

If Health Matters

Integrating Public Health Objectives in Transportation Planning

22 February 2012

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Abstract

This report investigates how transport policy and planning practices would change if public health objectives received greater priority. Conventional transport decision-making focuses on some health impacts but overlook others. It gives considerable attention to per-kilometer vehicle crash risk and pollution emissions, but overlooks the safety and pollution problems that result from increased vehicle mileage, and the negative health impacts resulting from less physically active travel. As a result, transportation agencies tend to undervalue strategies that reduce total vehicle travel and create a more diverse transport system. Various mobility management strategies are described and their impacts on traffic safety, pollution emissions and physical activity are evaluated. This analysis suggests that giving greater priority to health objectives in transport planning would reduce roadway and parking capacity expansion and increase support for mobility management strategies, particularly those that increase walking and cycling.

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Contents

Introduction	3
Transportation Health Impacts	4
Traffic Crashes	5
Vehicle Pollution	10
Physical Activity and Fitness	11
Community Cohesion	16
Mental Health Impacts	16
Comparing Transportation Objectives	18
Planning Practices	19
Safety and Health Impacts of Mobility Management Strategies	21
Vehicle Travel Reduction Incentives	21
Pay-As-You-Drive Vehicle Insurance	22
Mode Shifting	22
Mobility Substitutes	25
Travel Time and Route Shifts	25
Traffic Speed Reductions	25
Smart Growth	26
Health Impacts Summary	29
Conclusions	30
Information Resources	31
Endnotes	43

Introduction

Conventional public decision-making is *reductionist*: individual problems are assigned to specialized professions and organizations with narrowly defined responsibilities (Litman 1999). For example, transportation agencies are responsible for improving traffic flow, environmental agencies are responsible for reducing pollution, and health agencies are responsible for public health. This can result in an agency implementing solutions to one problem (those within their mandate) that exacerbate other problems (those outside their mandate), and it undervalues solutions that provide modest but multiple benefits.

This report examines a particular example of this sort of policy disconnect: the lack of coordination between transport and health objectives. It asks, “How would transport policy and planning practices change if transportation agencies considered public health one of their primary responsibilities?”

Many transportation professionals may be offended by this question because they do consider public health an important concern as reflected in their efforts to reduce traffic crashes and pollution emissions. However, as this report points out, current transport planning practices tend to focus on some health impacts but overlook others. For transportation agencies to better address public health objectives they will need to consider a wider range of health impacts and develop better tools for evaluating how particular policy and planning decisions affect public health objectives.

Transportation Health Impacts

Transport planning decisions impact public health in various ways (WHO 2006; Litman and Fitzroy 2006; Frank, Kavage and Litman 2006; APHA 2010). Table 1 summarizes major transportation health impacts.

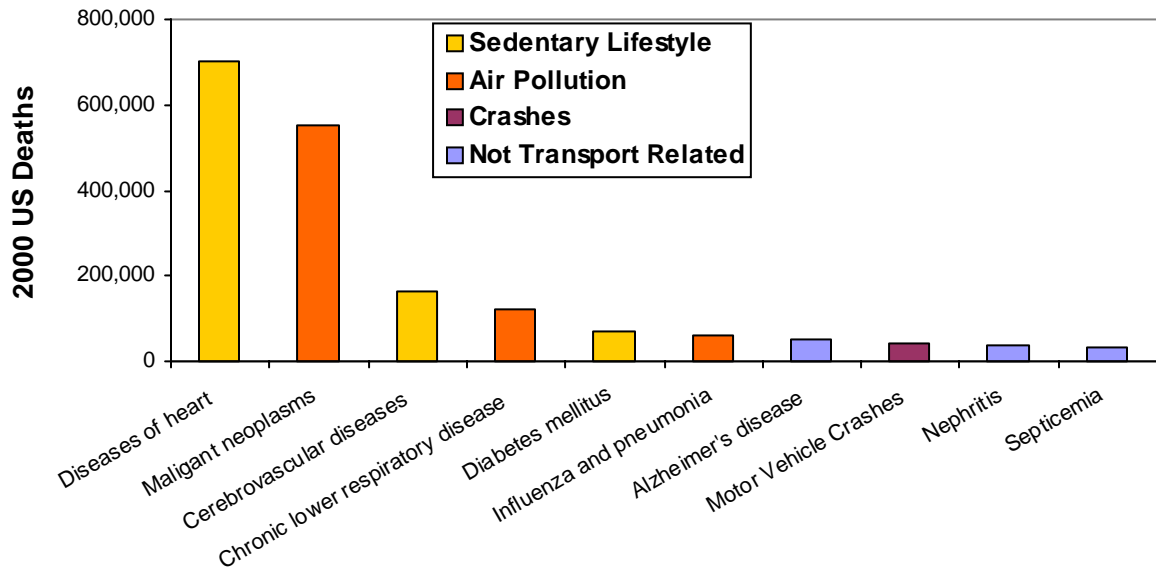
Table 1 Transportation Health Impacts (Ball, et al. 2009)

Health Enabling	Health Damaging
<ul style="list-style-type: none"> • Affordable access to health promoting services and activities (medical care, healthy food, recreation, schooling, employment, etc.). • Exercise, use of active transport modes such as walking and cycling. 	<ul style="list-style-type: none"> • Traffic accidents • Air pollution exposure • Noise pollution exposure • Stress and anxiety • Constraints on active transport modes • Constraints on outdoor space (such as sidewalks and yards) due to motor vehicle traffic. • Financial costs burdens due to high transport costs

This table summarizes major categories of transportation health impacts.

Of the ten most common causes of death in the U.S., seven are affected by transportation, as illustrated in Figure 1.¹

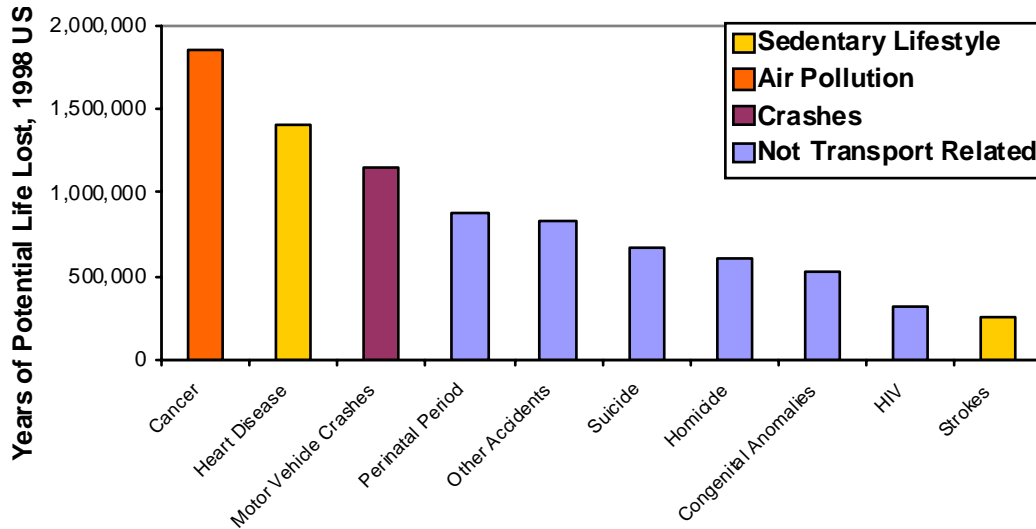
Figure 1 Ten Leading Causes of U.S. Deaths (CDC 2003)



Most major causes of death are affected by physical activity, air pollution or traffic risk.

Figure 2 provides a similar comparison, showing how transportation affects the ten main causes of Years of Potential Life Lost (YPLL), which takes into account age at death, and so ranks traffic crashes higher because they tend to kill younger people than illnesses associated with sedentary lifestyle and pollution.

Figure 2 Ten Leading Causes of Years of Potential Life Lost²



Transportation planning decisions can affect most major causes of death and disability.

Various transportation-related health impacts are examined below (CDC 2010).

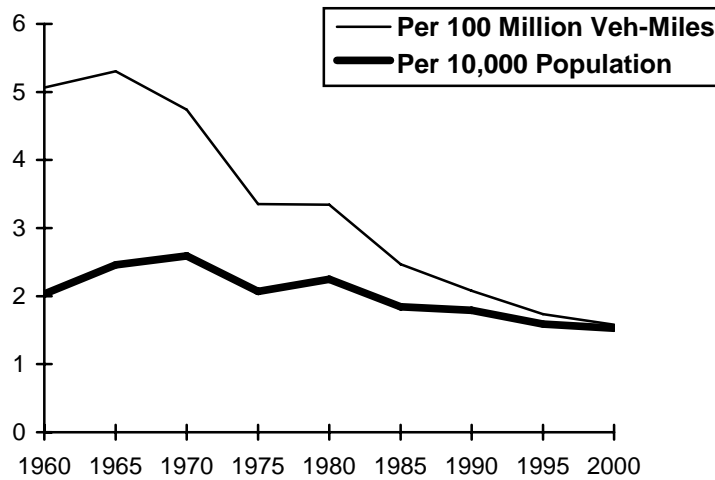
Traffic Crashes

Transport planning gives considerable attention to traffic safety. Many vehicle design features, roadway improvements and traffic safety programs are intended to prevent crashes or protect vehicle occupants when they crash.

Motor vehicle crash risk can be viewed in two different ways, giving two very different conclusions about the degree of danger and the effectiveness of various safety strategies. Transportation professionals usually measure crash rates per unit of travel (i.e., injuries and fatalities per hundred million vehicle-miles or -kilometers). Evaluated in this way, U.S. crash rates have declined by more than two thirds over the last four decades, indicating that traffic safety programs are successful and should be continued to further increase traffic safety.

But per capita vehicle mileage more than doubled over this period, which largely offset the decline in per-kilometer crash rates. When fatalities and injuries are measured *per capita* (e.g., per 10,000 population), as with other health risks there has been surprisingly little improvement despite large investments in safer roads and vehicles, increased use of crash protection devices, reductions in drunk driving, improved emergency response and trauma care during this period. Taking these factors into account, much greater casualty reductions should have been achieved. For example, the increase in seat belt use over this period, from about 0% in 1960 up to 75% in 2002, by itself should reduce fatalities by about 33% (wearing a seatbelt reduces the chances of a crash fatality by about 45%), yet, per capita traffic deaths only declined by about 25%. Figure 3 compares these two different ways of measuring traffic crash risk (NHTSA 2002).

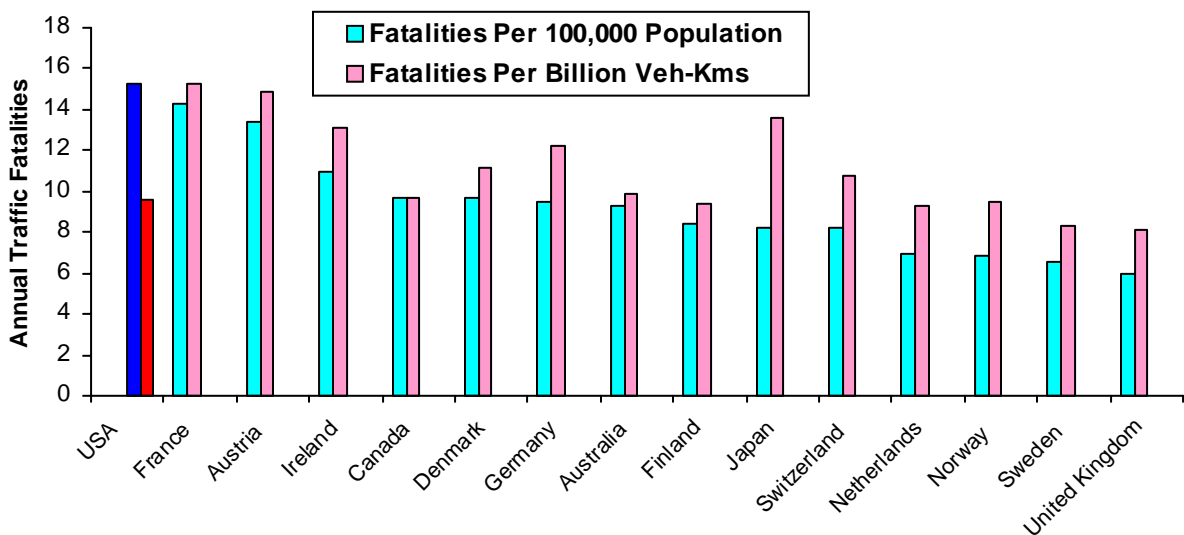
Figure 3 U.S. Traffic Fatalities (BTS 2000)



This figure illustrates traffic fatality trends over four decades. Per mile crash rates declined substantially, but per capita crash rates declined little despite significant traffic safety efforts.

Traffic crashes continue to be the greatest single cause of deaths and disabilities for people in the prime of life. Although among developed countries the U.S. has one of the lowest traffic fatality rates *per vehicle-km*, it has one of the highest traffic fatality rates *per capita*, as illustrated in Figure 4. The U.S. has more than twice the per capita traffic fatality rate as in the UK, Sweden and Norway, and a 50% higher rate than in Canada. From this perspective, traffic safety continues to be a major problem, current safety efforts are ineffective, and new approaches are needed to really improve road safety.

Figure 4 International Traffic Fatality Rates (OECD 2001)

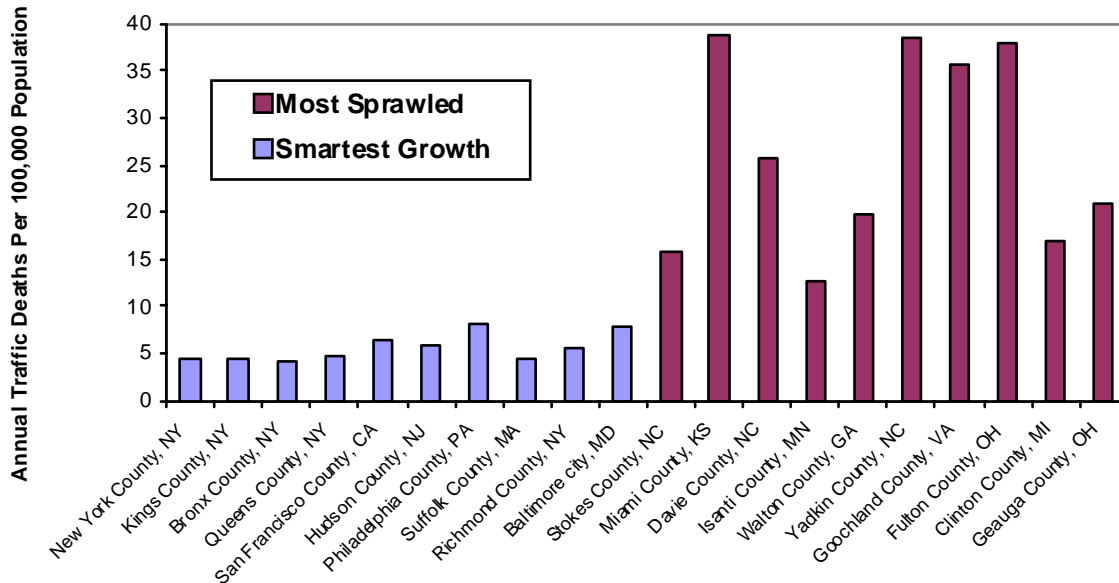


This figure compares national traffic fatality rates. Among developed countries the U.S. has one of the lowest rates per vehicle-kilometer and one of the highest rates per capita.

The relationship between mileage and traffic fatalities is quite different when compared between countries at different levels of development. Many developing countries have high per capita traffic fatality rates, despite low per capita vehicle ownership and mileage. For example, World Health Organization data show per capita traffic fatality rates are higher in Africa than in North America or Europe, although vehicle ownership is an order of magnitude lower (WHO 2004). Per-kilometer traffic fatality rates decline with increased motorization, as vehicle and road quality improves, and residents take more traffic safety actions (drive and walk more cautiously, wear seatbelts and helmets, better maintain their vehicles, etc.). However, these safety tends eventually plateau, and among developed countries, traffic risk is significantly affected by transportation and land use patterns.

Higher density, clustered development patterns tend to increase traffic density (vehicles per lane-km), which tends to increase crash rates per vehicle-kilometer, but reduces per capita vehicle mileage and crash severity (due to lower traffic speeds). As a result, per capita traffic fatalities tend to increase as land use patterns become more sprawled, as illustrated in Figure 5. The least sprawled U.S. cities average 5.6 traffic fatalities per 100,000 population, while the most sprawled average 26.3, nearly five times as high. For every 1% increase in a 100-point Smart Growth index, all-mode traffic fatality rates fell by 1.5% (Ewing, Schieber and Zegeer 2003). All told, city residents are much safer, even taking into account other risks that increase with urban living, such as pedestrian traffic fatalities and homicides (Lucy 2002).

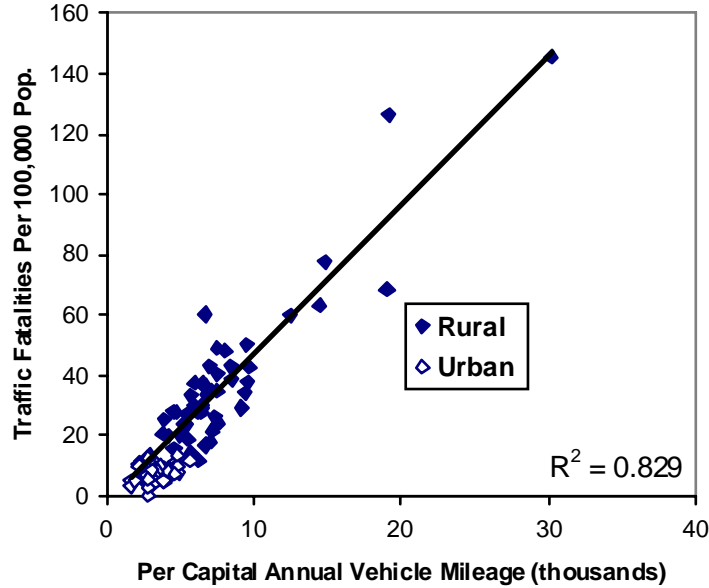
Figure 5 Annual Traffic Death Rate (Ewing, Schieber and Zegeer 2003)



The ten most sprawled U.S. communities have about five times the per capita traffic fatality rate as the ten Smartest Growth communities.

Per capita traffic fatalities tend to increase with per capita annual vehicle mileage, as shown in Figure 6. High mileage cities tend to have two or three times the traffic fatality rate as low mileage cities.

Figure 6 Fatal Traffic Accidents (Clark and Cushing 2004)



Per capita traffic fatalities tends to increase with per capita vehicle mileage.

Figure 7 Vehicle Mileage and Traffic Fatality Rates In OECD Countries (OECD 2003)

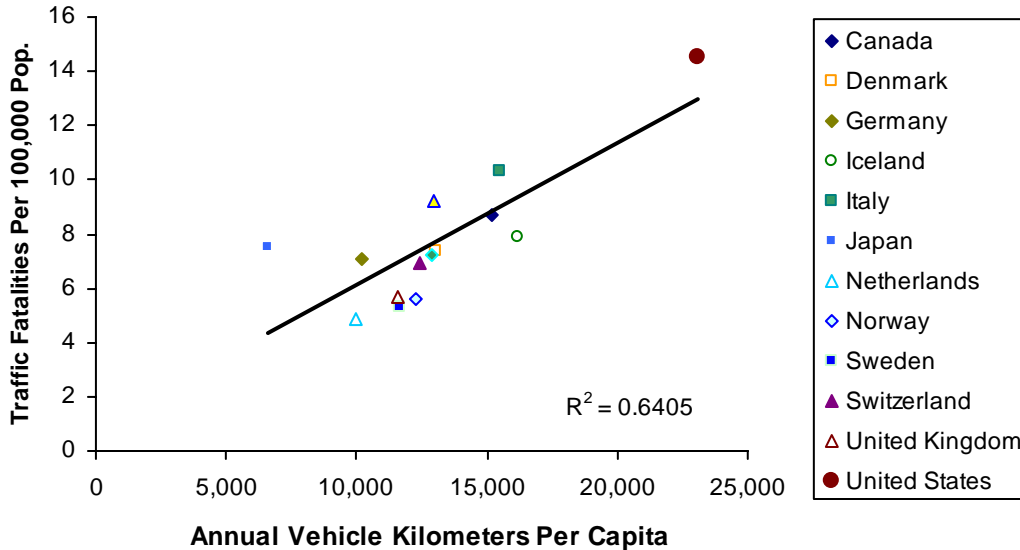
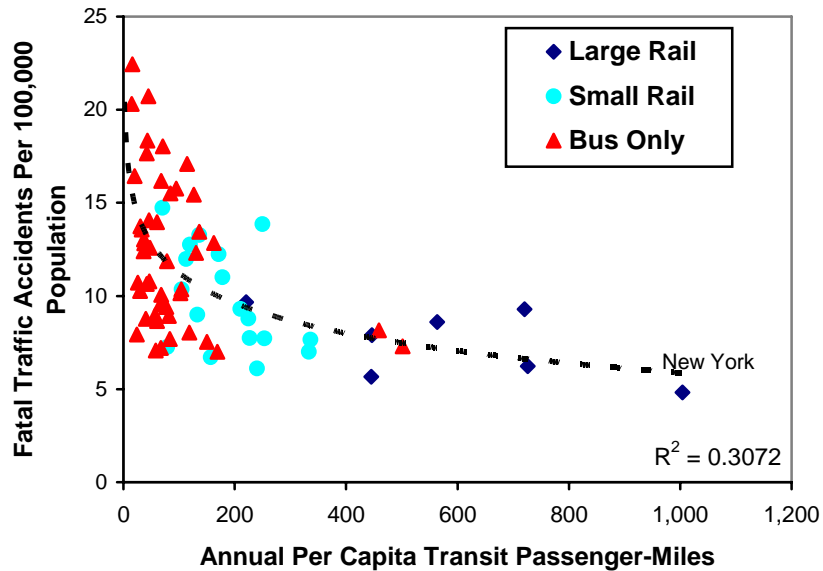


Figure 6 illustrates a moderate positive relationship between per capita vehicle mileage and traffic fatality rates (including pedestrian and transit deaths) for major U.S. cities.

Per capita traffic fatalities tend to decline as a city becomes more transit oriented, as illustrated in Figure 8.

Figure 8 Fatal Traffic Accidents (Litman 2004a)



Per capita traffic fatalities tend to decline with increased per capita transit ridership. Since cities with large rail systems tend to have higher transit ridership, they tend to have fewer traffic fatalities. These values include all deaths, including those in transit vehicles, deaths to automobile passengers hit by transit vehicles, and deaths to pedestrians.

Traffic fatality rates also tend to decline as walking and cycling activity increase in a community (ABW 2010).

When road risk is measured using a distance-based rate, such as crashes or fatalities per 100 million miles, increased vehicle mileage is not considered a risk factor and vehicle travel reductions are not considered a safety strategy. From this perspective, an increase in total crashes is not a problem provided mileage increases proportionally. For example, building grade-separated highways tends to reduce per-kilometer crash rates and increase total vehicle travel, and reduces crash rates per mile but not per capita (Noland 2003). Emphasizing per-kilometer crash rates ignores the potential safety benefits of mobility management policies (i.e., strategies that change travel behavior and reduce vehicle travel). Mobility management is considered a solution to urban traffic congestion and pollution problems, but generally not as a safety strategy.

Vehicle Pollution

A second category of transport-related health impacts involve vehicle pollution emissions (Litman 2010). Although tailpipe emissions tend to receive the most attention, pollution is also produced during fuel production and distribution (called “upstream” emissions), vehicle refueling, hot soak (i.e., evaporative emissions that occur after an engine is turned off), and mechanical emissions produced from road dust and wear of brake linings and tires.

Vehicle air pollution is widely recognized as health risk, and vehicle emission reduction programs are often cited as examples of technological success. It is common to hear claims that vehicle emissions have declined by 90% or more over the last few decades, but this is an exaggeration (DeCicco and Delucchi 1997). Although tailpipe emission rates measured by standard tests have declined significantly, actual reductions are smaller; tests do not reflect real driving conditions; vehicles produce harmful emissions are not measured in such tests; and rising vehicle travel has offset much of the reduction in per-mile emission rates, so traffic emissions continue to be a major air pollution source.

Many factors affect the human health impacts of vehicle pollutants, including emission rates per vehicle mile, per capita mileage, and exposure (the number of people located in areas where emissions are concentrated). As with accident risk, transportation professionals have traditionally focused on reducing vehicle emissions per vehicle-kilometer, although in recent years some efforts have been made to reduce emissions by reducing vehicle travel. Per capita air pollution emissions tend to increase with per capita vehicle mileage and highway capacity (Cassady, Dutzik and Figdor 2004). This suggests that efforts to reduce traffic congestion and improve mobility by increasing roadway capacity may increase total pollution emissions, and that strategies that reduce per capita vehicle mileage may be effective ways to reduce emissions.

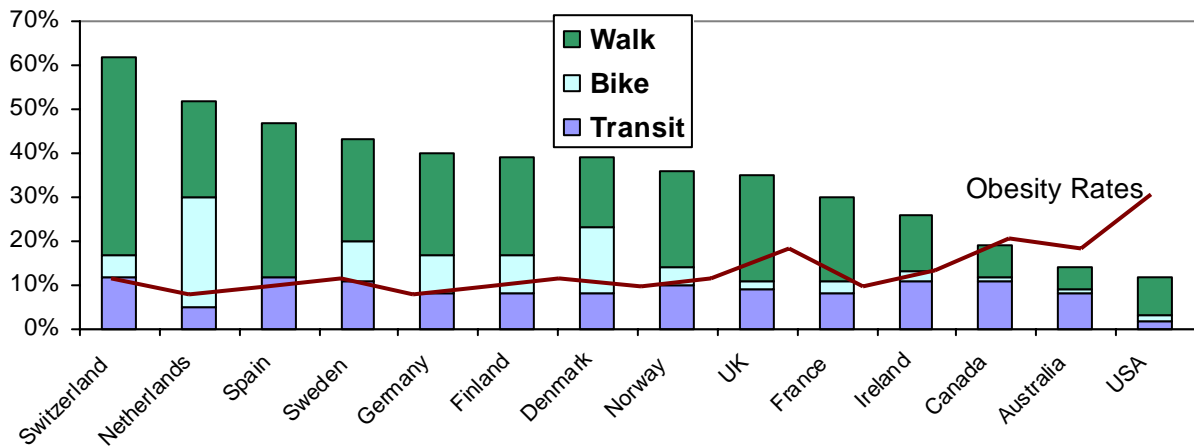
Motor vehicle air pollution probably causes a similar order of magnitude of premature deaths as traffic crashes, although air pollution deaths tend to involve older people, while traffic crashes are more likely to harm people during the prime of life and so cause greater reductions in Potential Years of Life Lost (PYLL) or Disability Adjusted Life Years (DALYs) (Murray 1996; “Health and Safety,” Litman 2010).

Physical Activity and Fitness

The third category of health impacts concerns the effects that transport planning can have on physical activity and fitness (WHO 2003). According to experts, such as the U.S. Center of Disease Control, adults should average at least 150 minutes a week (about 22 minutes a day) of moderate-intensity, or 75 minutes a week (about 11 minutes a day) of vigorous-intensity aerobic physical activity, and children should average at least one hour a day of physical activity (CDC 2008). Public health officials are increasingly alarmed at declining physical fitness, excessive body weight, and resulting increases in sedentary lifestyle diseases such as diabetes (DHHS 2008; Blair 2009).

There are many ways to be physically active, but most, such as team sports and gym exercise, require special time, skill and expense, which discourages consistent, lifetime participation. Many experts believe that more *Active Transport* (walking and cycling, and variants such as running and skating, also called *Nonmotorized Modes and Human Powered Transport*) are the most practical and effective way to improve public fitness (WHO 1999). Studies find significant health benefits from increased walking and cycling activity (Cavill, et al. 2008). Residents of automobile dependent, sprawled communities are found to have health risks, including less walking, increased obesity and increased hypertension (Ewing, et al. 2003). Among wealthy countries, those with higher rates of walking and cycling tend to have lower rates of obesity (Figure 9).

Figure 9 Mode Split Versus National Obesity Rates (Bassett, et al. 2008)



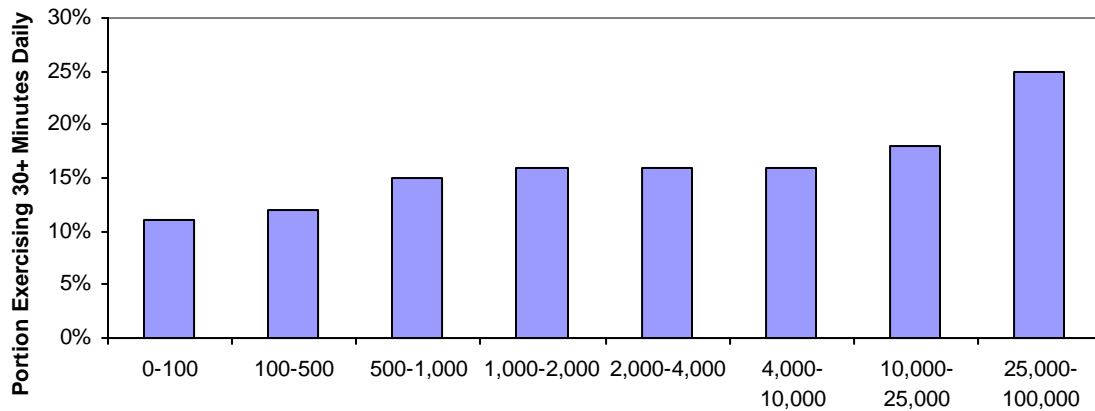
These data indicate that mode share is highly variable even among economically developed countries, and national obesity rates are inversely related to active transport (walking and cycling) share.

The *Aerobics Center Longitudinal Study* (a study of 80,000 adults in which researchers periodically measure the participants' body composition and body mass index) found that sedentary living accounts for about 16% of all deaths in both women and men, which is substantially higher than the risks associated with smoking, obesity, hypertension, high cholesterol and diabetes (Blair 2009). The analysis suggests that a physically active (i.e., walks 30 daily minutes), obese smoker is likely to live longer than a sedentary, thin, non-

smoker. Moderate physical exercise increases average longevity by 1.3 and 3.7 years in typical middle-age Americans (Franco, et al. 2005).

The *2010 Bicycling and Walking Benchmark Report* (ABW 2010) shows a negative relationship between walking and cycling activity in a region and rates of obesity and related illnesses such as diabetes and high blood pressure (ABW 2010). Residents of more walkable, multi-modal neighborhoods tend to achieve most of the minimum amount of physical activity required for health (Litman 2005). Transport modeler William Gehling found that the portion of residents who walk and bicycle at least 30 minutes a day increases with land use density, from 11% in low density areas (less than 1 resident per acre) up to 25% in high density (more than 40 residents per acre) areas (Figure 10).

Figure 10 Portion of Population Walking and Cycling 30+ Minutes Daily (Unpublished Analysis of 2001 NHTS by William Gehling)



As land use density increases the portion of the population that achieves sufficient physical activity through walking and cycling increases. Based on 2001 NHTS data.

Frank, et al. (2006) developed a *walkability index* that reflects the quality of walking conditions, taking into account residential density, street connectivity, land use mix and retail floor area ratio (the ratio of retail building floor area divided by retail land area). They found that a 5% increase in this index is associated with a 32.1% increase in time spent in active transport (walking and cycling), a 0.23 point reduction in body mass index, a 6.5% reduction in VMT, and reduced air pollution emissions. There appears to be significant latent demand for nonmotorized travel, that is, people would walk and bicycle more frequently if they had suitable facilities and conditions (ABW 2010).

Lachapelle and Frank (2009) found that the likelihood that Atlanta, Georgia residents would meet federal targets for physical activity by walking for transportation (at least 1.5 miles or 30 minutes a day of walking) were much higher (odds ratio 3.87) if they used transit that day, controlling for demographics, neighborhood density, presence of services near workplaces, distance from home to transit, and car availability. Lachapelle (2010) found that transit users have higher frequencies of utilitarian walking to destinations near the home and workplace independent of neighborhood walkability, car availability, and enjoyment of moderate physical activity.

Analysis of the National Household Travel Survey (NHTS) found that Americans who use public transit on a particular day spend a median of 19 daily minutes walking to and from transit, and 29% achieve 30 minutes of physical activity during transit access trips (Besser and Dannenberg 2005). Analysis of walking activity by Lachapelle, et al. (2011) found that public transit commuters average 5 to 10 more minutes of moderate-intensity physical activity, and walked more to services and destinations near home and near the workplace, than transit nonusers, regardless of neighborhood walkability. Similarly, Melbourne, Australia residents who use public transit average 41 minutes of daily walking or cycling for transport, five times more than the 8 minutes averaged by residents who travel only by automobile (BusVic 2010).

Cardiovascular diseases are the leading causes of premature death and disability in developed countries, causing ten times as many lost years of productive life as road crashes (Murray 1996). Even modest reductions in these illnesses could provide even greater overall health benefits than large reductions in traffic crashes. However, it is difficult to determine how a particular transport policy or planning decision will affect these diseases, since it depends on their ability to increase physical activity by otherwise sedentary people. The *Health Benefits Economic Model* provides a methodology for valuing the health benefits of more active transportation (ICLEI 2003).

A meta-analysis of 22 cohort studies estimated the effect of moderate physical activity on all-cause mortality (Woodcock, et al. 2010). The results indicate that, compared with no reported physical activity, 2.5 hours per week (about 30 minutes of moderate intensity activity 5 days a week) is associated with a 19% reduction in mortality, while 7 hours per week of moderate activity was associated with a 24% reduction. The authors conclude that being physically active reduces the risk of all-cause mortality, with the largest benefit from moving from sedentary to low activity levels, but even at high levels increased activity provides additional health benefits.

One study found that, accounting for demographic factors such as age, race/ethnicity, educational achievement and income, the frequency of self-reported chronic medical conditions such as asthma, diabetes, hypertension and cancer increased with sprawl (Sturm 2005). On average there are 1,260 reported chronic medical conditions per 1,000 population. A 50-point change from more to less sprawling cities is associated with 96 fewer conditions. Shifting from a very sprawled region such as San Bernardino, California to a less sprawled region such as Boston, Massachusetts would result in a reduction of 200 chronic medical conditions per 1,000 population, a 16% reduction. This effect appears to be particularly strong for the elderly and lower-income people.

A Korea Transport Institute study found that commuters who switching from driving to walking or cycling for eight weeks experienced significantly reduced lower blood pressure, improved lung capacity, and improved cholesterol counts (Sung, Park and Kim 2009). It estimated that active mode commuters achieve annual health and fitness benefits worth an average of 2.2 million Korean Won (about \$2,000). Incorporating these values

into transport planning can significantly affected outcomes, resulting in higher values for policies and projects that increase active transport among otherwise sedentary people. Rojas-Rueda, et al. (2011) quantified the overall health impacts to users caused by shifts from urban driving to urban cycling, including increases in accident risk, air pollution exposure and improved public fitness. In this case study, the 181,982 Barcelona residents that use the Bicing public bicycle rental system are estimated to experience 0.03 additional deaths from road traffic accidents, 0.13 additional deaths from air pollution, and 12.46 fewer deaths from improved fitness, resulting in 12.28 annual deaths avoided and a 77 benefit:risk ratio. This does not account for the additional health benefits from reduced accident risk to other road users or reduced air pollution emissions to city residents. The authors conclude that public bicycle sharing schemes can help improve public health and provide other benefits.

A New York City Department of Health (NYCDH 2011) study evaluated the health benefits of active transportation. The analysis indicates that people who commute by walking, cycling or public transit achieve about twice the total (transportation and recreational) exercise as automobile commuters, and so are much more likely to achieve public health targets of thirty or more daily minutes of moderate physical activity. This study can be a model for use in other communities interested in tracking physical fitness and health.

It's Better To Be Chubby And Fit Than Skinny And Stagnant: Exercise Benefits People Of All Weights, Studies Find

Jill Barker, *Vancouver Sun*, 27 December 2010

(www.vancouversun.com/health/better+chubby+than+skinny+stagnant/4028483/story.html)

The struggle to lose weight is a see-saw between success and failure. Lose a couple of pounds, and you can almost see yourself fitting into your favourite jeans again. Gain a couple, and you wonder if you'll ever reach your goal weight.

The constant yo-yoing of weight loss and gain is not only frustrating, it makes you question whether all that hard work in the gym is worth it. Before you pack up your workout gear for good, however, rest assured that gym workouts are well worth the time and effort -- even if those extra pounds stubbornly refuse to disappear.

Exercise has a lot more to offer than just a means to lose weight. Its most important role is the impact it has on health -- especially among those who carry extra pounds. Most people already know that exercise improves cardiovascular health and reduces the risks of some forms of cancer. What's less well known is that exercise also reduces the health risks associated with carrying extra weight. Studies suggest that chubby exercisers are healthier than skinny couch potatoes.

The first to speculate that it's possible to be fit and fat was Steven Blair, who in 1999 reported on a study of 22,000 men, all of whom were put through treadmill tests and body-composition assessments at the start of the study. During the eight years of followup the results were surprising. Lean men who scored poorly on the treadmill test were twice as likely to have died when compared with men who were overweight but fit. Similar results were found among women. In another study by Blair, published in 2003, moderately fit women of all weights had a 48% lower risk of dying prematurely (from all causes) when compared with unfit women -- even the skinny ones. The conclusion, said Blair, is that it's entirely possible to be fit and fat.

These results in no way suggest that it's okay to pack on extra weight. High blood pressure, heart disease, Type 2 diabetes, gallbladder disease, osteoarthritis, sleep apnea and breast, colon and endometrial cancer are all more prevalent in the overweight population. But for those who struggle to reach their goal weight, it's worth noting that exercise can ameliorate a lot of the risk factors associated with obesity. Bones get stronger, blood glucose is better regulated, blood pressure goes down, and psychological well-being improves.

To be clear, 150 minutes of exercise a week isn't going to result in substantial weight loss. It will, however, do as heralded and result in substantial health benefits, which, according to most public-health officials, is more important than a washboard set of abs.

Community Cohesion

Community cohesion refers to the quantity and quality of positive interactions among residents in a local community (Litman 2007). Community cohesion affects human health in various ways, including the mental health benefits of friendly social interactions, and the health benefits of increased neighborhood security (Jacobs 1961). Although many demographic and geographic factors affect neighborhood interactions, cohesion tends to increase with walkability and local services (OCFP 2005). This can increase connections and contact among dissimilar groups, helping to bridge social distance and increasing opportunities, for example, increasing the chance that children from economically disadvantaged families will interact with economically successful neighbors that serve as role models and mentors, providing long-term social and economic benefits (Allen 2008).

Mental Health Impacts

Improving walking, cycling and public transit services can improve mental health by reducing physical and emotional stresses (such as crowding, fear and frustration), increasing affordability (and therefore financial stresses), influencing their access to education and employment activities (and therefore their long-term economic opportunities), and by helping to create more walkable communities which increases physical activity and fitness. Increased neighborhood walkability is associated with reduced symptoms of depression in older men (Berke, et al. 2007). Physical activity is associated with reduced frequency of dementia (Larson, et al. 2006). In a study of 299 U.S. older adults (mean age 78 years) Erickson, et al. (2010) found significantly higher rates of grey matter volume and cognitive ability in those who, in previous years had walked more than 72 blocks a week. With high quality public transit service, many commuters find public transit less stressful than driving (Wener and Evans 2007). Such mental health benefits are difficult to quantify but potentially large.

Basic Mobility and Affordability

Basic mobility refers to peoples' 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. Transportation affordability refers to transportation that does not impose excessive financial costs on lower-income household (typically less than 20% of household budgets) (Litman 2008a). Basic mobility and transportation affordability are important for physical and mental health, and critical equity objectives. Inadequate or excessively costly transport can result in patients missing appointments, which can exacerbates medical problems and wastes medical resources, or forces patients or medical services providers to pay for more costly transport services, such as taxis (APTA 2003). One survey found that 4% of children (3.2 million) either missed a scheduled health care visit, or did not schedule a visit, during the preceding year because of transportation restrictions (Redlener, et al. 2006).

Study: Kids Take Walks If Parks, Stores Nearby

Stacy Shelton, *The Atlanta Journal-Constitution*, 12 December 2006

Young people in metro Atlanta are more likely to walk if they live in a city or within a half-mile of a park or store, according to a new study to be published next month in the *American Journal of Health Promotion*.

Of the 3,161 children and youth surveyed from 13 counties, the most important neighborhood feature for all age ranges was proximity to a park or playground. It was the only nearby walking attraction that mattered for children ages 5 to 8, who were 2.4 times more likely to walk at least half a mile a day than peers who don't live near a park, researchers said.

For older children and young adults up to age 20, a mix of nearby destinations including schools, stores and friends' houses also translated into more walking. Preteens and teenagers ages 12 to 15 who live in high-density or urban neighborhoods were nearly five times more likely to walk half a mile or more a day than those who live in low-density or suburban neighborhoods.

Lawrence Frank, the study's lead author and a former urban planning professor at Georgia Tech, said the research shows young people are particularly sensitive to their surroundings, most likely because they can't drive. "Being able to walk in one's neighborhood is important in a developmental sense," said Frank, now at the University of British Columbia. "It gives youth more independence. They start to learn about environments and where they live. There are also benefits for social networking for children."

The study used data collected from a larger study of land use and travel patterns, called SMARTRAQ, in the metro Atlanta area. It is funded by the Centers for Disease Control and Prevention, the Environmental Protection Agency, the Georgia Department of Transportation and the Georgia Regional Transportation Authority. Other SMARTRAQ findings showed a strong link between time spent driving and obesity.

Elke Davidson, executive director of the Atlanta Regional Health Forum, said getting kids to walk is "one of the most important health interventions that we need right now." Her group is a privately funded organization that works to integrate public health goals into local and regional planning. Health officials say half of all children diagnosed with diabetes today have Type 2, formerly known as adult-onset, which is linked to obesity. Exercise is a key strategy for preventing and treating the disease.

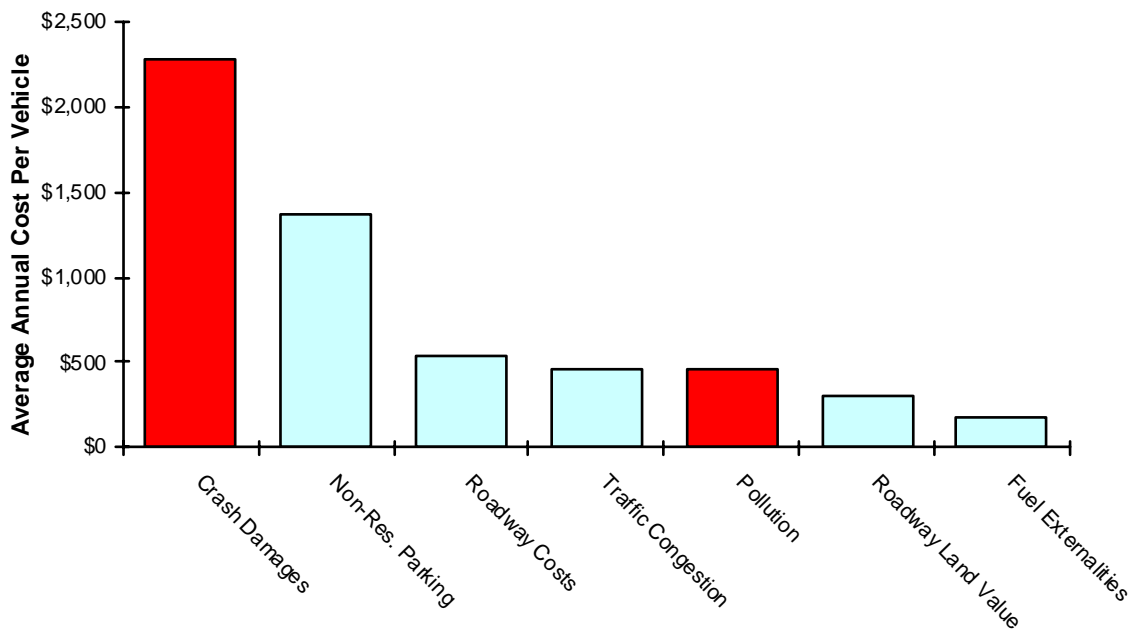
"We need not just to tell kids to get off their computers and go outside. If there are no parks and no place to walk, they're stuck," Davidson said. "A lot of the natural opportunities for physical activity, like walking to school or walking to your friends' house or walking downtown to get a soda ... those opportunities are increasingly limited when we build communities that are so auto-dependent."

George Dusenbury, executive director of Park Pride, said he chose to live in Atlanta's Candler Park neighborhood because it's close to parks, restaurants, stores and MARTA. Both his sons, ages 5 and 8, are used to walking, he said. "We recognize that encouraging your kids to walk early is the best way to ensure they stay healthy," he said. "I hate driving with a passion. So for me it's an environmental thing and it's a health thing."

Comparing Transportation Objectives

For this analysis it is interesting to compare the value of public health improvements with other transport planning objectives. Figure 11 illustrates the estimated magnitude of various transport costs. It indicates that crash damages are the largest categories of these costs, due to the large number of people killed and injured in the prime of life, and associated property damages (Miller 1999). As mentioned earlier, air pollution damages probably cause a similar number of premature deaths, but these generally involve older people and therefore cause smaller reductions in Disability Adjusted Life Years (DALY), and air pollution causes less property damage. The health costs of sedentary transport are even more difficult to quantify, but a plausible guess is that they are at least as great as the costs of air pollution, and may exceed the costs of crash damages.

Figure 11 Costs of Motor Vehicle Use in the U.S. (Litman 2010)



This figure illustrates the estimated magnitude of various transportation costs. Crash damages are one of the largest costs, far greater than traffic congestion or pollution costs.

This has important implications for transport planning. It indicates that a congestion reduction strategy is probably not worthwhile if it causes even small increases in crashes, pollution emissions or inactive transport. For example, if roadway capacity expansion reduces congestion by 10%, but increases crash damages by 2% due to additional vehicle travel or higher traffic speeds, its incremental costs exceed its incremental benefits. However, a congestion reduction strategy provides far greater total benefits if it causes even small reductions in crashes and pollution, or small increases in walking and cycling among people who are overly sedentary. For example, a strategy that reduces congestion by 5% provides twice the total benefit to society if it also reduces crashes by 1%.

Planning Practices

Current transport planning tends to focus on a subset of the various health impacts described above. Transportation professionals devote considerable attention to vehicle occupant safety and tailpipe emissions, measured per unit of travel, but give little consideration to the crash and environmental risks associated with increased vehicle mileage, or to the impacts their decisions have on physical activity and fitness.

Although transportation professionals do not intentionally increase vehicle mileage or reduce use of active modes, conventional transport planning practices are biased in various ways that tend to overvalue automobile-oriented improvements and undervalue alternative modes and mobility management strategies (Litman 2008b; MacMillen, Givoni And Banister 2010; Tranter 2010). Individually such transport planning decisions usually appear modest and justifiable, but they tend to create automobile-dependent transport systems and land use patterns that significantly increase per capita vehicle travel and reduce active transport.

Current transport planning tends to undercount and undervalue nonmotorized transportation (Litman 2002). Travel surveys ignore most walking trips. For example, if a traveler takes 10 minutes to walk to a bus stop, rides on the bus for five minutes, and takes another five minute walk to their destination, this *walk-transit-walk* trip is usually counted simply as a transit trip, even though the nonmotorized links take more time than the motorized link. Similarly, a 5-minute walk from a parking space to a destination is ignored. One researcher estimates that the actual number of nonmotorized trips is six times greater than what conventional surveys indicate (Rietveld 2000).

Current transportation and land use patterns tend to create barriers to walking and cycling (Jackson and Kochtitzky 2001). Widening roads, increasing traffic speeds, increasing parking supply and dispersing destinations all tend to make landscapes that are less suitable for nonmotorized transportation. Communities with suitable transportation and land use patterns have significantly higher levels of walking and cycling (Ewing and Cervero 2002; Boarnet and Crane 2001; Litman 2005).

Are there ways to achieve both transport planning objectives such as reduced congestion, and public health objectives such as reduced per capita crash rates and improved fitness? Yes there are. The general term for these is *Mobility Management* (also called *Transportation Demand Management* or *TDM*), which refers to various strategies that encourage more efficient use of transport resources. Mobility management is the transportation component of Smart Growth and Smart Growth is the land use component of mobility management (Killingsworth and Lamming 2001). Most of these strategies can help achieve a variety of planning objectives such as infrastructure cost savings, consumer choice, community livability and equity. Table 2 lists various mobility management strategies.

Table 2 **Mobility Management Strategies (VTPI 2004)**

Improve Transport Options	Incentives to Reduce Driving	Parking and Land Use Management	Programs and Policy Reforms
Alternative Work Schedules	Walking And Cycling Encouragement	Bicycle Parking	Access Management
Bicycle Improvements	Commuter Financial Incentives	Car-Free Districts and Pedestrianized Streets	Campus Transport Management
Bike/Transit Integration	Congestion Pricing	Clustered Land Use	Carfree Planning
Carsharing	Distance-Based Pricing	Location Efficient Development	Commute Trip Reduction Programs
Flextime	Fuel Taxes	New Urbanism	Market Reforms
Guaranteed Ride Home	HOV (High Occupant Vehicle) Priority	Parking Management	Context Sensitive Design
Park & Ride	Parking Pricing	Parking Solutions	Freight Transport Management
Pedestrian Improvements	Pay-As-You-Drive Vehicle Insurance	Parking Evaluation	Least Cost Planning
Ridesharing	Road Pricing	Shared Parking	Regulatory Reform
Shuttle Services	Speed Reductions	Smart Growth	School Transport Management
Small Wheeled Transport	Street Reclaiming	Smart Growth Planning and Policy Reforms	Special Event Management
Taxi Service Improvements	Vehicle Use Restrictions	Transit Oriented Development (TOD)	Mobility Management Marketing
Telework			Tourist Transport Management
Traffic Calming			Transportation Management Associations
Transit Improvements			
Universal Design			

Mobility management includes more than three dozen strategies that improve transportation options, encourage use of efficient modes, and create more accessible land use patterns.

Conventional transportation decision-making does not completely ignore mobility management, but tends to consider it a last resort for extreme urban traffic problems, to be implemented if conventional engineering solutions are infeasible. It is not usually considered a safety strategy. When transportation agencies evaluate strategies for achieving objectives such as reducing traffic congestion, parking problems or per-km crash risk, mobility management strategies do not usually rank very high. Most individual mobility management strategies have modest impacts, typically affecting only a small portion of total vehicle travel. However, these impacts tend to be cumulative and synergetic (total impacts can be greater than the sum of their individual impacts). A comprehensive mobility management program using a complementary set of cost-effective strategies (i.e., strategies that are fully justified for their direct economic and consumer benefits) can often reduce total per capita automobile travel by 20-40% compared with conventional, automobile dependent transportation and land use policies.

Safety and Health Impacts of Mobility Management Strategies

This section describes the safety and health impacts of various mobility management strategies. For more information see specific chapters in the *Online TDM Encyclopedia* (VTPI 2004).

Vehicle Travel Reduction Incentives

Many mobility management strategies (road and parking pricing, marketing programs, vehicle use restrictions) give motorists incentives to reduce their vehicle mileage. Some studies indicate that given modest incentives and encouragement, many people can reduce their vehicle travel by 10-20% (*TravelSmart* 2005).

A given change in annual mileage tends to cause a proportional change in that vehicle's chance of causing a crash and a proportionally greater change in total crash damages. For example, if you reduce your chances of *causing* a crash by 10% (perhaps by driving more cautiously), your total crash risk declines by about 7%, since other drivers cause about 30% of the crashes you are involved in. If your annual mileage declines by 10%, your chance of causing a crash declines by 10%, and your risk of being in a collision caused by other drivers' mistakes also declines, since you are no longer a crash target for those miles. If all other motorists reduce their mileage by 10%, but you do not, you can expect a 7% reduction in crash risk, since 70% of your crashes involve another vehicle (you are no longer at risk from their mistakes, and they are no longer at risk from your mistakes for the miles not driven). If all motorists reduce mileage by 10% and other factors are held constant, total crash costs should decline by about 17% (10% + 7%). Empirical studies support this conclusion, indicating that each 1.0% vehicle mileage reduction causes a 1.4-1.8% reduction in crashes, although these impacts may vary depending on the type of mileage reduced (Litman 2001; Edlin 1998).

Reductions in per capita vehicle mileage provide air emission reduction benefits. To the degree that they result in shifts to nonmotorized modes by otherwise sedentary people, they provide fitness benefits.

Congestion Pricing Safety Impacts (London 2004)

The central London congestion charging scheme was introduced on 17 February 2003, with the primary aim of reducing traffic congestion in and around the charging zone (London, 2004). First year results indicate that the program has reduced accidents:

- Total vehicle-kilometres reduced by 12%, car traffic reduced by 30%, crashes declined 28%.
- Moped and motorbike travel increased 10 –15%, with 4% fewer crashes.
- Bicycle travel increased 20%, with a 7% reduction in crashes.
- Crashes involving pedestrians declined 6%.
- Increased bus journey time reliability by up to 60%.
- No evidence of any overall increase in road traffic outside the zone.
- Subjective improvements in noise and air quality.

Pay-As-You-Drive Vehicle Insurance (Litman 2001; Edlin 1998)

Pay-As-You-Drive pricing converts vehicle insurance premiums from fixed costs into variable costs. Existing premiums are prorated by annual mileage, so insurance is priced by the vehicle-kilometer rather than the vehicle-year. This gives motorists an incentive to reduce their driving, with greater incentives for higher risk categories. For example, a low-risk motorist who currently pays \$300 annually for insurance would pay about 2.5¢ per mile, and so is predicted to reduce their mileage an average of 5%, while a higher-risk motorist who currently pays \$1,800 for insurance would pay 15¢ per mile, and so might reduce their annual mileage by 20%, since they save far more with each mile reduced. As a result this strategy can provide extra safety benefits. It also reduces pollution emissions and may cause some automobile travel to shift to nonmotorized modes.

Mode Shifting

Many mobility management strategies cause travelers to shift from driving to another transport mode, either by making alternatives more attractive or by discouraging automobile use. The safety impacts of shifts to specific modes are discussed below.

Public Transit (Litman 2010b)

Shifting from automobile to transit travel tends to reduce overall crash risk. Transit passengers have about one-tenth the crash fatality rates of automobile occupants, and shifts to transit reduce total vehicle traffic, reducing risks to other road users. In the U.S., transit has a relatively high fatality rates (including both occupants and other road users) per passenger-mile due to low load factors (passengers per vehicle-mile), but strategies that increase load factors have small marginal crash risk and so reduce crash rates.

Transit can be a catalyst for more accessible land use patterns that reduce per capita automobile travel and increase walking. Per capita traffic fatalities tend to be lower and per-capita walking trips tend to be higher in transit-oriented urban areas than in automobile-oriented cities (Page 2001). Most transit trips involve walking or cycling links, to get to a transit stop and to travel from a transit stop to the ultimate destination. Transit oriented communities require good walking conditions. As a result, mobility management strategies that encourage transit use are likely to increase active transport (MacDonald, et al. 2010).

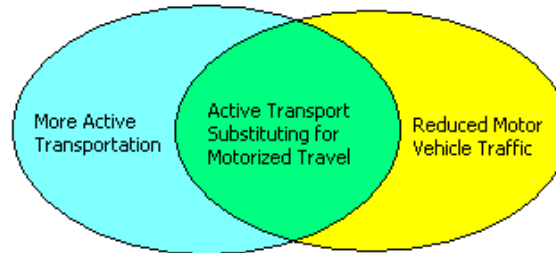
Ridesharing

Ridesharing refers to carpooling and vanpooling. Ridesharing reduces overall crash risk by reducing total vehicle traffic. Two people who carpool rather than drive alone bear about the same level of internal risk but reduce risk to others. It may result in somewhat safer driving, for example because drivers may be more cautious when they have passengers, carpools may tend to rely more on their more skilled motorist or safer vehicle, and because vanpool operators are sometimes required to take special safety tests. Some High Occupant Vehicle lanes have relatively high crash rates due to awkward merging conditions, and vanpools may have a relatively high rollover rate which may increase crash severity under some conditions, but there is currently insufficient data to quantify these factors, and improved designs have reduced these risks. Ridesharing

reduces air pollution and may increase walking, for example, rideshare commuters are more likely to walk for errands during breaks than if they had driven to work.

Nonmotorized Transport

Walking and cycling (also called *nonmotorized*, *human powered* or *active* transport) can provide a variety of benefits to individuals, businesses and governments, particularly when it substitutes for motorized travel, as illustrated below.



More active transport improves physical fitness, and provides additional health benefits when it reduces motor vehicle traffic, including reduced crash risk imposed on other road users, and reduced air pollution emissions.

Empirical evidence indicates that shifts from driving to nonmotorized modes tends to reduce per capita crashes. Urban regions with high rates of walking and cycling tend to have lower per capita traffic fatalities than more automobile-dependent communities. For example, walking and cycling travel rates are high in the Netherlands, yet the per capita traffic death rate is much lower than in automobile dependent countries (Pucher and Dijkstra 2000).

Residents of areas with higher rates of walking and cycling experience less obesity, diabetes and hypertension (Ewing, et al. 2003). For example, residents of the Netherlands, Denmark and Sweden have obesity rates only a third of those in the U.S., and Germany's is only half as high; residents of these four European countries live an average of 2.5 to 4.4 years longer while spending half as much on health care as in the U.S. (Pucher and Dijkstra 2003). Similar patterns are found in Shanghai, China (Matthews, et al. 2007).

Shifts from automobile to walking and cycling can provide proportionately large air pollution emission reductions because they usually replace short, cold start trips for which internal combustion engines have high emission rates. As a result, each 1% of automobile travel shifted to nonmotorized modes decreases motor vehicle air pollution emissions by 2% to 4% (Komanoff and Roelofs 2003).

Walking and cycling tend to have relatively high per-kilometer casualty rates, however, shifts from driving to nonmotorized travel does not necessarily increase overall health risks because (Litman 2004b):

- Nonmotorized travel imposes minimal crash risk to other road users.

- Nonmotorized trips tend to be shorter than motorized trips, so total per capita mileage declines. A local walking trips often substitutes for a longer automobile trip.
- High crash and casualty rates for pedestrians and cyclists result, in part, because people with particular risk factors tend to use these modes, including children, people with disabilities and elderly people. A skilled and responsible adult who shifts from driving to nonmotorized travel is likely to experience less additional risk than average values suggest.
- Nonmotorized travel provides health benefits that can offset crash risk. One study found that bicycle commuters have a 40% lower mortality than people who do not cycle to work, which suggests that the incremental risks of cycling are outweighed by health benefits, at least for experienced adult cyclists riding in a bicycle-friendly community (Anderson, et al. 2000).
- Some mobility management programs include education and marketing components that encourage safety, particularly for cycling. These can reduce per-kilometer crash rates (experienced cyclists tend to have lower per-kilometer crash rates than inexperienced, less skilled cyclists), although it is difficult to predict how much effect this has.

Active Transportation as an Investment (by John Z. Wetmore)

Health researchers recommend devoting about 30 minutes, or about 2% of each day, in moderate exercise, such as walking or cycling. Is this time a worthwhile investment?

The GAM83 mortality table used by insurance actuaries gives the probability of dying within one year for an X-year-old, for X from 5 to 110 (“Qx” for short). This table indicates that the expected value of age-at-death for an 18-year-old male alive today is 77.8, or 59.8 more years. An 18-year old male would need to live 102% of 59.8 = 61.0 years, or age at death 79.0 to offset a 30 minute a day exercise investment. That is, it is worthwhile to invest 2% of each day if it reduces the probability of death by 11% for later ages. Each Qx can be multiplied by a constant “C” that represents a reduction in the risk of dying (e.g., if Q76 = 4.9% and C = 0.8 then Q76 = 4.9% * 0.8 = 3.92%). The objective is to find C such that the expected age at death increases from 77.8 to 79.0. As it turns out, C is 0.89.

According to the Honolulu Heart Study (www.agenet.com/watchful_walking_adds.html), the probability of death for 61 to 81 year old males is about 50% less for those who walk two miles per day. Taking C times Q61 through Q81 and leaving alone Q5 through Q60 and Q82 through Q110. C turns out to be 0.84. That is, 30 minutes daily exercise is a worthwhile investment if the probability of death is 16% lower for ages 61 to 81 and unchanged for all other ages. The observed reduction of 50% is much better than the break-even point of 16% reduction.

Not only that, but many people consider time spent on moderate exercise enjoyable. The result is a double return on investment: health and enjoyment.

Meta-analysis by de Hartog, et al. (2010) indicates that people who shift from car to bicycling enjoy substantially larger health benefits (3 – 14 months gained) than the potential mortality effect of increased inhaled air pollution doses (0.8 – 40 days lost) and the increase in traffic accidents (5 – 9 days lost). Societal benefits are even larger due to reductions in air pollution and accident risk to other road users. The researchers conclude that the estimated health benefits of cycling were substantially larger than the risks relative to car driving for individuals shifting mode of transport.

Mobility Substitutes

Mobility substitutes include telework and delivery services. They tend to reduce vehicle mileage, which reduces crashes, although there may be rebound effects, such as the tendency of telecommuters to make special trips for errands that they would otherwise perform while commuting, and to move farther from their worksite to less accessible, exurban locations. This typically offsets about a third of mileage reductions and associated safety benefits (Mokhtarian 2000). For example, an employee who telecommutes three days a week would reduce commute mileage by 60%, but may drive additional miles for errands, resulting in a 40% net reduction in vehicle mileage and more modest safety benefits. Mobility substitutes that reduce total vehicle travel can provide significant air emission reductions, but they do not necessarily provide direct health and fitness benefits.

Travel Time and Route Shifts

Mobility management strategies that shift vehicle travel from peak to off-peak periods, or from congested highways to alternative routes, have mixed safety impacts. Per mile crash rates are lowest on moderately congested roads, and increase with lower and higher congestion levels, but fatalities decline at high levels of congestion, indicating a trade-off between congestion reduction benefits and crash fatalities (Shefer and Rietvald 1997). Shifting vehicle trips to less congested roadway conditions can reduce crashes, but the crashes that occur tend to be more severe due to higher travel speeds. As a result, the safety impacts of mobility management strategies that shift travel times and routes vary depending on specific circumstances, and are difficult to predict. Shifting travel time or route tends to do little to reduce air pollution emissions or increase health and fitness.

Traffic Speed Reductions

The emphasis in transport planning on increasing vehicle traffic speeds, which favors motor vehicle travel over slower modes, can contribute to ill-health through its impacts on local air pollution, greenhouse gas production, inactivity, obesity and social isolation (Tranter 2010). There has been considerable research concerning the effects of traffic speed and speed control strategies on road safety. Traffic calming (roadway design strategies to reduce traffic speeds on a particular roadway) and increased traffic law enforcement tend to increase safety. A meta-analysis of 33 studies concluded that area-wide traffic calming programs reduce injury accidents by about 15%, with reductions of about 25% on residential streets and about 10% on main roads (Elvik 2001).

Traffic speed reductions have mixed air emission impacts, depending on traffic conditions, driving conditions, vehicle type and which emissions are considered. Speed reductions can improve walking and cycling conditions, and so can improve health and fitness if applied to areas with latent demand for nonmotorized travel.

Smart Growth

Per capita traffic fatality rates tend to increase with urban sprawl, due to increased per capita vehicle mileage and traffic speeds. Previously described research indicates that regions with Smart Growth development patterns (higher density, with more balanced transportation systems) have a fifth the per capita traffic fatality rate as highly sprawled regions, and even greater differences exist at the local level.

Higher density development can increase per-kilometer emission rates (due to increased congestion) and exposure (due to more people located near roadways), but reduced per capita vehicle mileage. This tends to reduce overall pollution emissions (Ewing, Pendall and Chen 2002). Traditional community design is associated with increased walking and bicycling (Friedman, Gordon and Peers 1995). This suggests that mobility management strategies which create more accessible land use and more balanced transport systems can increase overall health, although more research is needed to quantify these impacts (Frank and Engelke 2000).

The research project, *Neighbourhood Design, Travel, and Health* (Frank, et al. 2010) describes various factors that affect walkability, methods for measuring those factors to create a walkability index, and the impacts of neighborhood walkability on per capita automobile travel, physical activity and fitness in the Vancouver, BC metropolitan region. The results indicate that:

- Adults living in the top 25% most walkable neighborhoods walk, bike and take transit 2-3 times more, and drive approximately 58% less than those in more auto-oriented (less walkable) areas.
- Residents living in the most walkable areas, with good street connectivity and land use mix, were half as likely to be overweight than those in the least walkable neighborhoods.
- Living in a neighbourhood with at least one grocery store was associated with a nearly 1.5 times likelihood of getting sufficient physical activity, as compared to living in an area with no grocery store, and each additional grocery store within a 1-kilometer distance from an individual's residence was associated with an 11% reduction in the likelihood of being overweight.
- The most walkable neighborhoods have the least ozone pollution, but the most pollution from nitric oxide. Neighborhoods with relatively high walkability and low pollution levels exist across the region.

Below is a list of specific planning practices that help create healthier communities:

- *Strategic planning.* Is there a comprehensive community vision which individual land use and transportation decisions should support?
- *Self-contained community.* Are common services such as shops, medical services, transit service, schools and recreation facilities located within convenient walking distance of houses and each other? Is there a good jobs/housing ratio within a 2-mile radius?
- *Walkability.* Do streets have sidewalks? Are sidewalks well designed, maintained and connected, and suitable for people using wheelchairs and pushing strollers and carts? Are streets easy to cross, even by people with disabilities?
- *Cycling.* Are there adequate bike paths, lanes and routes? Are there cycling skills training and law enforcement programs? Are there bike racks and changing facilities at worksites?
- *School access.* Are most children able to walk or bicycle to school? Are walking and cycling condition around the school adequate. Are there programs to improve walking and cycling, and encourage use of alternative modes for travel to school?
- *Mixed income communities.* Are there a mix of housing types and prices, allowing lower income and disabled people to live in the community? Are there programs to insure affordable housing is located in accessible, multi-modal areas where residents can easily walk to public services such as stores, medical clinics and transit stops?
- *Sense of place.* Does the community have a strong sense of identity and pride? Does the neighborhood have a name?
- *Transit service quality.* Does the neighborhood have high quality public transit, with more than 20 buses or trains a day (less than half-hour headways) and little crowding during peak periods?
- *Parking management.* Are parking requirements flexible, so developers and building managers can reduce their parking supply in exchange for implementing a parking management program?
- *Roadway and walkway connectivity.* Are streets and paths well-connected, with short blocks and minimal cul-de-sacs. Are streets as narrow as possible, particularly in residential areas and commercial centers. Are traffic management and traffic calming to control vehicle impacts.
- *Complete streets.* Are streets designed to accommodate walking, cycling and public transit, and comfortable and convenient for activities such as strolling, playing, shopping, sightseeing, eating and special events?
- *Site design and building orientation.* Are buildings to be oriented toward city streets, rather than set back behind large parking lots?
- *Transportation demand management.* Are TDM strategies and programs implemented to the degree that they are cost effective? Do employers have incentives to implement commute trip reduction programs? Is there a local transportation management association?
- *Greenspace.* Are there efforts to preserve greenspace, particularly wild areas such as streams, shorelines and forests?

To help consumers, real estate professionals and planning practitioners apply these concepts the *Healthy Location Index* below indicates the degree to which a particular site or neighborhood reflects healthy community planning principles.

Table 3 Healthy Community Index Calculations

Feature	How to Calculate	Points
Sidewalks on block	No (0 points) Yes (10 points)	
Portion of local streets with sidewalks.	Range from 0 points for no street within ½ kilometer have sidewalks up to 10 points for all streets have sidewalks.	
Portion of local streets and paths that accommodate wheelchairs.	Range from 0 points for no street within ½ kilometer with sidewalks that accommodate wheelchairs, up to 10 points for all streets with sidewalks that accommodate wheelchairs.	
School walkability	10 minus number of minutes required for a child to walk safely to school. 0 if walking to school is not feasible for a typical child.	
Cycling conditions	Portion of streets within 1 kilometer that safely accommodate bicycles, rated from 0 to 10.	
Neighborhood service destinations	One point for each of the following located within ½ kilometer convenient walking distance, up to 10 maximum: grocery store, restaurant, video rental shop, public park, recreation center, library.	
Public transit service quantity	Number of peak period buses per hour within ½ kilometer, up to 10 maximum.	
Public transit service quality	Portion of peak-period transit vehicles that are clean and comfortable from 0 (all vehicles are dirty or crowded) up to 10 (all vehicles are clean and have seats available).	
Local traffic speeds	Portion of vehicle traffic within 1-kilometer that have speeds under 40 kilometers per hour, from 10 (100%) to 0 (virtually none).	
Air Pollution	10 minus one for each exceedance of air quality standards.	
	<i>Total</i>	

This table summarizes the calculation of the Healthy Community Index, which can range from 0 (unhealthy location) to 100 (healthy location). It reflects various neighborhood design factors that affect residents' health.

Health Impacts Summary

Table 4 summarizes the safety and public health impacts of various mobility management strategies.

Table 4 Mobility Management Safety and Health Impact Summary

Travel Change	Strategies	Safety	Pollution	Fitness
Vehicle Mileage Reductions	Pricing, marketing, mode shifting and other incentives.	Each 1% mileage reduction reduces crashes 1.2-1.8%.	Proportional reduction in emissions.	May increase walking and cycling
Distance-Based Insurance	PAYD Insurance, Distance-based pricing.	Large potential safety benefits since higher risk drivers have the greatest incentive to reduce mileage.	10% mileage and emission reduction per participating vehicle.	May increase walking and cycling
Shifts to Transit	Transit Improvements, HOV Priority, Park & Ride	Increases safety due to greater safety for transit passengers and reduced vehicle traffic.	Reduces emissions, particularly if it leverages overall reductions in per capita mileage.	Generally increases walking and cycling.
Shifts to Ridesharing	Ridesharing, HOV Priority	Modest safety benefits.	Emission reductions proportional to mileage reductions.	May encourage some additional walking.
Shifts to Nonmotorized Modes	Walking and Cycling Improvements, Traffic Calming	Increases risk to participants, but reduces risk to other road users.	Reduces emissions.	Large potential benefits.
Mobility Substitutes	Telework, Delivery Services	Increases safety by reducing vehicle mileage, but rebound effects often offset some benefits.	Reduces emissions, but rebound effects often offset a portion of benefits.	No direct benefits.
Time & Route Shifts	Flextime, Congestion Pricing	Mixed. Reducing congestion tends to reduce crashes but increases the severity of crashes that do occur.	Mixed. Reducing congestion tends to reduce some emissions but increases others.	No direct benefits.
Traffic Speed Reductions	Traffic Calming, Speed Enforcement	Significantly increases safety by reducing crash frequency and severity.	Mixed. Reducing speed reduces some emissions but increases others.	Can significantly increase walking and cycling.
Land Use & Transport System Changes	Various land use management and planning reforms	Increases safety by reducing per capita vehicle mileage and traffic speeds.	Increased density increases some emissions and exposure, but tends to reduce total emissions.	Can significantly increase walking and cycling.

This table summarizes the crash reductions, emission reductions and fitness impacts of various mobility management strategies.

Conclusions

Transportation planning decisions affect human health in three ways: through traffic risk, pollution emissions, and by affecting physical activity and fitness. Although these risks are difficult to quantify with precision, they are each significant in magnitude, affecting large numbers of deaths and physical disabilities. Put more positively, transportation planning decisions that reduce these risks can provide significant human health benefits, resulting in reduced suffering, cost savings and increased productivity.

Conventional transportation decision-making tends to use a reductionist approach in which different organizations are responsible for narrowly-defined problems. As a result, they can implement solutions to one problem that exacerbate other problems, and they tend to undervalue strategies that provide multiple benefits.

Transportation agencies tend to focus on some health impacts while overlooking others. They give considerable attention to per-kilometer crash risk and pollution emissions, but generally ignore crash risk and pollution emissions that result from increased vehicle mileage, and negative health impacts from less physical activity. As a result, they tend to overvalue roadway and parking capacity expansion, and undervalue mobility management strategies that reduce vehicle travel and increase transport system diversity.

Health impacts are often greater in magnitude than impacts given priority in transport planning, such as traffic congestion. As a result, congestion reduction strategies that cause even a small increase in per capita crashes, emissions or physical inactivity are probably harmful to society overall, while congestion reduction strategies that support safety, environment and health objectives provide far greater total benefits.

Many factors affect transportation health impacts. Less developed countries tend to have high per-kilometer crash rates and pollution emissions, which decline with increased motorization, as vehicles, roads and traffic safety behavior improve. However, at a particular level of development, traffic risk and pollution emissions are significantly affected by per capita vehicle travel.

Mobility management can provide significant public health benefits, including improved safety, air quality and fitness. Yet, transportation professionals generally overlook traffic safety benefits when evaluating mobility management programs, and traffic safety professionals generally overlook mobility management as a traffic safety strategy. This reflects, in part, their tendency to measure traffic risk per vehicle-kilometer, which ignores the potential safety benefits of reduced vehicle travel.

Raising the priority of safety and health objectives in transport planning would reduce emphasis on roadway capacity expansion and increase emphasis on mobility management strategies, particularly those that result in more walking and cycling. This could provide significant health and safety benefits. Integrating health objectives into transport planning can be one of the most cost-effective ways to improve public health, and improved public health can be among the greatest benefits of mobility management.

Information Resources

Below are various information resources concerning transportation and health.

ABW (2010), *Bicycling and Walking in the U.S.: 2010 Benchmarking Report*, Alliance for Biking & Walking, (www.peoplepoweredmovement.org); at www.peoplepoweredmovement.org/site/index.php/site/memberservices/C529.

Active Living by Design (www.activelivingbydesign.org) encourages physical activity and health through community design and public policy strategies.

Active Living Storybank (www.activeliving.org) is a searchable database of projects, programs and initiatives that promote health through changes in the built environment, public policy and education.

Active Living Website (www.icma.org) by the International City/County Management Association.

AJHP, “Special Issue: Health Promoting Community Design,” *American Journal of Health Promotion* (www.healthpromotionjournal.com), Vol. 18, No. 1, Sept./Oct. 2003.

AJPH (2003), “Built Environment and Health,” *American Journal of Public Health* (www.ajph.org), Vol. 93, No. 9, September. Many of these articles are available at the *Active Living By Design* (www.activelivingbydesign.com) website.

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

America WALKs (www.webwalking.com/amwalks) is a coalition of walking advocacy groups.

American Academy of Pediatrics (2009), “The Built Environment: Designing Communities to Promote Physical Activity in Children,” *Pediatrics* Vol. 123 No. 6, June 2009, pp. 1591-1598 (doi:10.1542/peds.2009-0750); at <http://aappolicy.aappublications.org/cgi/content/full/pediatrics;123/6/1591>.

Lars Bo Andersen, et al. (2000), “All-Cause Mortality Associated With Physical Activity During Leisure Time, Work, Sports and Cycling to Work,” *Archives of Internal Medicine* Vol. 160, No. 11 (<http://archinte.ama-assn.org/issues/v160n11/full/loi90593.html>), pp. 1621-1628.

APA (2003), *Planning and Designing the Physically Active Community: A Resource List*, American Planning Association (www.planning.org/physicallyactive/pdf/ReferenceList.pdf).

APHA (2010), *The Hidden Health Costs of Transportation: Background*, American Public Health Association (www.apha.org); at www.apha.org/advocacy/reports/reports.

APHA (2011), *Transportation Issues from the Public Health Perspective: Website*, American Public Health Association (www.apha.org); at www.apha.org/advocacy/priorities/issues/transportation.

APTA (2003), *The Route to Better Personal Health*, American Public Transportation Association (www.apta.com); at http://spider.apta.com/lgwf/legtools/better_health.pdf.

J. Ball, M. Ward, L. Thornley, and R. Quigley (2009), *Applying Health Impact Assessment To Land Transport Planning*, Research Report 375, New Zealand Transport Agency (www.landtransport.govt.nz); at www.landtransport.govt.nz/research/reports/375.pdf.

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Endnotes

¹ Of course, these do not indicate the degree to which transportation affects each of the health risks: motor vehicle air pollution is only one of many contributors to respiratory illnesses, and nonmotorized travel is just one physical fitness strategy.

² *Web-based Injury Statistics Query and Reporting System: Years of Potential Life Lost (YPLL)*. National Center for Injury Prevention and Control, National Center of Disease Control and Prevention (www.cdc.gov/ncipc/wisqars), accessed 17 March 2003.