries of Europe, North America, and Australia. BMI was computed from measured height and weight. Data were obtained from national surveys of travel behavior and health indicators conducted between 1997 and 2006 (see text for details).

A possible explanation for the observed findings is that the increased energy expenditure required by walking, cycling, and public transit contributes to lower rates of obesity. Supporting evidence for this view comes from the developing nation of China, where the use of automobiles is rapidly increasing. In the 1980s, very few households in China owned motor vehicles, but 14% of Chinese households acquired a motor vehicle between 1989 and 1997. Bell et al[5] conducted a longitudinal study of 2485 adults (age 20 to 45 years) during this time period. They found that Chinese men who acquired a car experienced a 1.8 kg greater weight gain and were twice as likely to become obese compared with men whose vehicle ownership remained unchanged. These findings held even after adjusting for diet.

In both the United States and Europe, walking is the most common leisure-time physical activity.[20,21] On both continents, a high percentage of adults report having walked for exercise in the past 1 to 2 weeks, and walking participation is high for all age groups. However, although walking for health and fitness is popular in both Europe and North America, Europeans are more likely to walk for utilitarian purposes such as shopping, commuting to work, and school trips.[3,4] Short trips in Europe are often taken by walking,[22] but in the United States, they are usually taken by automobile. In the United States, the automobile is used for 55% of trips that are about 0.5 km in length, 85% of trips that are 1.0 km in length, and >90% of longer trips.[14]

Even within the United States, there are variations in the use of active transportation. Active transportation tends to be more prevalent in older cities with mixed land use (having residential, commercial, and civic buildings interspersed), sidewalks, and well-developed public transit systems.[23–25] Frank et al[6] studied 10,878 people in the Atlanta area and showed that land-use mix had a strong association with obesity, with each quartile increase in land-use mix yielding a 12.2% reduction in the likelihood of obesity. They concluded that each hour spent driving was associated with a 6% increase in the likelihood of being obese and that each additional kilometer walked per day was associated with a 4.8% reduction in the likelihood of obesity. The use of public transit has been shown to help Americans achieve recommended levels of physical activity. For example, Greenberg et al[2] found that 78% of New Jersey train commuters met the national recommendation for physical activity, compared with 45% of all US adults. Having a good transit system encourages more walk trips through walk-to-transit and reduces dependence on automobiles.

Another measure of active transportation is the number of kilometers walked and cycled per person per year. The European Commission's Directorate-General for Energy and Transport[26] has compiled summary data on walking and bicycling. In 2000, Europeans walked an average of 382 km (237 miles) per year, almost 3 times as much as the US average of 140 km (87 miles) per year. The average distance cycled each year in Europe is about 187 km (117 miles) per year, compared with 40 km (87 miles) per year in the United States (Figure 4). We estimated the calories burned per day by active transportation, based on the European Commission's figures. Published values for the energy expenditure of bicycling at 8 to 10 mph (4 METs) and walking at 3 mph (3.3 METs) were used to arrive at these calorie estimates.[7] In 2000, Europeans expended between 48 and 83 calories per

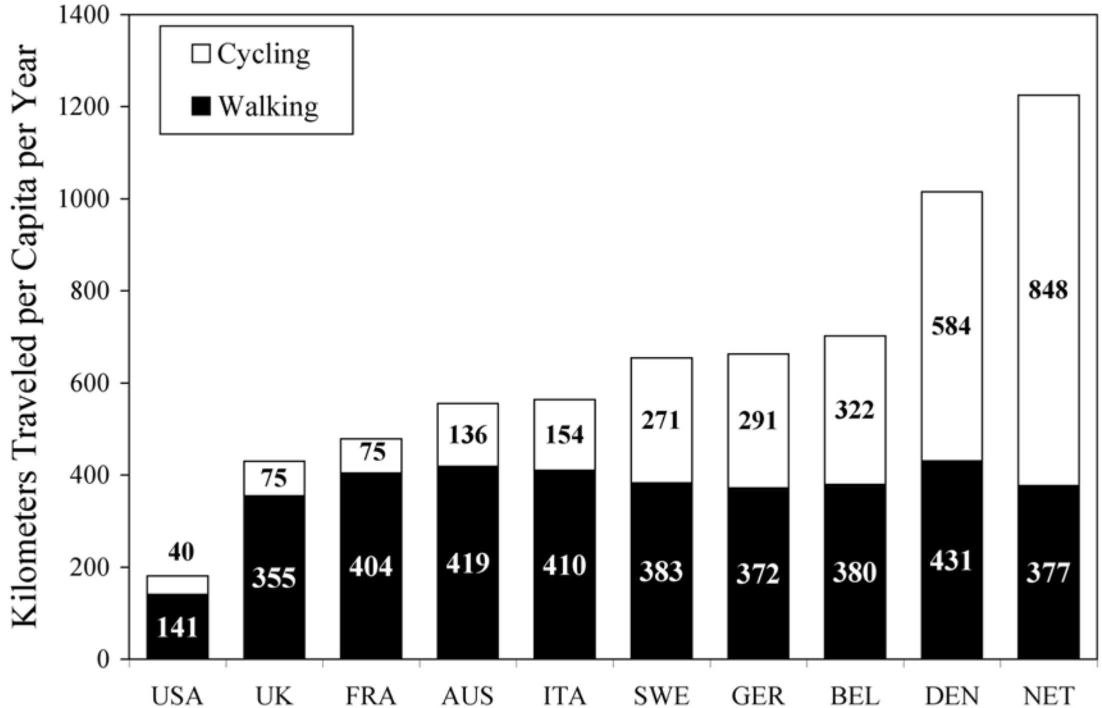

Figure 4 — Walking and cycling distances in selected European countries and the United States expressed in kilometers traveled per person per year in 2000. *Source:* European Commission's Directorate-General for Energy and Transport,[26] the Danish Ministry of Transport, and United States Department of Transportation.[46]

person per day in active transportation, compared with 20 calories per person per day in the United States (Figure 5).

The metabolic energy requirements for active transportation in Europe are roughly equivalent to oxidation of 5 to 9 lb of fat per person per year, compared with only 2 lb in the United States. Considering the substantial effects of daily travel mode choice, and the fact that adequate levels of physical activity are helpful in weight control,[27] it is reasonable to conclude that active transportation contributes to the lower rates of obesity seen in Europe. This conclusion is supported by longitudinal studies showing that habitual physical activity attenuates age-related weight gain. On the basis of such studies, DiPietro[28] has concluded that over decades, small reductions in excess weight gain accumulate into net savings that are quite significant in terms of obesity prevention.

Strengths and Limitations

The current study has both strengths and limitations. The main strength is that it provides a comprehensive, cross-sectional view of the link between active transportation and obesity prevalence. We used national surveys of travel and health behaviors, derived from representative samples of the residents of those countries, to establish that there is an inverse association between active transportation and obesity rates in developed nations on 3 continents.

The study also has several limitations. BMI, even if computed from clinical measures, is not the most accurate measure of adiposity. However, it is widely used in epidemiological research, and the World Health Organization recommends this method for population studies.[29] In addition, the obesity data and transportation data were not collected at precisely the same time, and the age range for participants varied.

Another limitation is that we were not able to control for other factors that could influence obesity rates. For instance, international differences in diet could contribute to obesity disparities. Unfortunately, energy intake cannot be readily compared among nations because of differences in the surveys and methods of analysis,[30] as well as the subjective nature of dietary recall. However, there is some evidence of differences in portion sizes between countries. For example, Rozin et al[31] found larger portion sizes in the United States compared with France. In our view, international differences in energy intake probably do exist, and this might be another factor contributing to disparities in obesity rates.

It is possible that differences in other physical activity domains (leisure-time, occupational, or domestic) could contribute to obesity disparities. However, just as in the case of energy intake, differences in physical activity surveys have hindered international comparisons. To our knowledge, there are no studies showing that differences in leisure-time, occupational, or domestic activity among developed nations are linked with differences in obesity rates. The International Physical Activity Questionnaire (IPAQ)[32] was recently developed to allow international comparisons, but the long form (which measures all physical activity domains) has not yet been widely adopted.

One final limitation is that we used aggregate data on transportation and obesity that were obtained from national surveys, rather than individual-level data.

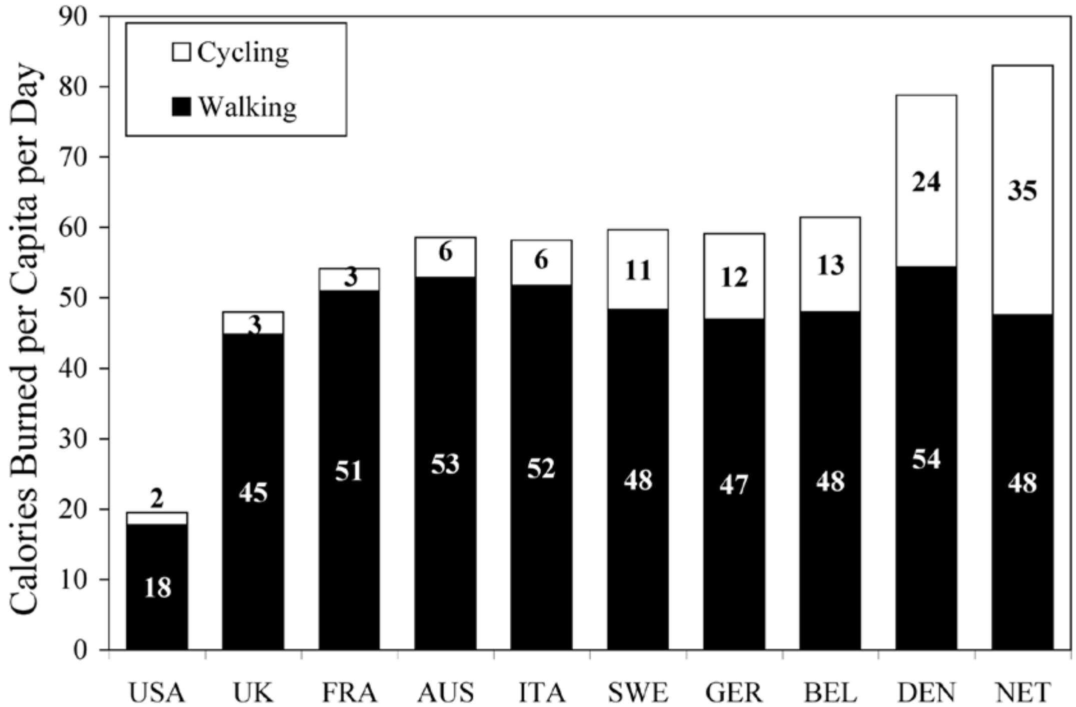

Figure 5 — Estimated energy expenditure by transportation-related walking and cycling in selected European countries and the United States in 2000, expressed as calories burned per person per day.

Thus, we did not show that *individuals* who engage in active transportation have a reduced likelihood of being obese. However, studies conducted in Sweden, the United States, and Australia have found that individuals who perform active transportation have a decreased odds ratio of obesity.[6,33,34] Thus, when considering all of these studies together, the relationship between active commuting and obesity appears to be quite strong.

Summary

Walking and bicycling are much more common in European nations than in the United States, Canada, and Australia. The current study shows that there is an inverse association between active transportation and obesity rates in these countries. These results do not necessarily indicate a causal relationship. However, given the fact that physically active individuals gain less weight over time,[28] it is possible that active transportation is one of the factors responsible for international differences in obesity rates. Future research should analyze to what extent walking and cycling infrastructure improvements, combined with expanded public transit systems, actually increase travel and, thus, provide additional physical activity that would help reduce obesity rates.

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