

Public Transportation and Health

ch. 3

TODD LITMAN, M.E.S.

Founder and Executive Director

Victoria Transport Policy Institute

Victoria, British Columbia



ABSTRACT >> *Improving public transportation service, encouraging its use, and integrating it into community development plans can make Americans healthier by reducing per capita automobile travel and associated risks, increasing walking and cycling activity, and improving mobility for disadvantaged people. Conventional transportation policies and planning practices tend to favor the automobile. Various reforms can help create more efficient and equitable transportation systems that, among other benefits, help improve public health. This paper investigates these issues, examines the role public transportation plays in an efficient and equitable transport system, and presents specific recommendations for transportation and land use policies to help achieve public health objectives.*

Public Transportation and Health

CONTENTS

Introduction	39
Public Transportation's Roles.....	39
Public Transportation Health Impacts.....	47
Traffic Crashes	47
Pollution Emissions	49
Physical Activity and Fitness	49
Community Cohesion	51
Mental Health Impacts	52
Basic Mobility.....	53
Policy Opportunities and Barriers	53
Recommendations.....	55
Convergence Opportunities	59
Conclusion.....	60

LIST OF ILLUSTRATIONS

Figures

1. Transit Commute Mode Split in Selected Cities	40
2. Cycle of Automobile Dependency and Sprawl	43
3. International Vehicle Travel Trends.....	44
4. Annual Change in Transit and Vehicle Travel	45
5. Transport Fatalities	46
6. Annual Traffic Death Rates	47
7. U.S. Traffic Deaths	48
8. Daily Walking Trips and Transit Travel	50
9. Mode Split vs. National Obesity Rates	52

Tables

1. Transit Level-of-Service Indicators.....	41
2. Personal Travel Mode Split of Various Countries	51
3. Scope of Conventional Planning Analysis	54
4. Healthy Transportation Policy Implementation	58

Introduction

Public transportation (also called *public transit* and *mass transit*) refers to various services using shared vehicles to provide mobility to the public, including buses, trains, and shared taxis. High-quality and affordable public transportation can help achieve various public health and equity goals by reducing traffic fatality rates, reducing air pollution emissions, increasing physical fitness, and improving nondrivers' access to elemental goods and services—fresh, healthy food and healthcare—and reducing financial burdens on low-income households. In addition, public transportation can bolster a community's quality of life by easing traffic congestion, energy costs, and pollution. Consequently, policies and investments that improve public transportation can be considered win-win strategies, providing diverse benefits and attracting broad support from a variety of interest groups.

However, current policies and planning practices fail to support public transportation to the degree justified by these benefits. Current evaluation practices overlook many benefits of public transportation, including many health benefits, and transportation financing systems provide inadequate funding. Without policy and planning reforms, public transportation will fail to provide its full potential benefits.

This paper examines the role public transportation plays in an efficient transportation system, the health benefits that can accrue from such a system, and models for creating a more equitable community by reforming transport policies and planning practices.

Public Transportation's Roles

Public transportation plays multiple roles in an efficient and equitable transportation system. It provides basic mobility for people who cannot use or access an automobile; it provides

efficient transportation on major urban corridors; and it serves as a catalyst for more compact, walkable communities, called transit oriented development.

Public transportation consists of:

- **Heavy rail**—relatively large, higher-speed trains, operating on separate rights-of-way, with infrequent stops, providing service between communities.
- **Light-rail transit**—moderate-size, medium-speed trains, operating mainly on separate rights-of-way, with variable distances between stations, providing service within an urban area.
- **Bus rapid transit**—bus systems with premium features, including grade separation, quick boarding, and frequent service.
- **Express commuter bus**—direct bus service from residential to employment areas.
- **Conventional urban bus transit**—medium- and full-size buses on fixed route, scheduled service.
- **Mini bus**—smaller buses or large vans used for public transportation.
- **Demand response paratransit**—small buses or vans that provide direct (door-to-door) service, often intended primarily for people with disabilities.

Each type of public transportation has its niche. Bus rapid transit and light-rail transit are the most appropriate on major urban corridors connecting large activity centers. Express commuter service is most appropriate on longer-distance commuter corridors with large employment centers (such as between suburbs and downtown). Conventional buses are most appropriate on urban and suburban roadways. Demand response is most appropriate in lower-density areas as well as for serving people with special needs.

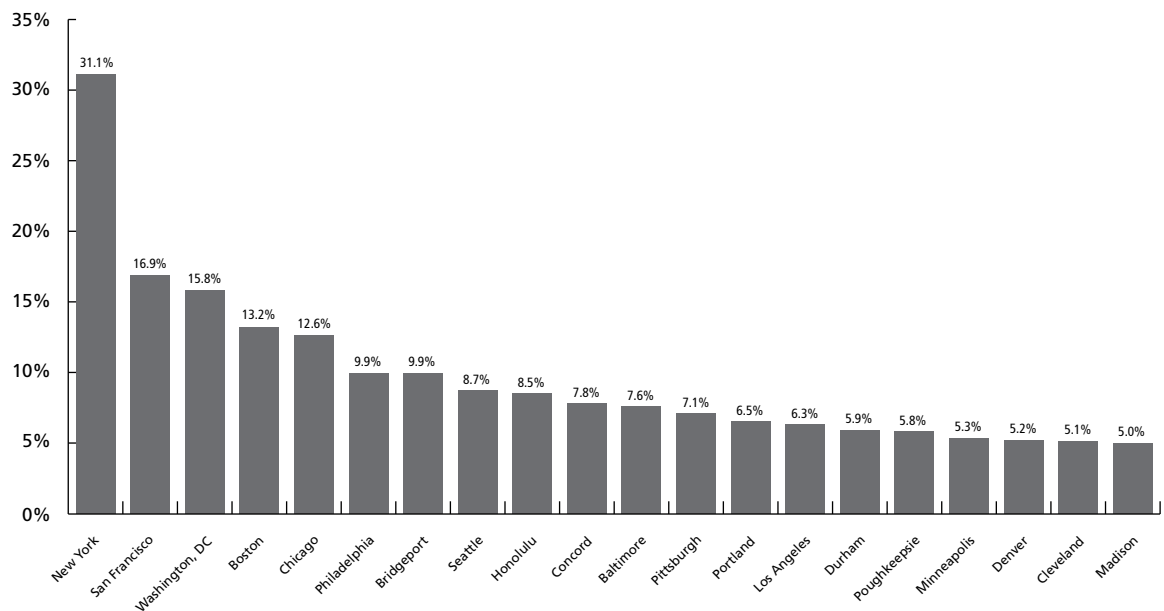
Public Transportation and Health

Although public transportation accounts for only a small portion of total travel in North America, it accommodates trips that are particularly important and costly to serve by other modes. In big cities, public transportation typically serves five to 15 percent of all commutes (figure 1) and as much as 20 to 60 percent of trips to major activity centers such as downtowns and university campuses. It provides mobility to people who are physically, economically, and socially disadvantaged and who would otherwise need to walk, bicycle, pay for a taxi, or simply not travel, sometimes to critical activities such as a doctor’s appointment, work, or school.

bus service that is convenient, fast, comfortable, and affordable) reduces automobile travel directly, by attracting travelers who would otherwise drive, and indirectly, by serving as a catalyst to help create more compact, walkable communities where residents drive less and rely more on alternative modes.² These indirect, or *leveraged*, impacts often produce bigger results: studies indicate that each passenger-mile traveled in quality public transportation reduces the number of automobile vehicle-miles traveled by two to nine automobile vehicle-miles.³ As a result, residents of communities with access to good public transportation systems tend to drive 20 to 40 percent fewer annual miles than they would if they lived in more automobile-dependent communities.⁴

High-quality public transportation (either rail or

Figure 1. *Transit Commute Mode Split in Selected Cities*¹



Although transit serves only a small portion of total travel, it serves a significant portion of urban trips.

Table 1. *Transit Level-of-Service Indicators*⁵

Feature	Description	Indicators
Availability	Where and when transit service is available	<ul style="list-style-type: none"> • Annual service-kilometers and service-hours per capita • Daily hours of service
Frequency	Frequency of service and average wait time	<ul style="list-style-type: none"> • Trips per hour or day • Headways (time between trips) • Average waiting times
Travel speed	Transit travel speed	<ul style="list-style-type: none"> • Average vehicle speeds • Transit travel speed relative to driving speed for the same trip
Reliability	How well service actually follows published schedules	<ul style="list-style-type: none"> • On-time operation • Portion of transfer connections made
Boarding speed	Vehicle loading and unloading speed	<ul style="list-style-type: none"> • Dwell time (time spent waiting at a stop or station) • Boarding and alighting speeds
Safety and security	Users' perceived safety and security	<ul style="list-style-type: none"> • Perceived transit passenger security • Number of accidents and injuries • Reported security incidents
Price and affordability	Fare prices, structure, payment options, ease of purchase	<ul style="list-style-type: none"> • Fares relative to average incomes • Fares relative to other travel mode costs • Targeted discounts or exemptions as appropriate • Payment options (cash, credit cards, etc.)
Integration	Ease of transferring between transit and other travel modes (bus, train, ferry, airport, etc.)	<ul style="list-style-type: none"> • Quality of transit service to transport terminals • Ease of accessing transit service information from transport terminals
Comfort	Passenger comfort	<ul style="list-style-type: none"> • Seating availability and quality • Space (lack of crowding) • Quiet (lack of excessive noise) • Temperature (neither too hot nor too cold) and air quality • Cleanliness
Accessibility	Ease of reaching transit stations and stops	<ul style="list-style-type: none"> • Transit oriented development • Distance from transit stations and stops to destinations • Walkability in areas serviced by transit
Baggage capacity	Accommodation of baggage	<ul style="list-style-type: none"> • Ability to carry onboard baggage, including special items such as pets • Ease and cost of carrying on baggage

Public Transportation and Health

Table 1 continued

Feature	Description	Indicators
Universal design	Accommodation of diverse users, including people with special needs	<ul style="list-style-type: none"> • Accessible design for transit vehicles, stations, and nearby areas • Accommodation for people with limited language ability
User information	Ease of obtaining user information	<ul style="list-style-type: none"> • Availability, accuracy, and understandability of route, schedule, and fare information • Real-time transit vehicle arrival information
Courtesy and responsiveness	Courtesy with which passengers are treated	<ul style="list-style-type: none"> • How passengers are treated by transit staff • Ease of filing a complaint • Responsiveness with which complaints are treated
Attractiveness	The attractiveness of public transportation facilities	<ul style="list-style-type: none"> • Attractiveness of vehicles and facilities • Attractiveness of documents and websites • Quality of nearby buildings and landscaping • Parks and recreational areas accessible by transit • Provision of public art
Marketing	Effectiveness of efforts to encourage using public transportation	<ul style="list-style-type: none"> • Popularity of promotion programs • Effectiveness at raising the social status of transit travel • Increase in public transportation ridership in response to marketing efforts

This table summarizes various factors to consider when evaluating public transportation services.

There are many ways to improve transit service and increase ridership (table 1). For instance, in the short-term, it is often possible to add new routes, increase service frequency, improve security, offer fare discounts, provide new amenities such as on-board refreshments and wireless Internet service (particularly for longer-distance express commuter service), and provide incentives such as parking cash out (offering commuters who currently receive subsidized parking the option of choosing its cash equivalent if they use alternative modes) and other rewards. In the medium-term, it is often possible to accelerate transit travel speeds,

increase reliability, improve stops and stations, provide real-time vehicle arrival information, upgrade vehicles for smoother and quieter rides, make trips more comfortable through better temperature control and fresh air, and provide park-and-ride facilities. In the long-term, it is often possible to create more transit oriented development so that more destinations (homes, worksites, and recreation and cultural centers) are located along major transit routes, with convenient pedestrian and bicycle access.

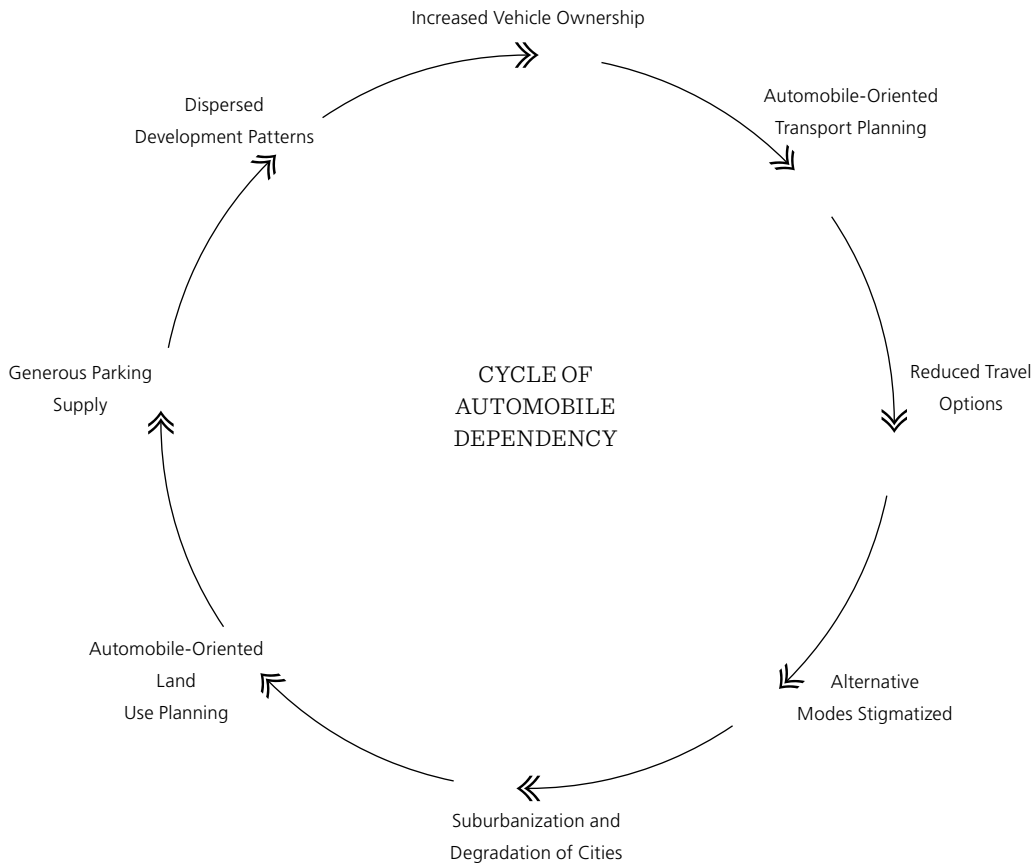
People sometimes mistakenly assume that these strategies are only feasible in large cities, but

some alternative modes are suitable for use in suburban and rural areas.⁶ These include ridesharing (car- and vanpooling), demand response transit (shuttle vans and buses that operate on flexible routes to provide door-to-door service in more dispersed areas), improved walking and cycling facilities (such as wider road shoulders and separated paths), telework (use of telecommunications as a substitute for physical travel, such as improving Internet networks and having more online public services in rural areas), and delivery services.⁷ Rural and suburban areas can become more accessible and multi-modal by encouraging village

development, where shops, public services, and housing (particularly for older adults and other nondrivers) are located close together and served by regional public transportation.

Improving and encouraging public transportation is a timely issue. During the past century, transportation planning focused primarily on cars, and transit systems were evaluated primarily in terms of automobile travel speed, affordability, and safety. Transportation improvements consisted primarily of building more roads and parking facilities. Planners barely considered other modes, which were

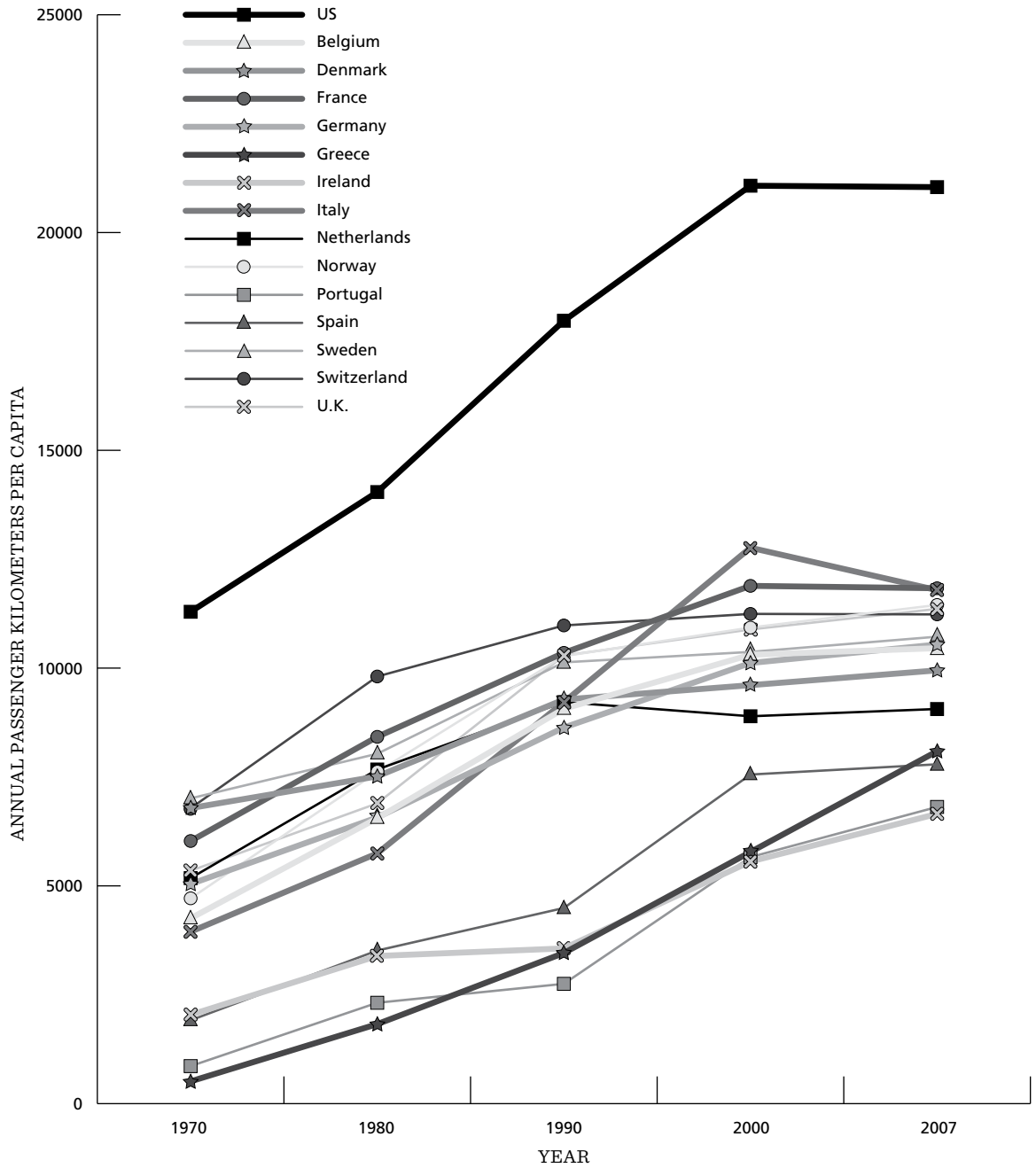
Figure 2. *Cycle of Automobile Dependency and Sprawl*



This figure illustrates the self-reinforcing cycle of increased automobile dependency and sprawl.

Public Transportation and Health

Figure 3. *International Vehicle Travel Trends*⁸



Per capita vehicle travel grew rapidly between 1970 and 1990 but has since leveled off in most OECD (Organizations for Economic Cooperation and Development) countries and is much lower in European countries than in the United States.

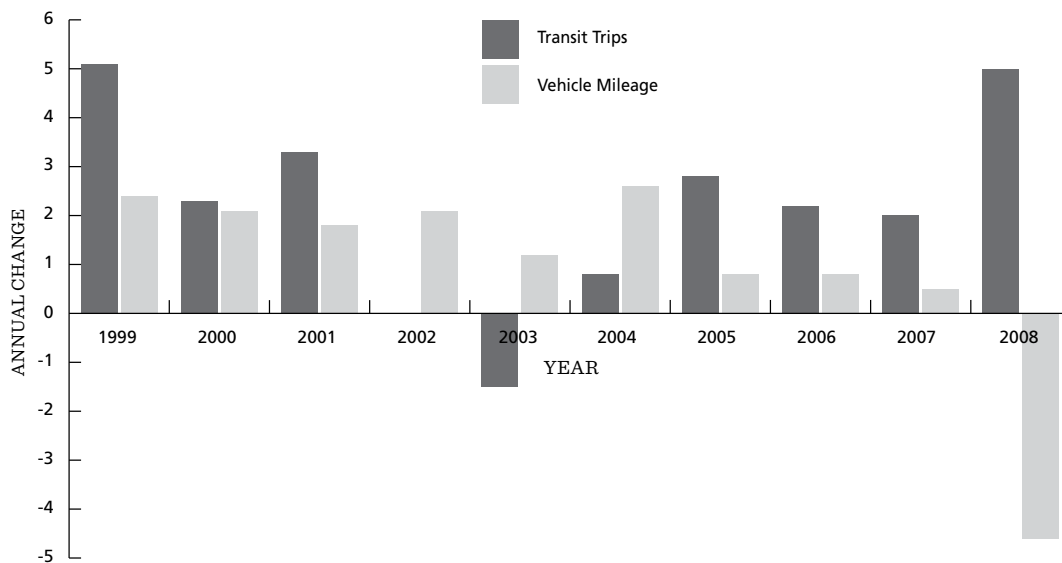
considered of declining relevance in a culture increasingly dependent on automobile travel. The result was a self-reinforcing cycle of increasing automobile dependency and sprawl, as illustrated in figure 2.

But per capita automobile travel has peaked and has recently started to decline slightly in most economically developed countries, as illustrated in figure 3.

These changes reflect demographic and economic trends that are reducing demands for automobile travel and increasing demands for alternative modes⁹:

- **Increasing health and environmental concerns.** Numerous individuals, organizations, and jurisdictions are now committed to reducing pollution and increasing physical fitness.
- **Aging population.** As the baby boom generation retires, per capita vehicle travel will decline and their demand for alternatives will increase.

Figure 4. *Annual Change in Transit and Vehicle Travel*¹⁰



Transit trips increased more than vehicle mileage during seven of the last 10 years.

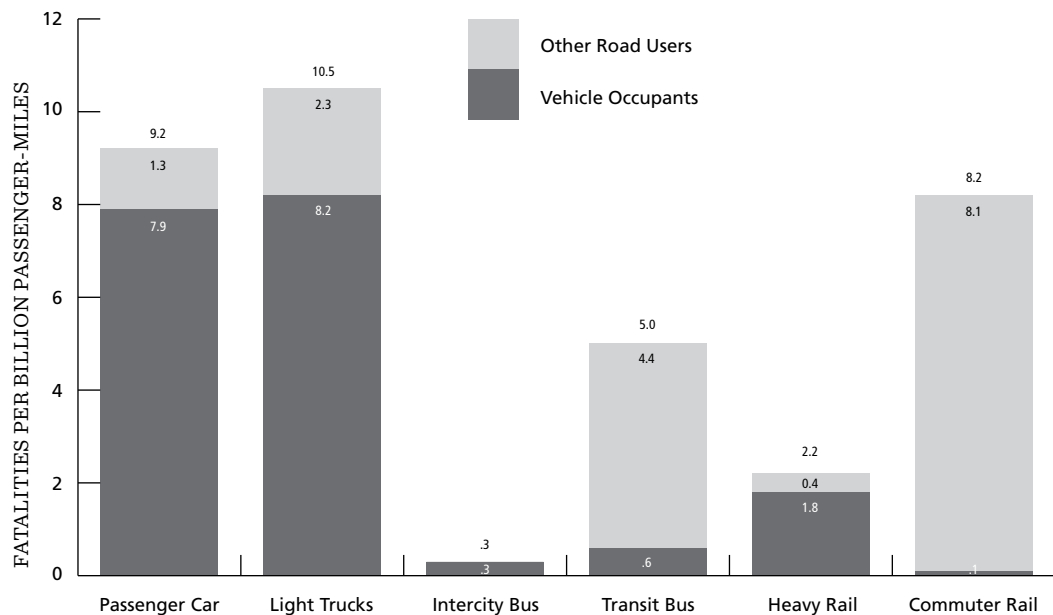
Note: Annual percent change in 2002 was zero. Therefore the chart does not include a visible bar for transit trips.

Public Transportation and Health

- Uncertain future fuel prices.** This uncertainty increases demand for energy-efficient travel options and more accessible, multi-modal locations for homes and businesses.
- Increasing urbanization.** An increasing portion of households are choosing to live in existing cities, and many suburbs are becoming more urbanized. This increases demand for urban modes (walking, bicycling, and public transportation).
- Increasing traffic congestion and roadway construction costs.** This increases the relative value of alternative modes that reduce congestion.
- Shifting consumer preferences.** Various indicators suggest that an increasing number of consumers prefer living in more densely populated urban neighbourhoods and using multiple modes of travel.

As a result of these shifts, public transportation travel grew more than automobile travel during seven of the last 10 years and each of the last four years, as illustrated in figure 4. During this period, transit travel increased 24 percent compared to a 10 percent increase in automobile vehicle miles traveled. Many transit systems now carry their maximum capacity during peak periods, constraining further growth. Increasing capacity and improving service quality would allow further growth in

Figure 5. *Transport Fatalities*¹³



Public transportation travel has lower crash rates than automobile travel, taking into account risks to all road users.

public transportation ridership and additional reductions in automobile travel.

There is also growing demand for housing in multi-modal communities.¹¹ The 2004 *American Community Survey* found that consumers place a high value on urban amenities such as shorter commute time and neighborhood walkability. Sixty percent of prospective homebuyers surveyed indicated that they preferred a neighborhood that offered sidewalks, a shorter commute, and amenities such as shops, restaurants, libraries, schools, and public transportation over more sparsely populated areas with larger lots but longer commutes and poorer walking conditions.¹²

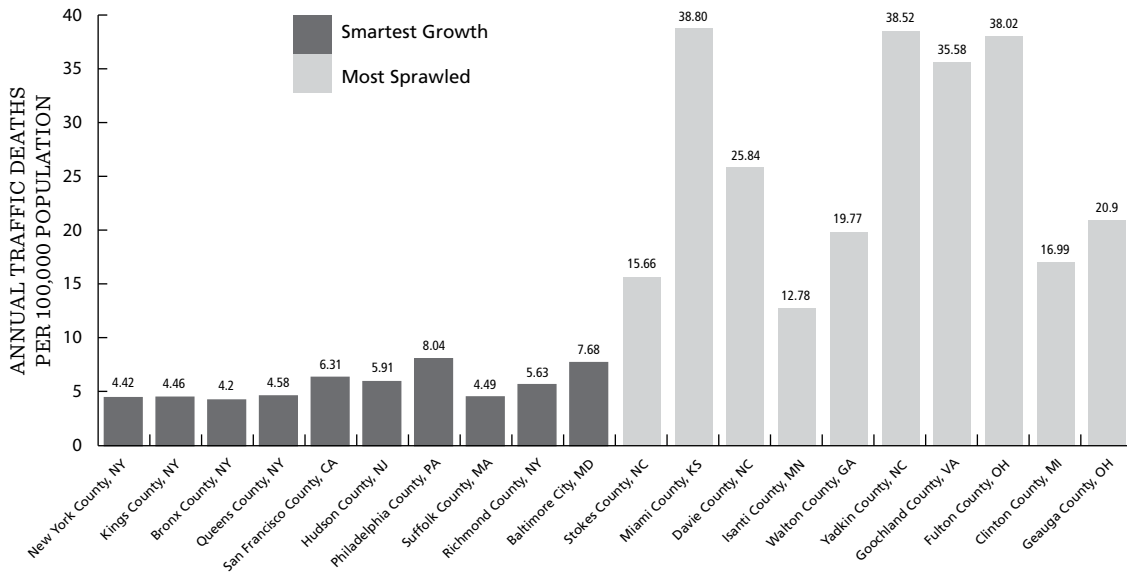
Public Transportation Health Impacts

This section describes ways that improving public transportation can help achieve health objectives.

Traffic Crashes

Public transportation is relatively safe, as indicated in figure 5. Transit vehicle occupants have about one-tenth the fatality rate as car occupants, and even considering the risk to other road users, public transportation causes fewer than half the total deaths per passenger-mile as automobile travel.

Figure 6. *Annual Traffic Death Rates*¹⁵



The smartest growth counties in the United States have one-fifth of the average per capita traffic fatality rate as the most sprawled counties.

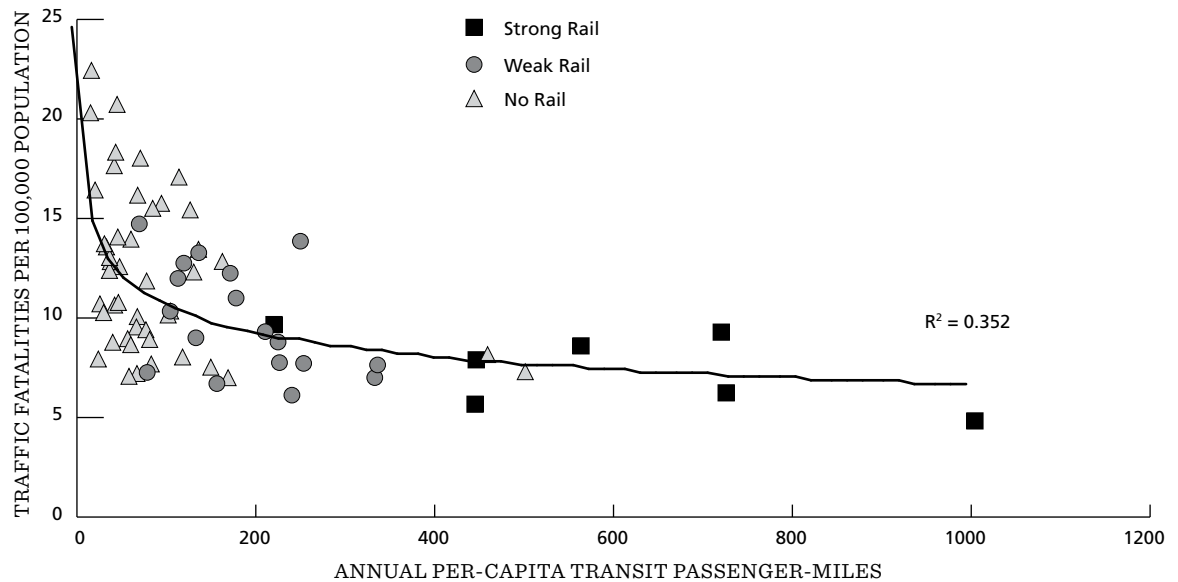
Public Transportation and Health

High-quality public transportation provides even greater safety benefits than indicated by these distance-based fatality rates because it tends to leverage additional reductions in per capita vehicle travel. People who live or work in transit oriented areas tend to drive less (due to more accessible, multi-modal community design), drive at lower traffic speeds (due to more compact development), and do less high-risk driving (for example, teenagers are less likely to have a driver's license and own a vehicle).¹⁴ As a result, such communities have about one-fifth of the total per capita traffic fatality rate as sprawled, automobile-dependent communities, taking into account all traffic deaths, including risks to pedestrians, bicyclists, and public transportation travelers (figure 6). Traffic deaths

are a subcategory of violent deaths and overall, urban residents have significantly lower rates of violent deaths, even taking into account homicide risk.¹⁶

Per capita traffic fatalities decline as transit ridership increases in a community, as indicated in figure 7. The reduction in per capita crash rates is much larger than the reduction in per capita mileage in these cities, reflecting the combined effects of various transportation and land use factors associated with transit oriented development that increase safety, as previously described.

Figure 7. *U.S. Traffic Deaths*¹⁷



Per capita traffic deaths (including transit and automobile occupants as well as pedestrians) tend to decline with increased transit ridership and are particularly low in cities with strong rail transit systems.

Pollution Emissions

A second category of transport-related health impacts involves vehicle pollution emissions, including tailpipe emissions; also included are emissions from fuel production and distribution (“upstream” emissions), hot soak (evaporative emissions that occur after an engine is turned off), and particulates from road dust, brake linings, and tire wear.¹⁸

Many factors affect vehicle pollutant human health impacts, including emission rates per vehicle mile, per capita mileage, and exposure (the number of people located in areas where emissions are concentrated). Motor vehicle air pollution is estimated to cause a similar order of magnitude of total premature deaths as traffic crashes, although the victims tend to be older; thus air pollution causes smaller reductions in Potential Years of Life Lost (PYLL) than traffic crashes.¹⁹

Public transportation tends to produce less pollution per passenger-mile, particularly electric-powered trains and newer buses with state-of-the-art engines. And, as previously discussed, transit oriented development tends to reduce automobile travel and, therefore, emissions. On the other hand, older diesel buses tend to have high emission rates; public transportation tends to concentrate activity close to roadways; and bus depots are often located in low-income communities. Consequently, in some situations, increased transportation service and transit oriented development may *increase* human exposure to harmful air pollutants such as particulates and carbon monoxide unless implemented with bus emission reduction programs.

Physical Activity and Fitness

Another category of health impacts concerns the effects transport has on physical activity and fitness.²⁰ Public health officials have become increasingly alarmed about declining physical fitness, increasing body weight, and

resulting increases in diseases associated with a sedentary lifestyle.²¹ There are many ways to be physically active, but many, such as team sports and gym exercise, require special time, skill, and expense, which discourage consistent, ongoing participation. Many experts believe that increasing community walking and bicycling (together called “active transportation”) are the most practical ways to improve public fitness, particularly for vulnerable populations—children, older adults, and people with low incomes who may be unable to participate in structured exercise programs due to financial and time constraints.²²

Public transportation and active transportation tend to be complementary: most public transportation trips involve walking links; transit oriented development includes walking and biking improvements; and efficient transit systems incorporate amenities such as bike racks on buses and bike lockers at transit stations.²³ As a result, increased transit travel tends to increase physical activity.

The National Household Travel Survey (NHTS) indicates that people who use public transportation on a particular day spend a median of 19 minutes daily walking to and from transit, and 29 percent achieve 30 minutes of physical activity during transit access trips—much higher than the rates by nontransit users.²⁴ Using pedometers and surveys to track walking activity, Wener and Evans found that train commuters walked an average of 30 percent more steps daily, more frequently reported walking for 10 minutes or more, and were four times more likely than automobile commuters to achieve the 10,000 steps daily recommended for fitness and health.²⁵

Similarly, a travel survey conducted in Atlanta, GA, found that public transportation users are more likely to walk, to walk longer average distances, and to meet recommended physical activity targets by walking than nontransit users.²⁶ The study revealed that the chance a person meets minimum walking targets (2.4

Public Transportation and Health

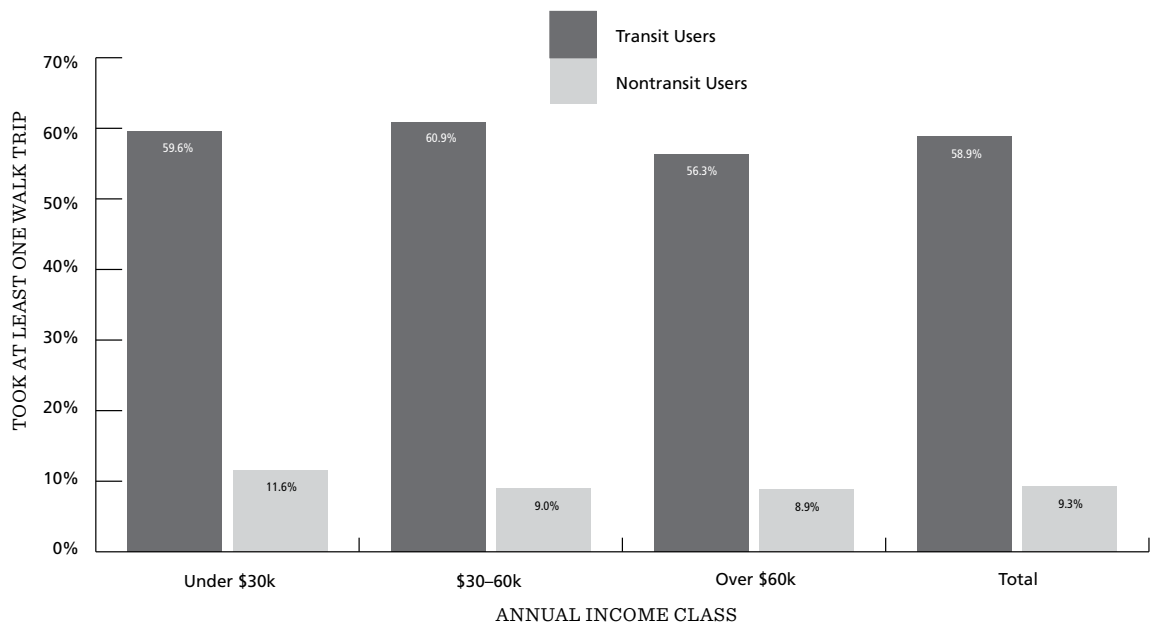
kilometers walked daily) increases by 3.87 for each transit trip taken and is 2.23 times greater for commuters who use an employer-sponsored public transportation pass. Public transportation travel increased walking activity for all income classes, as illustrated in figure 8, indicating that encouraging transit travel can support public health for a variety of demographic groups.

Residents of transit oriented communities tend to walk more and have lower rates of obesity and hypertension than residents in sprawled areas. A recent study collected transportation mode split and obesity rate data for various economically developed countries, as summarized in table 2 and figure 9. Two important points are illustrated: travel

patterns are highly variable, even among similar countries, and national obesity rates tend to be inversely related to rates of active transportation (walking and biking), suggesting that transport policy affects public fitness and health.

As a result, policies and planning practices that support public transportation tend to increase public fitness and health. Sturm estimates that shifting from a sprawled area such as San Bernardino, CA, to a areas which reflect smart growth principles such as Boston, MA, reduces chronic medical conditions about 16 percent, with greater reductions for older adults and low-income people because they tend to be most sedentary.³⁰

Figure 8. *Daily Walking Trips and Transit Travel*²⁷



Public transportation users are much more likely to take walking trips and walk much farther than nontransit users.

The total health costs that result from inadequate physical activity are far greater than those from traffic crashes. Cardiovascular diseases cause about 10 times the loss in productivity as do road crashes, and sedentary living contributes to a variety of other health problems—hypertension, non–insulin-dependent diabetes, colon cancer, osteoarthritis, osteoporosis, and probably depression. Even modest reductions in these illnesses could provide large health benefits. However, it is difficult to determine how a particular transportation policy will affect these diseases overall because it depends on the ability of otherwise sedentary people to increase their physical activity. The Health Benefits Economic

Model provides a methodology for valuing the health benefits of more active transportation.³¹

Community Cohesion

Community cohesion refers to the quantity and quality of positive interactions among residents in a local community.³² It affects human health in various ways, including the mental health benefits of friendly social interactions and the health benefits of increased neighborhood security.³³ Although many demographic and geographic factors affect neighborhood interactions, cohesion tends to increase with walkability and local services.³⁴ High-quality public transportation and transit oriented

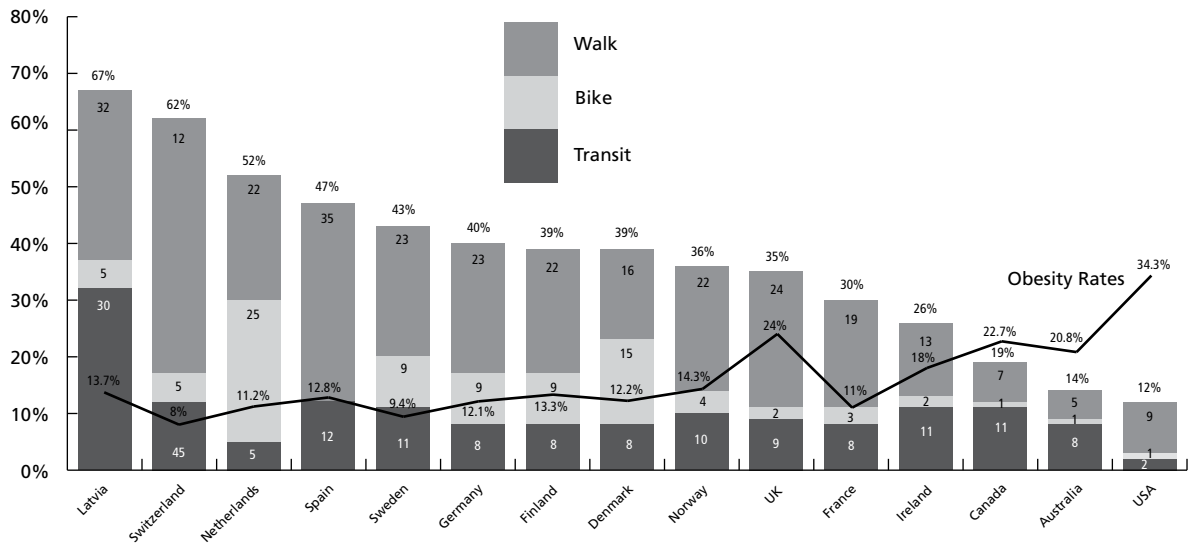
Table 2. *Personal Travel Mode Split of Various Countries*²⁸

Country	Year	Transit	Bike	Walk	Obesity Rates*
Latvia	2003	32%	5%	30%	(13.7%*)
Switzerland	2005	12%	5%	45%	8%
Netherlands	2006	5%	25%	22%	8.1% (11.2%*)
Spain	2000	12%	N/A	35%	12.8%
Sweden	2006	11%	9%	23%	9.4%
Germany	2002	8%	9%	23%	12.1%
Finland	2005	8%	9%	22%	13.3%
Denmark	2003	8%	15%	16%	12.2%
Norway	2001	10%	4%	22%	14.3%*
U.K.	2006	9%	2%	24%	24%*
France	1994	8%	3%	19%	11%
Ireland	2006	11%	2%	13%	18%
Canada	2001	11%	1%	7%	15.2 (22.7%*)
Australia	2006	8%	1%	5%	16.2% (20.8%*)
U.S.	2001	2%	1%	9%	34.3%*

* Combined male and female obesity prevalence based on body mass index (BMI). Values in parentheses are from national health examination surveys. Other values are based on self-reported weight and height.

Public Transportation and Health

Figure 9. *Mode Split vs. National Obesity Rates*²⁹



This data set indicates that transportation mode split is highly variable, even among economically developed countries, and national obesity rates are inversely related to rates of active transportation (walking and bicycling).

development can increase community cohesion by creating opportunities for residents to interact while walking, waiting at transit stops, and riding on transit vehicles. Further, they reduce total automobile traffic, which improves the public realm, for example, by reducing traffic noise on sidewalks and front yards.³⁵ This can increase connections and contacts among dissimilar groups, helping to bridge social distance and widening opportunities by introducing disadvantaged children to more affluent families and broadening the pool of role models and mentors available to low-income youths.³⁶ Long-term social and economic benefits can result by increasing educational and

employment opportunities and reducing crime and dependence on social assistance.

Mental Health Impacts

Public transportation improvements such as increased service, improved climate control, more comfortable waiting conditions, and improved service reliability can improve mental health by reducing physical and emotional stresses (crowding, fear, and frustration), increasing affordability (and therefore reduced financial stress), influencing access to education and employment activities (and therefore long-term economic opportunities), and helping

to create more walkable communities, which increases physical activity and fitness.³⁷ With high-quality service, many commuters find public transportation less stressful than driving.³⁸ These mental health benefits are difficult to quantify but potentially large.

Basic Mobility

Basic mobility refers to people’s ability to access services and activities that society considers *basic* or *essential*, including medical and dental services, food and other basic goods, banking, education, and employment opportunities.³⁹ Basic mobility is important for physical and mental health and is a critical equity objective. Public transportation provides basic mobility and accessibility, including access to medical services, affordable and healthy food, education, and employment. Inadequate transport options can result in patients missing appointments, which can exacerbate medical problems and waste medical resources, or force patients or medical service providers to pay for more costly transport services such as taxis.⁴⁰ One survey found that four percent of U.S. children (3.2 million in total) either missed a scheduled healthcare visit or did not schedule a visit during the preceding year because of transportation restrictions.⁴¹ Although it is difficult to quantify the ultimate health benefits from basic mobility provided by public transportation, anecdotal evidence suggests that these impacts can be significant.

Policy Opportunities and Barriers

As noted, alternative modes—walking, cycling, and public transportation—can provide many economic, social, and environmental benefits. Yet current policy analysis and planning practices tend to undervalue alternative

modes and thus provide less support for and investment in them than is optimal.⁴² Some specific ways that alternative modes are undervalued are described below.

Conventional transportation planning analysis tends to focus on a limited set of impacts and objectives and overlooks others, as summarized in table 3. The impacts that conventional planning focuses on most—travel speed, congestion, and vehicle operating costs—tend to favor automobile transportation. Many benefits of public transportation, such as basic mobility for nondrivers and parking cost savings, are generally overlooked in conventional policy and planning analysis. Some of these omissions reflect the difficulty of quantifying impacts such as equity and sprawl costs, but others (parking costs and mileage-based depreciation, for example) are ignored simply out of tradition.

For example, when comparing highway expansion projects with public transportation improvements, conventional planning generally ignores the effects of generated traffic (the additional peak-period vehicle travel that results if congested roads are expanded), additional downstream congestion (additional traffic on surface streets), parking costs, vehicle ownership costs, traffic accidents, energy consumption, and pollution emissions—all costs that can be reduced if improved service allows the same trips to be made by public transportation. In addition, conventional analysis assumes that everybody (or, at least, everybody who matters) has a vehicle and can drive and thus assigns no explicit value to improving mobility for nondrivers.

Conventional analysis assigns no value to the fitness, health, and enjoyment benefits of increased walking and cycling activity⁴⁴; conventional planning analysis would recognize

Public Transportation and Health

the value of a motor vehicle trip to a gym to allow passengers to exercise on a treadmill, or to a park to walk or bike on public paths, but would not recognize the value of being able to walk or bike, rather than drive, for local errands.

Conventional planning tends to evaluate transport system performance based on the speed, convenience, and affordability of automobile travel, using indicators such as roadway level of service, average traffic speeds, congestion delay, parking supply per 1,000 square feet of building floor area, crash risk per 100 million vehicle-miles, and vehicle operating costs (particularly fuel costs). Comparable indicators are not usually provided for alternative modes, so it is more difficult to identify walking, cycling, and public transportation problems

as well as opportunities to improve these modes. For example, urban transportation models are often used to produce maps that show roadway congestion delays, indicated by roadway level-of-service grades from A to F, but no comparable indicators are provided for walking, cycling, and public transportation problems, putting these modes at a competitive disadvantage for investment.

This type of analysis often implies that public transportation investments are not cost effective, but this results, in part, from biases in conventional traffic models that tend to exaggerate the benefits of highway expansion and understate the benefits of improving alternative modes, particularly high-quality public transportation.

Table 3. *Scope of Conventional Planning Analysis* ⁴³

Usually Considered	Often Overlooked
Financial costs to governments	Downstream congestion impacts
Travel speed (reduced congestion delays)	Generated traffic impacts
Vehicle operating costs (fuel, tolls, tire wear)	Nondriver mobility, convenience, and comfort
Per-mile crash risk	Transportation diversity value (e.g., mobility for nondrivers)
Project construction environmental impacts	Parking costs
	Vehicle ownership and mileage-based depreciation costs
	Project construction traffic delays
	Total energy consumption and pollution emissions
	Strategic land use objectives
	Per capita crash risk
	Impacts on physical activity and public health
	Some travelers' preference for transit (lower travel time costs)

Conventional transportation planning tends to focus on a limited set of impacts, exaggerating the benefits of highway expansion and undervaluing transit improvements.

Transportation financing is also biased in favor of roadway improvements. A major portion of transportation funding is legally or practically restricted to automobile facilities and cannot be used to improve public transportation services, even when such improvements are more cost effective and beneficial overall.⁴⁵ Thirty of the 50 states have constitutional amendments that limit fuel tax revenue to be spent only on highways, and most zoning codes require developers to provide generous amounts of vehicle parking—a large subsidy of driving that is difficult to convert into transit subsidy, even if preferred by some travelers (a concept called *parking cash out*). More neutral financing (sometimes called *least cost planning*) tends to increase funding for alternative modes and mobility management strategies.

Current transportation markets are further distorted in favor of automobile travel by underpricing. Although automobiles are expensive to own, they are relatively cheap to drive because most of the costs are either fixed or external. This gives motorists an incentive to drive more annual miles than optimal. An efficient transportation market would require increased road, parking, and fuel prices, along with distance-based insurance and registration fees, which would significantly increase the marginal cost of driving, particularly under urban peak conditions.

Together, these planning and market distortions increase automobile travel beyond what is economically optimal, reduce use of alternative modes, and stimulate more dispersed, automobile-oriented land use development. Described differently, with more optimal transport planning and pricing, consumers would choose to drive less, rely more on alternative modes, select more multi-modal communities, and be better off overall as a result.⁴⁶ Although it is difficult to predict the exact magnitude of these changes, they are likely to be large, particularly over the long-term.

Recommendations

Various transportation policy and planning reforms can improve public safety, fitness, and health by creating more efficient and multi-modal transportation systems where people drive less and rely more on alternative modes.⁴⁷ Improved public safety, fitness and health are just three of many possible justifications for these reforms: they would help solve a variety of transportation problems, they reflect market principles and so increase economic efficiency, and they respond to changing consumer demands.⁴⁸

The following are specific policies and planning strategies that can help create more diverse, more efficient, and healthier transportation systems:

- **Educate decision makers** concerning the relationships among transportation, land use, and public health; the full benefits of a more diverse, less automobile-dependent transportation system; and the trends that are changing future travel demands and strategic objectives.⁴⁹ These all tend to increase the value of alternative modes, mobility management solutions, and smart growth land use development.
- **Create a strategic vision** of a more efficient and diverse transportation system and supportive land use development to accommodate changing demands and planning objectives, including public health objectives. This vision, which should be created by the federal government, should guide individual transportation and land use policies and planning practices, such as how transportation system quality is evaluated and how transportation funding is allocated.
- **Increase public transportation funding for capital and operation costs.** Transportation funding practices that currently favor investments in roads and parking facilities should be changed to allow significant new investments

Public Transportation and Health

in public transportation. For example, economic stimulation and other economic development funds should be invested in public transportation. Transportation funds currently dedicated to roadways should be spent on public transportation improvements whenever it is more cost effective overall, taking into account *all* benefits and costs. Similarly, resources currently spent by governments and developers on parking facilities should be reinvested in public transportation whenever it is a cost-effective way to provide access. New funding sources should be developed to help finance public transit improvements, including parking taxes, congestion pricing, local property taxes, land value capture, and dedicated sales taxes.⁵⁰ Higher levels of government (federal and state) should provide grants that leverage additional regional and local match funding. Regional and local governments must create stable sources of transit funding through dedicated fuel, sales, property, and parking taxes.

- **Improve public transportation affordability.** Insure that public transit services are affordable, particularly for lower-income users. This may include targeted discounts and exemptions, and research to identify better ways to meet the mobility needs of economically, physically and socially disadvantaged people.
- **Establish transportation and land use** policies that support *transit oriented development* so that more people are able to live and work in areas with high-quality public transportation services, good walking and biking conditions, compact and mixed land use development, and other supportive features.
- Implement transportation and land use policies that **increase housing affordability** in transit oriented communities.⁵¹ This includes changing development practices to encourage development of more compact and *diverse* housing types (small-lot single-family, townhouses, multi-family, etc.) with

unbundled parking in transit-rich, walkable areas with mixed land use and appropriate public services (schools, shops, parks, etc.), and employment.⁵² Public infrastructure investments and housing subsidies should be structured to support these objectives.

- **Improve walking and bicycling conditions** and promote active transportation. Encourage transportation professionals to recognize the importance of walking as a transport mode and to develop tools for evaluating the full benefits of improved walking and biking conditions and increased active transportation. Improve walking and bicycling access to transit stops and stations. Have bike racks on buses and trains, *bike parking* at stations, and bike rental services. Promote “walk and bike to school” and community walking and cycling events.
- Work to **integrate affordable housing and affordable transportation** so that physically, economically, and socially disadvantaged households can live in accessible, multi-modal communities. This requires a suitable mix of housing (affordable and subsidized housing included), public services (stores, medical and dental clinics, schools, parks, etc.), and high-quality public transportation located within convenient walking distance, with universal design features to ensure that everybody (including people using wheelchairs, walkers, pushing strollers, and hand carts) can easily travel to common destinations.
- Develop and apply **multi-modal level-of-service standards** to evaluate the service quality of various modes, including walking, biking, public transportation, taxi, car-sharing, and telecommunications within a community. Transportation agencies and professionals should use these to identify mobility and accessibility problems, particularly for the most vulnerable populations (children, older adults, people with disabilities, people with low incomes, immigrants, etc.).



- Apply **least-cost planning** so that transportation improvement resources (public funds and land) are invested in the most cost-effective improvements and consider all impacts and objectives, including public health objectives. Allow funds currently dedicated to roads and parking to be used for alternative modes and management strategies when they are more beneficial overall or support strategic planning objectives.
- Implement **mobility management strategies and programs** that encourage the use of alternative modes, such as efficient road and parking pricing, distance-based vehicle fees, and commute-trip reduction programs. Implement these in conjunction with transit service improvements.
- Develop and apply more **comprehensive transportation planning tools** for evaluating transit service quality, transportation affordability, basic mobility, equity, affordability, and public health impacts.
- Sponsor research to **improve public transit vehicles** so that they are quieter, smoother, more spacious, climate controlled, less polluting, and easier to board; they should accommodate people with disabilities and offer amenities such as wireless Internet service. Give transit priority in traffic (bus lanes and signal control systems).
- Sponsor research and development to **improve transit stops and stations** so that they are more spacious, more comfortable, and safer; they should include amenities such as washrooms and refreshments.
- Develop **convenient, integrated fares** (for example, one payment system that can be used on various public transportation systems within a region) using electronic payment systems.
- Improve **transit user information and marketing**, such as real-time vehicle arrival signs, better-way finding, and culturally appropriate promotion programs.
- Apply **more efficient parking management**, such as efficient sharing, regulation, and pricing of parking facilities. Apply more flexible and reduced minimum parking requirements in transit oriented areas, particularly to increase housing affordability.
- **Build coalitions** involving public health and safety advocates and other interest groups that can benefit from transportation policy and planning reforms creating more efficient and diverse transportation systems—existing transit and community advocacy groups, transportation professionals, environmental organizations, local public officials, and economic development advocates. Use these coalitions to create the political support needed to achieve this vision.

Public Transportation and Health

Table 4. *Healthy Transportation Policy Implementation*

Reforms and Actions	Leaders	Federal Legislative Role
Educate decision makers	Professional and advocacy organizations	Support policy analysis, research, and information sharing
Create a strategic vision	All levels of government; professional and advocacy organizations	Establish a national vision and encourage other levels of government to develop complementary visions
Increase public transportation funding	All levels of government	Change transport funding to support public transportation, increase federal funding for public transportation programs, and use federal policies to leverage funding by other levels of government
Insure public transport affordability	All levels of government	Provide funding, research and other support to insure that transit service is affordable and responds to the needs of disadvantaged people.
Support transit oriented development	All levels of government; transportation and land use planning agencies and professions	Change transport and land use policies to support transit oriented development and smart growth
Improve walking and cycling conditions	All levels of government; transportation and land use planning agencies and professions	Change transport funding and planning practices to support active transportation and walkable community development
Integrate affordable housing and affordable transportation	All levels of government	Change transport and housing policies to support development of affordable housing in transit oriented areas
Apply multi-modal level-of-service standards	All levels of government; transportation agencies and professions	Change transport funding and planning practices so they are based on multi-modal performance evaluation
Apply least-cost planning	All levels of government; transportation agencies and professions	Change transport funding and planning practices to allow alternative modes and mobility management strategies to be funded whenever they are most cost effective, considering all impacts and objectives
Implement mobility management strategies and programs	All levels of government; transportation agencies and professions	Change transport funding and planning practices to support mobility management whenever it is cost effective, considering all impacts and objectives; support pricing reforms such as increased fuel taxes, road pricing, and distance-based insurance and registration fees

Reforms and Actions	Leaders	Federal Legislative Role
Develop more comprehensive transportation planning tools	All levels of government; transportation agencies and professions	Support research for more comprehensive transport planning tools
Improve transit vehicles	Vehicle engineers, manufacturers, transit agencies, and governments	Support research; develop procurement guidelines
Improve transit stops and stations	All levels of government; transportation and land use planning agencies; private companies; and developers	Support innovative design and business models; support transit oriented development
Develop convenient, integrated fares	Regional governments and transit agencies	Support research, design, and implementation
Improve transit user information and marketing	Regional governments and transit agencies	Support research, design, and implementation
Apply more efficient parking management	All levels of government; transportation and land use planning agencies; private companies; and developers	Support transit oriented development and smart growth; provide incentives for local and regional governments to implement parking management
Build coalitions	Professional and advocacy organizations	N/A

This table indicates how various stakeholders can help implement transportation policy reforms to improve public fitness and health. Public transit improvements can play a key role in many of these strategies.

Implementing these reforms will require action by various stakeholders, including federal, state, regional, and local governments, as well as diverse interest groups and advocates. Federal legislation can help support many of these reforms and actions by providing guidance and incentives. Such leadership and guidance can significantly accelerate the implementation of these reforms and avoid conflicts between existing and desired transportation policies. Table 4 indicates the level of government,

organization, or interest group that can provide leadership for implementing these recommendations and outlining the role of federal legislation.

Convergence Opportunities

Many interest groups and organizations with a wide range of objectives and perspectives have reasons to support policies to create a more efficient and diverse transportation system.

Public Transportation and Health

This diverse interest offers an opportunity to build broader support for transit investments and supportive transportation and land use policies. For example, this is an ideal time to create collaborations among existing public transportation and community advocacy groups (wanting to achieve equity objectives), transportation professionals (wanting to reduce problems such as traffic and parking congestion), environmental organizations (wanting to reduce energy consumption, pollution emissions, and land use damages), local public officials (wanting to support urban redevelopment), senior advocacy groups (wanting to improve mobility options for nondrivers, to increase affordability, and to provide practical ways for older Americans to safely exercise), and health professionals (wanting to improve public fitness and health).

To fully achieve the potential benefits of high-quality public transportation, these diverse interest groups will need to overcome cultural and practical barriers. For example, correcting existing policy and planning biases that favor mobility over accessibility and automobile transportation over other modes will probably require a combination of professional education, planning agency reforms, and political advocacy to change laws and funding practices. No single interest group can achieve all these changes, but a collaborative effort can succeed.

Public transportation improvements can play a much greater role in creating a more diversified and efficient transportation system than indicated by its relatively modest share of total travel. High-quality public transportation often provides a catalyst for creating a more diverse transportation system and accessible, multi-modal land use development. Public transportation travel both supports and is supported by walking and biking trips. As a result, public transportation improvements can leverage large reductions in automobile travel and increases in walking and cycling activity.



The involvement of health professionals can significantly improve the chances for success because they can contribute a new sense of urgency, expertise, and leadership into transportation and land use policy reform debates. Previous public health successes, such as reduced tobacco use and increased breastfeeding, can provide models.

Conclusion

Transportation planning decisions impact public health in various ways: by affecting traffic risk, pollution exposure, physical activity and fitness, community cohesion, mental health, basic mobility, and affordability. Communities where people drive less and rely more on alternative modes are healthier places to live and work, particularly for physically, economically, and socially disadvantaged people. Transportation policy and planning reform improvements can play a significant role in creating healthier communities. High-quality public transportation (convenient, comfortable, frequent, fast, reliable, and safe) provides significant direct benefits when people shift from automobile to transit for individual trips. It provides even larger indirect benefits by providing a catalyst for development of more accessible, multi-modal communities where people own fewer



automobiles; drive less; and rely more on walking, biking, and public transportation for utilitarian trips and recreation.

This is a timely issue. Current demographic, economic, and market trends are reducing the demand for automobile travel and increasing the demand for alternative modes. This is not to suggest that Americans will give up driving altogether; but at the margin, that is, relative to current travel patterns, many people would prefer to drive less and rely more on alternative modes, provided that these alternatives are convenient, comfortable, safe, and affordable. This means that many consumers will choose healthier transport habits if given appropriate options, including high-quality public transportation and accessible, multi-modal communities.

Current transportation and land use planning practices favor automobile transportation and undervalue alternative modes and smart growth development. Various transportation policy and planning reforms can help achieve public health and social equity objectives by helping to create more diverse and efficient transportation systems. More comprehensive analysis is needed that accounts for the additional indirect costs of policy and planning decisions that increase automobile travel and sprawl and the additional indirect benefits of more compact, walkable, and transit oriented communities. Current funding is inadequate, causing public transportation service quality to decline and fares to increase in many communities. Budgeting practices must be reformed to provide adequate, reliable funding to ensure high-quality and affordable public transportation services. Land use development policies should change to better support smart growth and reduce sprawl.

These reforms are justified for a number of reasons, due to the diverse economic, social, and environmental benefits provided by public transportation improvements. When all impacts are considered, improving public transportation may be among the most cost-effective ways to improve public health, and improving public health is one of the best reasons to improve public transportation.

Chapter 2: Transportation Authorization 101: A Backgrounder

- ¹ Federal Highway Administration, *Safe Routes to Schools Program Factsheet*, <http://www.fhwa.dot.gov/safetealu/factsheets/saferoutes.htm>.
- ² American Public Health Association, *At the Intersection of Public Health and Transportation: Promoting Healthy Transportation Policy*, <http://www.apha.org/NR/rdonlyres/43F10382-FB68-4112-8C75-49DCB10F8ECF/0/TransportationBrief.pdf>.
- ³ Northeast-Midwest Institute, *What is the Highway Trust Fund?*, <http://www.nemw.org/HWtrustfund.htm>.
- ⁴ Federal Highway Administration, *Surface Transportation Program Factsheet*, <http://www.fhwa.dot.gov/safetealu/factsheets/stp.htm>.
- ⁵ Federal Transit Agency, *Large Cities Program* (5307), http://www.fta.dot.gov/funding/grants/grants_financing_3561.html.
- ⁶ Federal Highway Administration, *Highway Safety Improvement Program Factsheet*, <http://www.fhwa.dot.gov/safetealu/factsheets/hsip.htm>.
- ⁷ Federal Transit Agency, *Jobs and Reverse Commute Program*, http://www.fta.dot.gov/funding/grants/grants_financing_3550.html.
- ⁸ Federal Transit Administration, *New Starts Factsheet*, http://www.fta.dot.gov/planning/newstarts/planning_environment_2607.html.
- ⁹ Surface Transportation Policy Partnership, *From the Margins to the Mainstream*, http://www.transact.org/PDFs/margins2006/STPP_guidebook_margins.pdf.
- ¹⁰ Ibid.

Chapter 3: Public Transportation and Health

- ¹ U.S. Census Bureau, *2007 American Community Survey 1-Year Estimates*, 2007, <http://www.census.gov>.
- ² Transportation Research Board, *Does the Built Environment Influence Physical Activity? Examining the Evidence*, Special Report 282, Committee on Physical Activity, Health, Transportation, and Land Use, 2005, <http://onlinepubs.trb.org/onlinepubs/sr/sr282.pdf>.
- ³ ICF International, *The Broader Connection between Public Transportation, Energy Conservation and Greenhouse Gas Reduction*, American Public Transportation Association, 2008, http://www.apta.com/research/info/online/documents/land_use.pdf; and Todd Litman, *Evaluating Public Transit, Benefits and Costs*, Victoria Transport Policy Institute (VTPI), 2008, <http://www.vtpi.org/tranben.pdf>.
- ⁴ John E. Evans and Richard H. Pratt, "Travel Response to Transportation System Changes," in *Transit Oriented Development*, TCRP Report 95, Transportation Research Board, 2007, <http://www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=1034>.
- ⁵ VTPI, "Multi-modal Level-of-service Indicators," *Online TDM Encyclopedia*, 2008, <http://www.vtpi.org/tdm/tdm129.htm>.

Notes

- ⁶ Federal Highway Administration (FHWA), *Rural Transportation Planning*, <http://www.fhwa.dot.gov/planning/rural/index.html>.
- ⁷ PATH, *The PATH Guide: Planning Ideas, Tools, and Examples to Achieve Transportation Access and Equity in Rural California*, prepared by Natural Resources Services, A Division of Redwood Community Action Agency, Eureka, CA, <http://www.nrsrcaa.org/path>, 2006, with funding from The Caltrans Environmental Justice Program, http://www.nrsrcaa.org/path/pdfs/PATHGuide5_06.pdf.
- ⁸ European Commission, *Energy and Transport in Figures*, Directorate-General for Energy and Transport, European Commission, 2007, http://ec.europa.eu/dgs/energy_transport/figures/pocketbook/doc/2007/pb_1_general_2007.pdf; and FHWA, Highway Statistics, annual reports, <http://www.fhwa.dot.gov/policy/ohpi/hss/index.htm>.
- ⁹ Robert Puentes, *The Road . . . Less Traveled: An Analysis of Vehicle Miles Traveled Trends in the U.S.* (Washington, DC: Brookings Institution, 2008); and Todd Litman, "Changing Travel Demand: Implications for Transport Planning," *ITE Journal* 76, no. 9 (September 2006): 27–33, <http://www.vtpi.org/future.pdf>.
- ¹⁰ APTA, *Transit Statistics*, various years, <http://www.apta.com/research/stats/agency/index.cfm>; and FHWA, *Highway Statistics*, annual reports, <http://www.fhwa.dot.gov/policy/ohpi/hss/index.htm>.
- ¹¹ Reconnecting America, *Hidden in Plain Sight: Capturing the Demand for Housing near Transit*, Center for Transit-Oriented Development, for the Federal Transit Administration, 2004, <http://www.reconnectingamerica.org/public/download/hipsi>.
- ¹² Belden Russonello & Stewart, *2004 American Community Survey: National Survey on Communities*, conducted for the National Association of Realtors and Smart Growth America, October 2004.
- ¹³ APTA, *Transit Statistics*, various years, <http://www.apta.com/research/stats/agency/index.cfm>; FHWA, *Highway Statistics*, annual reports, <http://www.fhwa.dot.gov/policy/ohpi/hss/index.htm> (see endnote 10 for more details on both citations).
- ¹⁴ Todd Litman and Steven Fitzroy, *Safe Travels: Evaluating Mobility Management Traffic Safety Benefits*, VTPI, 2006, <http://www.vtpi.org/safetrav.pdf>.
- ¹⁵ Reid Ewing et al., "Relationship between Urban Sprawl and Physical Activity, Obesity, and Morbidity," *American Journal of Health Promotion* 18, no. 1 (September/October 2003): 47–57, <http://www.healthpromotionjournal.com> and http://www.smartgrowth.umd.edu/research/pdf/EwingSchmidKillingsworthEtAl_SprawlObesity_DateNA.pdf.
- ¹⁶ William H. Lucy, "Mortality Risk Associated with Leaving Home: Recognizing the Relevance of the Built Environment," *American Journal of Public Health* 93, no. 9 (September 2003): 1564–69, <http://www.ajph.org/cgi/content/full/93/9/1564>.
- ¹⁷ Todd Litman, *Rail Transit in America: Comprehensive Evaluation of Benefits*, VTPI, 2004, <http://www.vtpi.org/railben.pdf>.
- ¹⁸ Alison Cassady, Tony Dutzik and Emily Figdor, *More Highways, More Pollution: Road-building and Air Pollution in America's Cities*, U.S. PIRG Education Fund, 2004, <http://www.uspirg.org>; and Anming Zhang et al., *Towards Estimating the Social and Environmental Costs of Transportation in Canada*, Centre for Transportation Studies, University of British Columbia, for Transport Canada, 2005, <http://www.sauder.ubc.ca/cts/docs/Full-TC-report-Updated-November05.pdf>.

- ¹⁹ Christopher J. L. Murray et al., *Global Burden of Disease and Injury*, Center for Population and Development Studies, Harvard School of Public Health, 1996.
- ²⁰ Peggy Edwards and Agis D. Tsouros, *A Healthy City Is an Active City: A Physical Activity Planning Guide*, World Health Organization Europe, 2008, http://www.euro.who.int/InformationSources/Publications/Catalogue/20081103_1; and U.S. Surgeon General, *Physical Activity and Health*, CDC, 1999, <http://www.cdc.gov/nccdphp/sgr/sgr.htm>.
- ²¹ Oscar H. Franco et al., "Effects of Physical Activity on Life Expectancy with Cardiovascular Disease," *Archives of Internal Medicine* 165, no. 20 (November 2005): 2355–60, <http://archinte.ama-assn.org/cgi/content/abstract/165/20/2355>.
- ²² World Health Organization, *A Physically Active Life Through Everyday Transport: With a Special Focus on Children and Older People and Examples and Approaches from Europe*, Regional Office for Europe, 2003, <http://www.euro.who.int/document/e75662.pdf>; and Richard Gilbert and Catherine O'Brien, *Child- and Youth-Friendly Land-Use and Transport Planning Guidelines*, Centre for Sustainable Transportation, 2005, http://cst.uwinnipeg.ca/documents/Guidelines_ON.pdf.
- ²³ Ewing et al. (see endnote 15).
- ²⁴ Lilah M. Besser and Andrew L. Dannenberg, "Walking to Public Transit: Steps to Help Meet Physical Activity Recommendations," *American Journal of Preventive Medicine* 29, no. 4: 2005, http://www.cdc.gov/healthyplaces/articles/besser_dannenberg.pdf.
- ²⁵ Richard E. Wener and Gary W. Evans, "A Morning Stroll: Levels of Physical Activity in Car and Mass Transit Commuting," *Environment and Behavior* 39, no. 1 (2007): 62–74, <http://eab.sagepub.com/cgi/content/abstract/39/1/62>.
- ²⁶ Ugo Lachapelle and Lawrence D. Frank, "Mode of Transport, Employer-Sponsored Public Transit Pass, and Physical Activity," *Journal of Public Health Policy* 30, Suppl. no.1 (2009): S73–S94.
- ²⁷ Ibid.
- ²⁸ Lawrence Frank et al., "Many Pathways from Land Use to Health: Associations between Neighborhood Walkability and Active Transportation, Body Mass Index, and Air Quality," *Journal of the American Planning Association* 72, no. 1 (Winter 2006): 75–87, <http://www.planning.org>.
- ²⁹ David Bassett et al., "Walking, Cycling, and Obesity Rates in Europe, North America, and Australia," *Journal of Physical Activity and Health* 5, no. 6 (November 2008): 795–814, <http://www.humankinetics.com/jpah/journalAbout.cfm>.
- ³⁰ Roland Sturm, *Urban Design, Lifestyle, and the Development of Chronic Conditions*, the Built Environment and Childhood Obesity Plenary Session, National Institute of Environmental Health Sciences, 2005, <http://www-apps.niehs.nih.gov/conferences/drcpt/oe2005/speakerdocs/strum-doc.pdf>.
- ³¹ International Council for Local Environmental Initiatives, *Health Benefits Economic Model*, Cities for Climate Protection, 2003, <http://www3.iclei.org/ccp-au/tdm/index.html>.
- ³² Todd Litman, *Community Cohesion as a Transport Planning Objective*, VTPI, 2007, <http://www.vtpi.org/cohesion.pdf>.
- ³³ Jane Jacobs, *Death and Life of the Great American Cities* (New York: Random House, 2001).
- ³⁴ Ontario College of Family Physicians, *The*

Notes

Health Impacts of Urban Sprawl Information Series: Volume Four—Social & Mental Health, 2005, <http://www.ocfp.on.ca/local/files/Urban%20Sprawl/UrbanSpraw-Soc-MentalHlth.pdf>.

³⁵ Donald Appleyard, *Livable Streets* (Berkeley, CA: University of California Press, 1981).

³⁶ Heather Allen, *Sit Next to Someone Different Every Day—How Public Transport Contributes to Inclusive Communities*, Thredbo Conference, 2008, http://www.thredbo.itls.usyd.edu.au/downloads/thredbo10_papers/thredbo10-plenary-Allen.pdf.

³⁷ Ethan M. Berke et al., “Protective Association between Neighborhood Walkability and Depression in Older Men,” *Journal of the American Geriatrics Society* 55, no. 4 (2007): 526–33, <http://www.blackwell-synergy.com>.

³⁸ Wener and Evans, “A Morning Stroll” (see endnote 25).

³⁹ VTPI, “Basic Accessibility and Mobility,” *TDM Encyclopedia*, 2008, <http://www.vtpi.org/tdm/tdm103.htm>.

⁴⁰ APTA, *The Route to Better Personal Health*, 2003, http://spider.apta.com/lgwf/legtools/better_health.pdf.

⁴¹ Irwin Redlener et al., *The Growing Health Care Access Crisis for American Children: One in Four at Risk*, The Children’s Health Fund, 2006, <http://www.childrenshealthfund.org/calendar/WhitePaper-May2007-FINAL.pdf>.

⁴² Todd Litman, “Transportation Market Distortions” (issue theme “Sustainable Transport in the United States: From Rhetoric to Reality?”), *Berkeley Planning Journal* 19 (2006): 19–36, <http://www-dcrp.ced.berkeley.edu/bpj>, and http://www.vtpi.org/distortions_BPJ.pdf.

⁴³ Todd Litman, *Comprehensive Transport Planning Framework: Best Practices for Evaluating All Options and Impacts*, VTPI, 2007, <http://www.vtpi.org/comprehensive.pdf>.

⁴⁴ Kjartan Sælensminde, “Cost-benefit Analysis of Walking and Cycling Track Networks Taking into Account Insecurity, Health Effects, and External Costs of Motor Vehicle Traffic,” *Transportation Research A* 38, no. 8 (October 2004): 593–606, <http://www.elsevier.com/locate/tra> at http://www.toi.no/toi_Data/Attachments/887/sum_567_02.pdf.

⁴⁵ Robert Puentes and Ryan Prince, *Fueling Transportation Finance: A Primer on the Gas Tax* (Washington, DC: Brookings Institution, Center on Urban and Metropolitan Policy, 2003), http://www.brookings.edu/reports/2003/03transportation_puentes.aspx.

⁴⁶ Lawrence Frank, Sarah Kavage, and Todd Litman, *Promoting Public Health Through Smart Growth: Building Healthier Communities Through Transportation and Land Use Policies*, Smart Growth BC, 2006, http://www.vtpi.org/sgbc_health.pdf; and Richard Killingsworth, Audrey De Nazelle, and Richard Bell, “Building a New Paradigm: Improving Public Health Through Transportation,” *ITE Journal* 73, no. 6 (June 2003): 28–32, <http://www.ite.org>.

⁴⁷ World Health Organization (WHO), *World Report on Road Traffic Injury Prevention*, WHO and World Bank, 2004, http://www.who.int/entity/world-health-day/2004/infomaterials/world_report; and International City/County Management Association (ICMA), *Creating a Regulatory Blueprint for Healthy Community Design: A Local Government Guide to Reforming Zoning and Land Development Codes*, ICMA (<http://www.icma.org>) and Active Living By Design (<http://www.activelivingleadership.org>), 2005.

- ⁴⁸ Dan Emerine and Eric Feldman, *Active Living and Social Equity: Creating Healthy Communities for All Residents*, International City/County Management Association, 2005, <http://bookstore.icma.org>.
- ⁴⁹ *Active Living Research* (<http://www.activelivingresearch.org>).
- ⁵⁰ VTPI, "Financing Options," *Online TDM Encyclopedia*, 2008, <http://www.vtppi.org/tdm/tdm119.htm>.
- ⁵¹ Center for Neighborhood Technology, *Housing + Transportation Affordability Index*, 2008, <http://htaindex.cnt.org>.
- ⁵² Congress for the New Urbanism, *Parking Requirements and Affordable Housing*, 2008, <http://www.cnu.org/node/2241>.

Chapter 4: Walking, Bicycling, and Health

- ¹ J. Pucher and R. Buehler, "Making Cycling Irresistible: Lessons from the Netherlands, Denmark, and Germany," *Transport Reviews* 28 (2008): 495–528.
- ² Ibid.
- ³ Ibid.
- ⁴ J. Pucher, J. Dill, and S. Handy et al., "Infrastructure, Programs, and Policies to Increase Bicycling: An International Review," *Preventative Medicine*. Vol 48, No. 2, February 2010.
- ⁵ U.S. Department of Health and Human Services, "2008 Physical Activity Guidelines for Americans," <http://www.health.gov/PAGuidelines/pdf/paguide.pdf> (accessed March 27, 2009).
- ⁶ Centers for Disease Control and Prevention (CDC), "Prevalence of Regular Physical Activity among Adults – United States, 2001 and 2005," *Morbidity and Mortality Weekly Report* 56 (2007): 1209–12.
- ⁷ J. N. Morris and A. E. Hardman, "Walking to Health," *Sports Medicine* 23 (1997): 306–32.
- ⁸ D. Ogilvie et al., "Interventions to Promote Walking: Systematic Review," *British Medical Journal* 334 (June 2007): 1204.
- ⁹ National Highway Traffic Safety Administration (NHTSA), "Traffic Safety Facts 2007 Data: Pedestrians," 2008, http://www.nhtsa.dot.gov/portal/nhtsa_static_file_downloader.jsp?file=/staticfiles/DOT/NHTSA/NCSA/Content/TSF/2007/810994.pdf (accessed March 27, 2009); and NHTSA, "Traffic Safety Facts 2007 Data: Bicyclists and Other Cyclists," 2008, www.nhtsa.dot.gov/portal/nhtsa_static_file_downloader.jsp?file=/staticfiles/DOT/NHTSA/NCSA/Content/TSF/2007/810986.pdf (accessed March 27, 2009).
- ¹⁰ C. Gidelow et al., "A Systematic Review of the Relationship between Socio-economic Position and Physical Activity," *Health Education Journal* 65 (2007): 338–67; and CDC, "Prevalence of Regular Physical Activity among Adults – United States, 2001 and 2005," *Morbidity and Mortality Weekly Report* 56 (2007): 1209–12.
- ¹¹ L. M. Besser and A. L. Dannenberg, "Walking to Transit: Steps to Help Meet Physical Activity Recommendations," *American Journal of Preventive Medicine* 29 (2005): 273–80.