

If Health Matters

Integrating Public Health Objectives in Transportation Planning

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Abstract

This report investigates various ways that transportation planning decisions affect public health, and how planning practices can better incorporate public health objectives. Conventional planning tends to consider some public health impacts, particularly traffic accident risks and pollution emissions measured per vehicle-kilometer, but generally ignores the additional accidents and pollution emissions caused by increased vehicle mileage, and health problems resulting from less active transport (reduced walking and cycling activity). This tends to undervalue strategies that reduce total vehicle travel and increase transport system diversity. This study identifies various “win-win” strategies that help improve public health and achieve other planning objectives.

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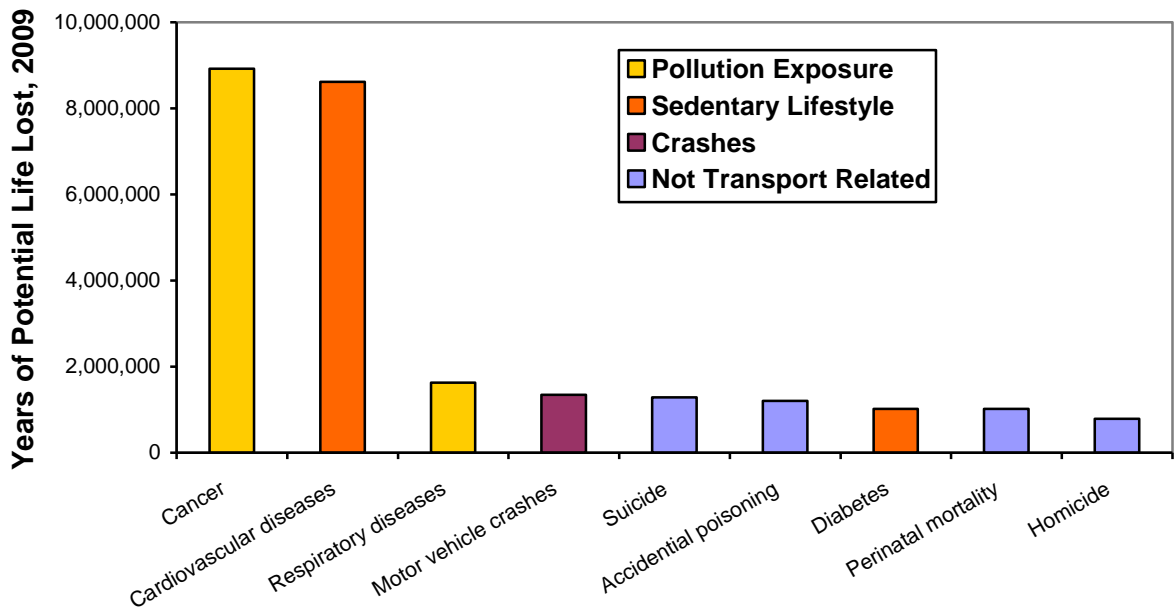
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Introduction

Most people want to lead healthy lifestyles. There is much that people can do individually to protect their health including driving safely, wearing seatbelts, avoiding tobacco smoke and air pollution, exercising regularly, eating healthy food and having regular checkups. But many health risks are also influenced by community factors, including transportation and land use planning decisions. This report examines how transport policies and planning practices can help create healthier communities.

Transport affects health in various ways. Transport policies and planning decisions affect rates of cancer, cardiovascular disease and traffic crashes, (three of the largest causes of reduced longevity in the U.S., as illustrated in Figure 1) and can also affect people’s ability to access health-related goods and services such as food and healthcare.

Figure 1 Leading Causes of Reduced Longevity, U.S. (Subramanian 2012)



Transport planning decisions affect major health risks including cancer, cardiovascular disease, traffic accidents and diabetes by influencing pollution exposure, physical activity and crashes. Of course, other factors also affect these risks including other pollution sources and individual behaviors.

New research is revealing how specific policy and planning decisions affect health outcomes (APHA 2010). Some of these relationships are indirect and complex, and so may be overlooked or undervalued in conventional planning. More comprehensive analysis can better incorporate public health objectives into transport planning.

This report investigates these issues. It describes how transport planning decisions affect public health, discusses new perspectives and strategies for evaluating public health impacts, and identifies “win-win” solutions that can help improve public health in addition to other planning objectives such as traffic and parking congestion reduction.

Transportation Health Impacts

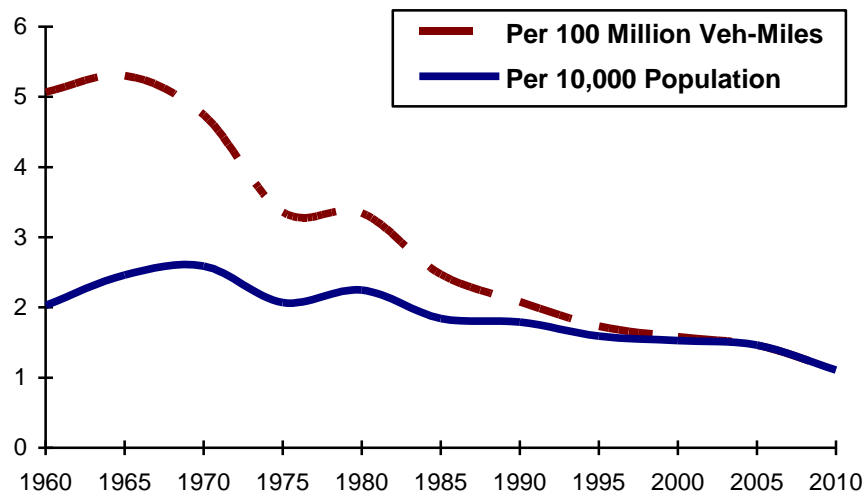
Major categories of transport-related public health impacts are discussed below.

Traffic Crashes

Traffic accidents are a major cause of injuries and deaths (together called *casualties*). This risk can be viewed in different ways which lead to different conclusions about this danger and the effectiveness of traffic safety strategies. The conventional paradigm assumes that motor vehicle travel is overall safe, and most crashes result from specific high-risk groups and behaviors such as inexperienced and impaired drivers, so safety programs should target these risks (FHWA 2010). Drivers tend to take pride in their skill and responsibility, and most consider themselves “safer than average,” called *superiority bias* (McCormick, Walkey and Green 1986). From this perspective it would be inefficient and unfair to increase safety by reducing overall vehicle travel since this “punishes” all motorists for problems caused by an irresponsible minority. An alternative paradigm recognizes that all vehicle travel imposes risk; even drivers who observe all traffic laws contribute to accidents outside their control, such as a vehicle or roadway failure, and by being a potential target of another driver’s errors.

Conventional traffic safety analysis tends to measure crash rates per unit of travel (i.e., injuries or fatalities per million vehicle-miles or billion passenger-kilometers). Evaluated this way, U.S. crash rates declined more than two thirds between 1960 and 2000, indicating that traffic safety programs are successful. But per capita vehicle travel more than doubled during this period which largely offset declining per-kilometer crash rates as illustrated in Figure 2. If measured per capita (e.g., per 10,000 population), as with other health risks, there was relatively little improvement despite large investments in safer roads, improved vehicle occupant crash protection, reductions in drunk driving, as well as improved emergency response and trauma care during this period.

Figure 2 U.S. Traffic Fatalities (BTS 2000)



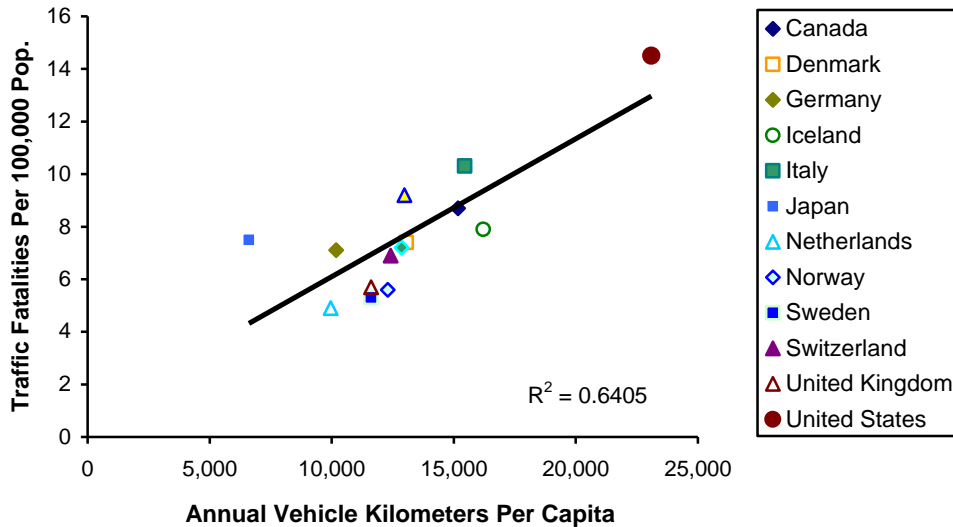
This figure illustrates traffic fatality trends over six decades. Per mile crash rates declined substantially, but per capita crash rates declined little despite significant traffic safety efforts. Both crash rates declined together after 2000 when per capita vehicle travel started to decline.

Taking these factors into account, much greater casualty reductions should have been achieved. For example, the increase in seat belt use, from about 0% in 1960 up to 75% in 2002, by itself should reduce fatalities by about 33% (wearing a seatbelt reduces crash fatality rates about 45%), yet, per capita traffic deaths only declined about 25% during that period. Some research indicates that if motorists feel safer, for example because their vehicles have airbags, they tend to drive more *intensively* (take more risks, such as driving faster) which reduces net safety gains (Chirinko and Harper 1993).

The conventional safety paradigm emphasizes that most crashes are associated with special risk factors, so general increases in vehicle travel need not increase crashes, and general (not targeted at high-risk driving) vehicle travel reduction strategies (called *mobility management* or *transportation demand management*) do little to increase safety. However, extensive research based on various analysis methods and data sets indicates that per capita traffic casualties do increase with per capita vehicle travel and general vehicle travel reductions do significantly reduce crashes (Duduta, Adriazola-Steil and Hidalgo 2013; Ilyushchenko 2010; Sivak and Schoettle 2010). Although crash rates vary depending on driver, vehicle and conditions, broad changes in mileage tend to include a mix of higher- and lower-risk vehicle kilometers, and since most injury crashes involve multiple vehicles, broad vehicle travel reductions tend to provide additional safety by reducing traffic density and therefore the frequency of interactions among vehicles (Litman and Fitzroy 2011; Vickrey 1968).

The relationship between mileage and traffic fatalities varies between regions. Less developed countries tend to have high traffic casualty rates which decline with increased motorization due to improved roads and vehicles, better driver training and traffic law enforcement, plus improved emergency response and medical treatment (WHO 2004). However, among peer countries, per capita crash rates tend to increase with per capita vehicle travel, as illustrated in Figure 3.

Figure 3 Vehicle Travel and Traffic Fatality Rates In OECD Countries (OECD 2006)



Among developed countries, per capita traffic fatalities increase with per capita vehicle travel.

Table 1 Fatalities Per Billion Miles Traveled, 2001 (Litman and Fitzroy 2011, Table 8)

	User	Others	Totals
Intercity Bus	0.3	0	0.3
Heavy Rail	1.8	0.4	2.2
Transit Bus	0.6	4.4	5.0
Passenger Car	7.9	1.3	9.2
Trucks – Light	8.2	2.3	10.5
Trucks – Heavy	2.8	16.7	19.5
Bicyclists	82	0	82
Pedestrians	198	0	198
Motorcyclists	303	1.8	305

This table compares traffic fatality rates for various travel modes. Crash rates are lowest for public transit, higher for automobile travel, and highest for walking, cycling and motorcycles.

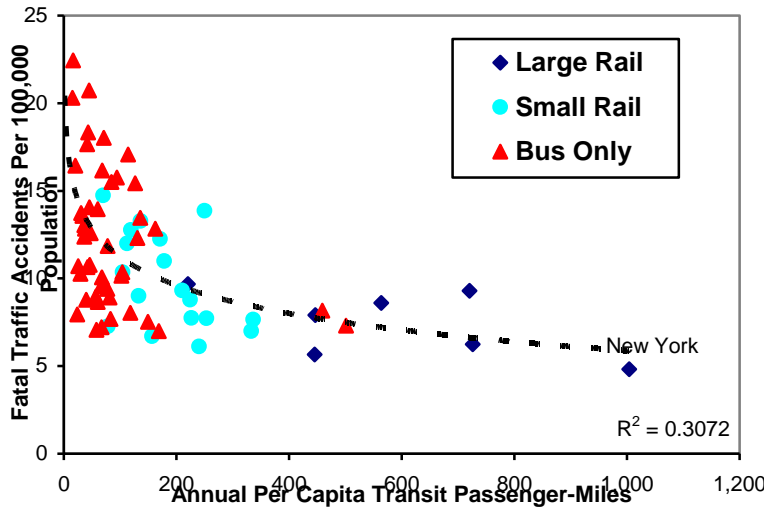
Traffic risk also varies by mode, as indicated in Table 1. Traffic casualty rates per passenger-mile or -kilometer tend to lowest for public transit, higher for automobile travel, and higher still for bicycling, walking and motorcycle travel. This implies that shifts from motorized to *active modes* (walking and cycling, also called *non-motorized transport*) increases traffic casualties. However, the actual incremental risk is smaller than these statistics suggest for the following reasons:

1. Active travel imposes minimal risk to other road users.
2. Drivers tend to be more cautious and communities tend to invest in active transport improvements as walking and cycling increases in an area.
3. Walking and cycling trips tend to be shorter than motorized trips and a local walking trip often substitutes for a longer automobile trip, so total per capita mileage declines. As motor vehicle mode share increases, total passenger-kilometers per capita also increases.
4. Some walking and cycling promotion programs include education and facility improvements that reduce per-kilometer bicycle crash rates.
5. 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 active travel is likely to experience less additional risk than these average values suggest.
6. Walking and cycling provide health benefits, including pollution emission reductions and improved public fitness that may offset increased accident risks.

As active travel increases in an area, both per capita and distance-based traffic casualty rates tend to decline (ABW 2010; Marshall and Garrick 2011), an effect called *safety in numbers* (Jacobsen 2003). Economically developed countries with high rates of active travel, such as Germany and the Netherlands, have pedestrian fatality rates per billion kilometers walked a tenth as high, and bicyclist fatality rates only a quarter as high, as in the United States (Fietsberaad 2008).

Traffic fatality rates also decline with increased transit travel, as illustrated below.

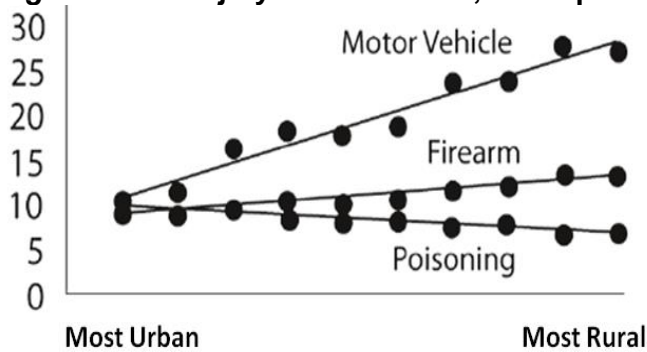
Figure 4 Traffic Fatality Rates for U.S. Urban Regions (Litman 2004 and 2016)



Total traffic fatalities per capita tend to decline in urban regions with higher transit ridership.

Overall, urban residents tend to be safer than suburban or rural residents taking into account both traffic fatality and homicide risks (Lucy 2002). Myers, et al. (2013) compared injury death rates for all U.S. counties rated on a ten-point urban-rural scale between 1999 and 2006. A total of 1,295,919 injury deaths in 3,141 counties were analyzed. The overall injury death rate was 56.2 per 100,000 residents, of which 27% were motor vehicle accidents, the largest risk category. Urban counties had the lowest death rates; after normalizing for factors such as income, education, race and region of the country injury death risk was 1.22 times higher in the most rural counties compared with the most urban, primarily due approximately three times higher traffic accident fatality rates, as illustrated in Figure 19.

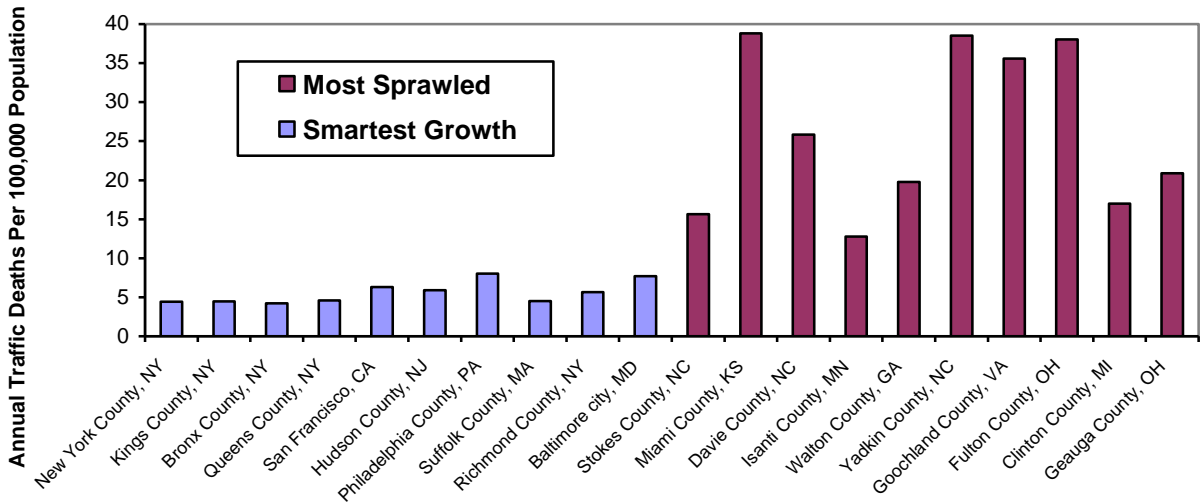
Figure 5 Injury Death Per 100,000 Population (Myers, et al. 2013)



Total injury deaths increase as counties become more rural, primarily due to the much higher traffic fatality rates, the largest cause of injury deaths. The most rural counties have approximately three times the traffic crash death rate as the most urban counties.

Compact, *smart growth* development tends to increase traffic density which increases crashes per vehicle-kilometer, but these are mostly minor collisions. Lower density, sprawled development tends to increase per capita vehicle travel and traffic speeds which increase traffic casualty rates. Smart growth communities have about a fifth the traffic fatality rate as sprawled, automobile dependent communities as illustrated in Figure 6.

Figure 6 Annual Traffic Death Rate (Ewing, Schieber and Zegeer 2003)



Traffic fatality rates tend to increase with land use sprawl.

Conventional planning tends to focus on certain traffic safety impacts and strategies, but overlooks others, as summarized in Table 2. It favors targeted safety programs and improved crash protection, but tends to ignore the additional crashes that can result from policies which stimulate more or faster vehicle travel and the safety benefits of mobility management strategies that reduce overall vehicle travel (Litman 2016).

Table 2 Traffic Safety Strategies and Impacts Summary

Conventional strategies	<p>Restrictions or additional requirements for higher-risk drivers, such as youths and seniors (e.g. graduated licenses and cognitive drivers' tests).</p> <p>Targeted programs to reduce high-risk travel, such as impaired driving.</p> <p>Crash protection (seat-belts, air bags, energy-absorbing roadway barriers).</p>
Additional strategies	<p>Improving alternative modes (walking, cycling and public transit).</p> <p>Pricing reforms (more efficient road and parking pricing, fuel price increases, distance-based insurance and registration fees).</p> <p>Mobility management marketing.</p> <p>Smart growth land use policies.</p>
Often-overlooked impacts	<p>Policies that make driving more convenient and affordable tend to increase per capita crash rates.</p> <p>Reducing congestion and increasing traffic speeds tends to increase crash severity.</p> <p>Automobile-dependent, sprawled land use development tends to increase per capita traffic casualty rates.</p> <p>Increasing perceived vehicle and road safety encourages more intensive driving which partly offsets crash-reduction benefits.</p>

This table indicates conventional and additional traffic safety strategies and impacts that are often overlooked in conventional planning.

Vehicle Pollution Exposure

A second category of transport-related health impacts involve vehicle pollution emissions (called *mobile sources*). Motor vehicles produce various pollutants which can cause various health problems, plus ecological damages such as climate change (HEI 2010; Litman 2010; Gwilliam and Kojima 2004). Although control technologies have reduced emissions per vehicle-kilometer, mobile source pollution remains a major health risk, in part because reduced emission rates are partly offset by increased vehicle travel. Some pollutants, such as carbon monoxide and particulates, have localized impacts so their health risks are affected by the proximity of emissions and human lungs.

Potential transport emission exposure reduction strategies are summarized below.

Table 3 Potential Vehicle Emission Exposure Reduction Strategies

Reduce Emission Rates	Reduce Vehicle Travel	Reduce Proximity
New vehicles emission controls	Improve lower-polluting modes (walking, cycling and public transit). Encourage use of less-pollution vehicles through pricing reforms and incentives. Smart growth land use policies (more compact, mixed development).	Create walkways and bike lanes away from busy roadways.
Improve emission violation identification and enforcement		Discourage location of homes, schools and hospitals downwind of busy roadways.
Smooth traffic flow (congestion reduction, replace stop signs with traffic circles)		Setback buildings away from roadways.
Encourage use of less polluting fuels (electric or natural gas)		Locate building HVAC air intakes away from roadways.

There are many possible ways to reduce pollution exposure.

Some planning decisions can have mixed emission exposure impacts. For example, more compact land use development tends to reduce per capita vehicle travel and emissions but increases proximity between vehicles and human lungs. Similarly, shifts from motorized to non-motorized modes reduce emissions, but because pedestrians and cyclists inhale deeply they may have additional health risks when traveling along busy roadways.

Motor vehicle air pollution probably causes a similar number of premature deaths as traffic crashes. For example, a World Health Organization study concluded that, “Initial estimates show that tens of thousands of deaths per year are attributable to transport-related air pollution in the Region, similar to the death toll from traffic accidents” (WHO 2005). Leigh and Geraghty (2008) estimate that sustained 20% increases in U.S. gasoline prices would reduce 1,994 traffic accident deaths and 600 air pollution deaths. Pollution-related deaths tend to involve older people and so are likely to cause smaller reductions in potential years of life lost (“Health and Safety,” Litman 2010). Some studies indicate much larger total air pollution deaths (Pope, et al. 2009), but these generally include emissions from all sources; motor vehicles are estimated to contribute 5-55% of urban air pollution (HEI 2009).

Conventional planning tends to focus on certain emission reduction strategies and impacts, but overlooks others, as summarized in Table 4.

Table 4 Vehicle Pollution Exposure Reduction Strategies and Impacts Summary

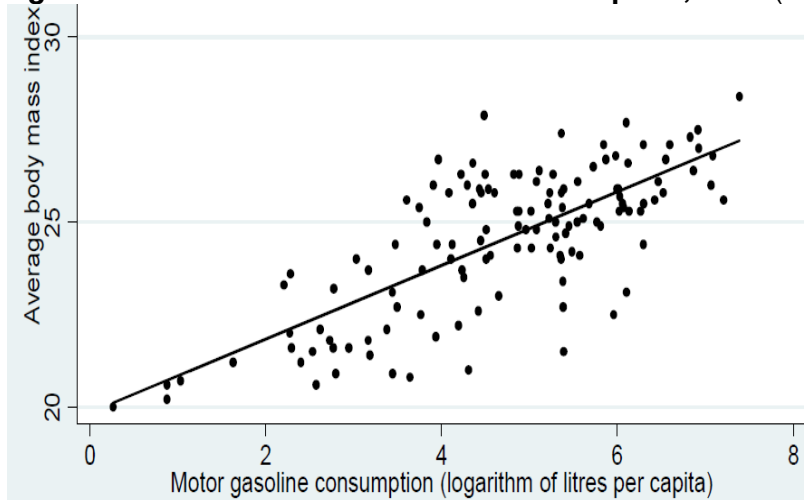
Conventional strategies	Vehicle emission control technologies. Cleaner and alternative fuels. Reduce traffic congestion.
Additional strategies	Mobility management strategies that reduce total vehicle travel. Restrict development of housing, schools, hospitals and parks near major roads. Locate walking and cycling facilities away from busy roads. Design buildings with HVAC intakes away from busy roads.
Often-overlooked impacts	Policies that make driving more convenient and affordable stimulate sprawled development patterns that tend to increase per capita emission rates. More sprawled development may increase distances between emission sources and lungs but increase total vehicle travel and per capita emission rates.

This table indicates conventional and additional emission reduction strategies and impacts that are often overlooked in conventional planning.

Physical Activity and Fitness

The third category of health impacts concerns the effects that transport planning decisions have on physical activity and fitness (WHO 2003). Public health officials are increasingly concerned about declining physical fitness, excessive body weight and resulting health problems (DHHS 2008). They recommend that adults average at least 150 weekly minutes of moderate-intensity physical activity, and children average about three times that amount (CDC 2008). Increased automobile travel is associated with obesity and related health problems (Frank, Andresen, and Schmid 2004; Roberts 2011). Improving walking and cycling condition, improving public transit services, more connected roadway networks, more compact and mixed development, improved access to parks and recreational facilities, and programs that promote active transport tend to increase public fitness and health (CPSTF 2017).

Figure 7 BMI Versus Gasoline Consumption, 2005 (Roberts 2011)



This graph of 130 countries shows a strong positive relationship between vehicle fuel consumption and average men’s body mass index (BMI).

The *Aerobics Center Longitudinal Study*, which periodically evaluates 80,000 adults' health, concluded that sedentary living causes about 16% of all deaths, substantially more than smoking, high cholesterol, hypertension and diabetes (Blair 2009). The analysis suggests that a physically active (walks 30+ daily minutes), obese smoker is likely to live longer than a sedentary, thin non-smoker. A meta-analysis of 22 cohort studies concluded that, compared with no reported physical activity, 2.5 weekly hours of moderate activity is associated with a 19% reduction in mortality and 7 weekly hours is associated with a 24% reduction (Woodcock, et al. 2010).

There are many ways to be physically active, but most, such as gym exercise and organized sports, require special time, skill and expense, which discourages consistent lifetime participation. Many experts believe that high levels of automobile transport contribute to sedentary living. Creating more walkable and bikeable communities is one of the most practical and effective ways to increase public fitness and health (WHO 1999). A study of 4,297 adults in Texan metropolitan areas which controlled for various demographic and health factors found that commute distance was negatively associated with physical activity and cardio-respiratory fitness, and positively associated with BMI, waist circumference, systolic and diastolic blood pressure, and continuous metabolic score (Hoehner, et al. 2012).

It's Better To Be Chubby And Fit Than Skinny And Stagnant

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. The constant yo-yoing of weight loss and gain is not only frustrating, it makes you question whether all that hard work is worth it. Before you pack up your workout gear for good, however, rest assured that exercise is 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 follow-up the results were surprising. Lean men who scored poorly on the treadmill test were twice as likely to have died compared with overweight but fit men. Similar results were found among women. 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. Blair concluded that it's possible to be fit and fat.

This is not to ignore the risks of excess body weight. High blood pressure, heart disease, diabetes, gallbladder disease, osteoarthritis, sleep apnea, and certain cancers 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 many risks associated with obesity. Bones get stronger, blood pressure goes down, and psychological well-being improves. 150 weekly minutes of exercise isn't going to result in substantial weight loss. It will, however, result in substantial health benefits.

Increased walking and cycling can provide significant health benefits (Cavill, et al. 2008). Research indicates a negative relationship between walking and cycling, and obesity and related illnesses such as high blood pressure and diabetes (ABW 2010). A major study of 429,334 UK residents found that, accounting for other demographic factors, incremental increases in neighborhood walkability are associated with significantly reduced blood pressure and hypertension risk, indicating large public health benefits (Sarkar, Webster and Gallacher 2018). Controlling for other factors Frank, et al. (2006) found that a 5% increase in a walkability index is associated with a 32% increase in active transport, a 0.23 point reduction in body mass index, a 6.5% VMT reduction, and reduced per capita air emissions. Meta-analysis by de Hartog, et al. (2010) indicates that people who shift from car to bicycling live longer overall, indicating that health benefits offset any increase in traffic accident risk. Using data for 11,041 high-school students in 154 U.S. communities, Slater, et al. (2013) found that the odds of students being overweight or obese decreased with increased walkability index scores. There appears to be significant latent demand for active transport; many people want to walk or bicycle more than they do, and will use these mode more if conditions are improved (ABW 2010; Litman 2008).

Most public transit trips include walking links so physical activity tends to increase with transit travel (Besser and Dannenberg 2005; Litman 2011). Lachapelle (2010) found that transit users more frequently walk to destinations near the home and workplaces independent of neighborhood walkability, car availability, and enjoyment of moderate physical activity. Lachapelle, et al. (2011) found that transit commuters average 5 to 10 more minutes of moderate-intensity physical activity, and walked more to services and destinations than nonusers. Similarly, Melbourne, Australia residents who use public transit average 41 daily minutes of walking or cycling for transport, five times more than the 8 minutes averaged by residents who travel only by automobile (BusVic 2010).

Land use patterns also affect health. One study found that, accounting for demographic factors such as age, race/ethnicity, education and income, the frequency of self-reported chronic medical conditions such as asthma, diabetes, hypertension and cancer increased with sprawl (Creatore, et al. 2016). Shifting from very sprawled regions such as San Bernardino, California to less sprawled regions such as Boston, Massachusetts reduces approximately 200 chronic medical conditions per 1,000 residents, a 16% reduction. This effect appears to be particularly strong for the elderly and lower-income people. In a study of residents in 14 cities, Sallis, et al. (2016) found that controlling for other demographic factors, net residential density, intersection density, public transport density and number of parks were significantly, positively related to physical activity. The physical activity differences between residents of the most and least activity-friendly neighbourhoods ranged from 68 to 89 min/week, which represents 45–59% of the 150 min/week recommended by guidelines. This implies that transportation and land use planning decisions can significantly affect public fitness and health.

Improving walking, cycling conditions and public transit also tends to improve mental health by increasing physical activity and *community cohesion*, the quantity and quality of positive interactions among neighbors (Litman 2007; OCFP 2005). Increased neighborhood walkability is associated with reduced symptoms of depression in older men (Berke, et al. 2007), and 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 previously walked more than 72 blocks a week. High quality public transit service can reduce commute stress compared with driving (Wener and Evans 2007).

Table 5 summarizes key conclusions. Conventional planning tends to consider physical fitness a special activity that requires special time and equipment, such as exercising at a gym or participating in organized sports. More comprehensive analysis recognizes that for many people the most practical way to increase physical activity is to walk and bicycle for recreation and transport, which requires supportive planning practices.

Table 5 Physical Activity Strategies and Impacts Summary

Conventional strategies	<p>Exercise at a gym. Subsidize gym memberships.</p> <p>Participate in sports. Sponsor community sports programs.</p> <p>Promote recreational walking and cycling.</p> <p>Build recreational trails.</p>
Additional strategies	<p>Improve walking and cycling conditions, and public transit service.</p> <p>Encourage walking, cycling and public transit travel.</p> <p>Create more compact, mixed, walkable and bikeable communities.</p>
Often-overlooked impacts	<p>Wider roads and increased traffic speeds tend to discourage active transport.</p> <p>Sprawled development tends to reduce active transport.</p>

Conventional planning tends to overlooks physical activity strategies and impacts.

Access to Health-Related Goods and Services

Transport planning decisions can affect physically and economically disadvantaged people’s ability to access health-related goods and services, such as healthcare, healthy food and recreation. *Basic mobility* and *basic access* are general terms for people’s ability to reach goods and services considered essential.

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). Transportation affordability may also affect health, for example, if high vehicle or fuel costs reduce the amount a household can spend on medical care or healthy food.

Conventional planning tends to emphasize three approaches to providing basic access:

1. Keep automobile travel available and affordable with modest drivers’ license requirements, relatively low fuel taxes and minimal charges for using roads and parking facilities;
2. Provide general public transit, plus special mobility services for people with severe disabilities
3. Implement universal design so transport facilities and services accommodate all potential users, including people with disabilities and other impairments.

More comprehensive analysis also recognizes the role that active transport plays in providing basic access, the impacts of land use patterns on overall accessibility, and the tendency of

automobile-oriented planning and sprawl to reduce accessibility for non-drivers and increase total transportation costs.

Table 6 Basic Access Strategies and Impacts Summary

Conventional strategies	<p>Keep automobile travel available and affordable.</p> <p>Provide general public transit and special mobility services for people with severe disabilities.</p> <p>Universal design (transport facilities and services that accommodate all potential users, including people with disabilities and other impairments).</p>
Additional strategies	<p>Pedestrian and cycling improvements.</p> <p>Carshare and taxi service improvements.</p> <p>Smart growth policies to create more accessible, multi-modal communities.</p> <p>Affordable housing in accessible locations.</p>
Often-overlooked impacts	<p>Policies that favor automobile travel and sprawl tend to reduce accessibility for non-drivers and increase total transportation costs.</p>

This table indicates conventional and additional physical activity strategies and impacts that are often overlooked in conventional planning.

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."

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."

Cumulative Effects

Several studies have examined the overall health outcomes associated with more or less automobile-oriented communities.

A major study by the University of Utah's Metropolitan Research Center developed a sprawl index that incorporates four factors: *density* (people and jobs per square mile), *mix* (whether neighborhoods had a mix of homes, jobs and services), *centricity* (the strength of activity centers and downtowns) and *roadway connectivity* (the density of connections in the roadway network); a higher rating indicates more compact, *Smart Growth* development (Ewing and Hamidi 2014). The analysis indicates that:

- Smart Growth reduces the amount of time that residents spend driving and increases walking. For every 10% increase in index score, drive time declines 0.5% and walk mode share increases by 3.9%.
- Smart Growth community residents tend to live longer. For every doubling in an index score, life expectancy increases about 4%. For the average American with a life expectancy of 78 years, this translates into a three-year difference in life expectancy between people in a less compact versus a more compact county. This probably reflects significantly lower rates of traffic fatalities, obesity, high blood pressure and diabetes in Smart Growth communities, which are somewhat offset by slightly higher air pollution exposure and murder risk.
- Counties with less sprawl have more but less severe vehicle crashes. For every 10% increase in an index score, fatal crashes decrease by almost 15%. People in smarter growth communities also have significantly lower blood pressure and rates of diabetes.

Frederick, Riggs and Gilderbloom (2017), analyzed the relationships between commute mode diversity (CMD, the portion of commuters who do not drive an automobile, which ranges from 11% to 36%) as an indicator of a multimodal community, and twelve indicators of measure public health and quality of life outcomes for various mid-size U.S. cities and counties. The results indicate that, after adjusting for various demographic factors, there is a strong statistical relationship between more modal diversity and positive public health outcomes including healthier behaviors reported in the Gallup/Healthway's Well-Being Index, more leisure quality reported by Sperling's Cities Ranked and Rated, more access to exercise reported by the Environmental Systems Research Institute, less sedentary living and obesity reported in the Center for Disease Control's Diabetes Interactive Atlas, more Years of Potential Life Lost (an indicator of longevity and overall health), and higher birth weights (an indicator of infant health) reported by the National Center for Health Statistics. These relationships are stronger than many other sociological, geographical, and economic indicators including density, latitude, race, education and income, suggesting that living in a more multimodal community provides significant health benefits. These findings underscore the positive impact of sustainable transportation policies on community health and open up a new direction for public health research and the built environment.

Travel Impacts

It is important that transport planning consider all travel impacts, including indirect and long-term effects such as the following.

Induced Vehicle Travel

Induced travel refers to the additional vehicle travel that occurs when a roadway improvement increases traffic speeds or reduces vehicle operating costs (Litman 2001). Induced travel tends to reduce roadway expansion congestion reduction benefits, and increase accidents, pollution emissions, sprawl, and associated public health problems. Failure to consider these effects tends to exaggerate roadway expansion benefits and undervalues alternative solutions to transportation problems such as improvements to alternative modes, mobility management strategies and smart growth.

Leverage Effects

Under some circumstances, walking, cycling and public transit improvements can leverage additional vehicle travel reductions by stimulating more compact land use development patterns where residents tend to own fewer cars and rely more on local services (Litman 2008). This generally requires high quality facilities and services that attract discretionary travelers (people who would otherwise drive), and support strategies such as smart growth policies. Where this occurs, an additional unit of walking, cycling or public transit travel reduces 3 to 6 times as much automobile-travel (ICF 2010; Litman 20010b). For example, Guo and Gandavarapu (2010) found that sidewalk improvements in a typical town increase average daily walking and cycling by 0.097 miles and reduce automobile travel by 1.142 vehicle-miles, about 12 miles of reduced driving for each mile of more active travel. These result from the following factors:

- *Vehicle Ownership.* Motor vehicles are costly to own but relatively cheap to use, so once a household purchases an automobile they tend to use it, including discretionary travel that could easily be avoided. Households tend to own one vehicle per driver if located in an automobile-dependent community which results in more driving. Households own fewer vehicles in a multi-modal community and so drive significantly less.
- *Land Use Patterns.* Walking, cycling and public transit improvements support more compact, mixed land use by reducing the amount of land required for roads and parking facilities and encouraging local trips.
- *Social Norms.* In automobile-dependent communities, use of alternative modes tends to be stigmatized. Improving alternative modes can help make their use more socially acceptable.

Not every project has all these effects, and a portion of these impacts reflect self-selection, that is, relocation by people who, from necessity or preference, minimize vehicle travel. However, under the right conditions, walking, cycling and public transit improvements implemented with supportive policies can result in significant reductions in per capita automobile travel, including indirect leverage effects. Conventional planning generally ignores these indirect impacts and so underestimates the full impacts and benefits of walking, cycling and public transit improvements. Considering these indirect impacts can increase estimated benefits by an order of magnitude.

Health Improvement Strategies

This section evaluates various transport strategies for improving public health. For more information see APHA (2011), CDC (2010) and the Online TDM Encyclopedia (VTPI 2011).

Traffic Calming and Speed Control

Traffic calming and speed reduction strategies (such as lower speed limits and improved speed enforcement) tend to improve safety by reducing crash frequency and severity, and sometimes by reducing total vehicle travel (NCCHPP 2012). Air emission impacts vary depending on traffic control type and conditions. Reductions from high to moderate speeds tend to reduce per-kilometer vehicle emission rates, but very low speeds or more stop-and-go driving tends to increase emission rates. Speed humps tend to increase local emissions while replacing traffic signals with traffic circles tends to reduce local emissions. Speed reductions tend to improve walking and cycling conditions which can reduce per-capita emissions, increase physical activity, and improve basic access.

Active Transport (Walking and Cycling) Improvements

Many walking and cycling facility improvements (such as better sidewalks, crosswalks and paths), reduce these modes' crash risk, and as previously described, by increasing active transport they tend to reduce total crash rates due to the *safety in numbers* effect. In a typical situation, doubling active travel increases pedestrian and cycling injuries by 32%, while injuries to other road users decline, reducing total traffic casualties (Jacobsen 2003). Shifts from driving to active modes can provide proportionately large air pollution emission reductions since these modes tend to reduce shorter urban vehicle trips that have high per-kilometer emission rates due to cold starts and congestion, so each 1% shift tends to reduce emissions by 2-4%. Integrated walking and cycling improvement programs can leverage additional vehicle travel reductions, providing additional benefits. Such improvements tend to increase physical activity and basic access.

Public Transit Service Improvements

Public transit service improvements, such as more service, nicer vehicles and stations, grade separation, and improved user information, which attract discretionary users tend to reduce total crash rates and pollution emissions. Bus priority lanes and signal controls can reduce bus emission rates. Increased use of older diesel buses may increase local pollution. Transit improvements integrated with supportive land use policies can create transit-oriented development which leverages additional vehicle travel reductions, providing additional benefits. Since most transit trips include walking and cycling links, and transit-oriented development improves active transport conditions, transit improvements tend to increase physical fitness. Transit improvements also tend to improve basic access.

Transport Pricing Reforms

Transport pricing reforms include efficient road and parking pricing (motorists pay directly for using roads and parking facilities, with higher prices under congested conditions), variations such as parking unbundling (parking is rented separately from building space, so occupants only pay for parking spaces they want) and cash out (travelers can choose to receive cash instead of a parking subsidy if they use other modes), reduced fuel subsidies and increased fuel taxes, and distance-based vehicle insurance and registration fees (motorists pay in proportion to their annual vehicle travel). These can significantly reduce vehicle travel. For example, charging

motorists directly for parking typically reduces affected vehicle trips by 20%, and distance-based insurance and registration fees is predicted to reduce affected vehicle travel by 10-12%.

These pricing reforms can provide significant health benefits (Litman 2012). Grabowski and Morrisey (2006) estimate that a one-cent state gasoline tax increase reduces per capita traffic fatalities by 0.25%, and traffic fatalities per vehicle-mile by 0.26%. Leigh and Geraghty (2008) estimate that a sustained 20% gasoline price increase would reduce approximately 2,000 traffic crash deaths (about 5% of the total), plus about 600 air pollution deaths. Studies by Chi, et al. (2010a and 2010b) show that fuel price increases reduce per-mile crash rate, so a 1% vehicle travel reduction reduces crashes more than 1%. For example, in the state of Mississippi, controlling for other risk factors, they find that each 1% inflation-adjusted gasoline price increase reduces total (all types of drivers) crashes per million vehicle-miles 0.25% in the short-run and 0.47% in the medium-run (one to five years) (2010a). Efficient road and parking pricing should have similar impacts, and distance-based insurance can provide even larger crash reductions since higher-risk motorists pay more per vehicle-kilometer and so have the greatest incentive to reduce their mileage and crash risk (Ferreira and Minike 2010; Litman 2012).

Pricing reforms can also significantly reduce pollution emissions, particularly congestion pricing (which improves traffic flow) and fuel price increases (which encourages use of lighter vehicles). Pricing reforms tend to increase use of active modes and therefore physical fitness. Higher road, parking and fuel prices may reduce basic access for lower-income motorists, but if they contribute to alternative mode improvements (for example, if congestion pricing reduces bus delays, or fuel tax revenues are used to finance public transit improvements) they may increase basic access, particularly for non-drivers.

Mobility Management Marketing

Mobility management marketing includes various programs, incentives and information that encourage people to change their travel behavior. This includes commute trip reduction programs, through which employers encourage their employees to use alternative modes, transportation management associations through which businesses support and encourage use of alternative modes, ridematching and vanpool support programs, and direct marketing programs which encourage travelers to try alternative modes. Such programs tend to support transport options such as flextime, telework and delivery services, and implement strategies such as parking cash out and vanpool organizing. Voluntary programs typically reduce participant's vehicle travel 5% to 8%. Much larger reductions are possible with programs that include financial incentives, such as parking cash out (Spears, Boarnet and Handy 2011). Such programs probably provide similar reductions in traffic accidents and pollution emissions, and increased physical activity, although impacts may vary depending on circumstances and the degree they are integrated with other mobility management strategies such as improvements to alternative modes and transport pricing reforms.

Smart Growth Land Use Development Policies

Smart growth policies encourage more compact and mixed development, more connected path and road networks, better integration between transport and land use planning, improved walkability, more efficient parking management, and other features that improve accessibility and transport diversity, particular for physically, economically and socially disadvantaged people. People who live and work in such communities tend to own fewer motor vehicles, drive less and rely more on walking, cycling and public transport. Smart growth residents typically

drive 20-40% less than they would if located in automobile-dependent sprawl (Ewing and Cervero 2012; Giles-Corti, et al. 2013; Litman 2008).

Ewing, et al. (2014) found that Smart Growth is associated with reduced obesity and associated health problems, and Ewing and Hamidi (2014) found that it increases longevity; doubling their Sprawl Index increased life expectancy approximately 4%, which translates into an average three-year difference in life expectancy between people in less compact versus more compact counties.

Hamidi, et al. (2018) used cross-sectional to evaluate the associations between sprawl and life expectancy for metropolitan counties in the United States in 2010. After controlling for sociodemographic characteristics, this study found that life expectancy was significantly higher in compact counties than in sprawling counties. It identified significant direct and indirect associations between urban sprawl and life expectancy. Compactness affects mortality both directly, and indirectly. For example, it may be that sprawling areas have higher traffic speeds and longer emergency response times, lower quality and less accessible health care facilities, or less availability of healthy foods. Compactness affects mortality indirectly through vehicle miles traveled, which is a contributor to traffic fatalities, and through body mass index, which is a contributor to many chronic diseases. These findings support further research and practice aimed at identifying and implementing changes to urban planning designed to support health and healthy behaviors.

The report, *Healthy Housing for All: How Affordable Housing is Leading the Way* (UDI 2018), examines ways to create healthier communities by building more affordable housing in walkable urban neighborhoods. Table 7 summarizes key features for healthy buildings and communities.

Table 7 Healthy Building Features (UDI 2018)

Interior features	Exterior Features	Location Features
Wide, inviting staircases	Sidewalks	
Indoor fitness area	Protected bike lanes	
Long-term bike parking	Pedestrian and bike-friendly entrances	
Shared kitchen area with cooking classes	Short-term bike parking	
Smoke-free property	Public art	Walking trails and bike paths
Daylight and outdoor views	Drinking fountains	Food access
Blackout shades	Lighting by entrances and paths	Mixed-use development
Healthy building materials	Community and rooftop gardens	Public transit access
Good ventilation and air filtration	Outdoor amenities	Nature/greenery
Acoustic comfort	Gathering spaces	Playgrounds
	Stormwater management	

Many features can help create healthier buildings and communities.

Creatore, et al. (2016) found that smart growth community residents tend to live longer: for every doubling in a smart growth index score, life expectancy increases about 4%. For the average American this translates into a three-year difference in life expectancy between smart growth versus sprawl community residents. This probably reflects the combined effects of increased physical activity and significantly lower rates of traffic fatalities, obesity, high blood pressure and diabetes, although these may be offset by slightly higher air pollution exposure. The *Bicycling and Walking in the U.S.: 2014 Benchmarking Report* found a strong (R2=0.43)

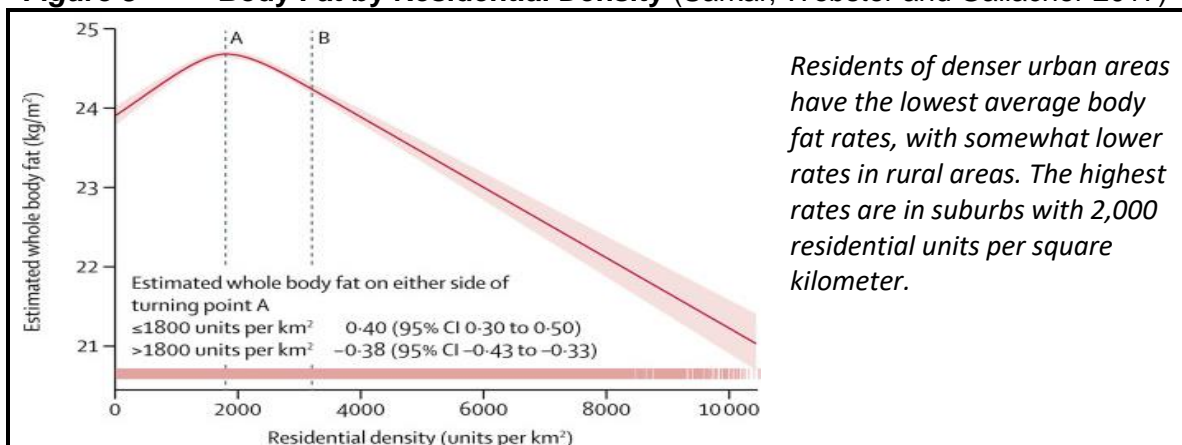
positive relationship between active transport (walking and cycling) commute mode share and the portion of the population that achieves national physical fitness targets of 150 weekly minutes of moderate physical activity (ABW 2014). It also found strong negative relationships between active transportation commute mode share and rates of traffic accidents, obesity, high blood pressure and diabetes.

Smart growth tends to significantly increase active transport, because it includes walking and cycling improvements, and because more destinations are within walking and cycling distances. This tends to improve public fitness and health. In a study that examined how land use factors affect travel activity in Vancouver, BC, Frank, et al. (2010) found 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.

A major British study found the lowest obesity rates in the densest urban areas, followed by rural areas, and the highest obesity rates in suburban areas (Sarkar, Webster and Gallacher 2017). Increased densities provided particularly large benefits for younger, female, employed and physically active individuals. They conclude that public policies that discourage suburban densification, for example, by prohibiting the subdivision of single lot housing, may prevent suburbs from becoming healthier places to live.

Figure 8 Body Fat by Residential Density (Sarkar, Webster and Gallacher 2017)



Public Health Impacts Summary

Table 7 compares the impacts of various transport safety and health strategies. Most conventional strategies, such as targeted safety programs (e.g., graduated licenses and anti-drunk-driving campaigns), crash protection (e.g., seatbelt, helmet, and airbag regulations and encouragement), more efficient and alternative fuel (e.g., hybrid and electric) vehicles, and exercise and sport fitness programs, provide limited benefits. Mobility management strategies, which improve travel options and encourage vehicle travel reductions, tend to provide multiple public health benefits and support other planning objectives, and so are considered win-win solutions. More comprehensive planning is needed for win-win solutions to be implemented as much as justified, as discussed in the next chapter.

Table 7 Public Health Impact Summary

Strategies	Safety	Pollution	Fitness	Basic Access	Other
Conventional Safety and Health Strategies					
Targeted safety programs	Large benefits	No benefit	No benefit	No benefit	
Crash protection	Large benefits	No benefit	No benefit	No benefit	
Efficient and alt. fuel vehicles	No benefit	Large benefits	No benefit	No benefit	Energy conservation
Exercise and sport promotion	No benefit	No benefit	Large benefits	No benefit	User enjoyment
Innovative Mobility Management Strategies					
Traffic calming and speed control	Large benefits	Mixed impacts. Some strategies increase local emissions.	Large benefit	Large benefit	
Active transport improvements	Large benefits, particularly if targeted safety strategies are included	Large benefits	Large benefits	Large benefits	Reduced traffic and parking congestion
Public transit improvements	Large benefits	Large benefits	Large benefits	Large benefits	Reduced traffic and parking congestion
Transport pricing reforms	Large benefits	Large benefits	Large benefits	Mixed. Can improve travel options.	Reduced traffic and parking congestion
Mobility management marketing	Moderate benefits	Moderate benefits	Moderate benefits	Small benefits	Reduced traffic and parking congestion
Smart growth development policies	Large benefits	Mixed. Reduces emissions but may increase proximity	Large benefits	Large benefits	Open space preservation, more efficient public services

This table summarizes safety, emission reductions, fitness and accessibility impacts.

Transport Planning Reforms for Healthier Communities

This section discusses transport planning reforms to support public health.

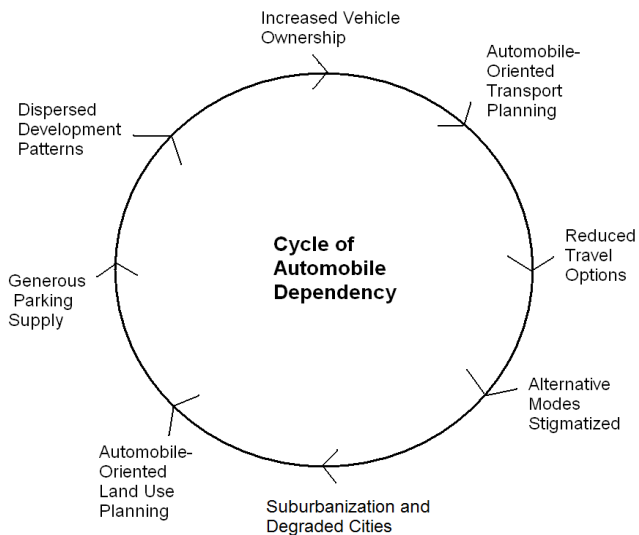
Planning Biases

Conventional planning tends to be biased in various ways that encourage automobile travel and sprawl (Blais 2010; Brown, Morris and Taylor 2009; Litman 2006):

- Transport system performance is evaluated based primarily on automobile traffic speed; other modes of travel and other planning objectives often receive less consideration.
- A major portion of transport funding is dedicated to roadways and cannot be used for alternative modes or mobility management strategies, even if they are more cost effective and beneficial overall.
- Most jurisdictions require developers to provide generous parking supply which stimulates sprawl and subsidizes automobile travel.
- Restrictions on development density and mix, and fees and taxes that fail to reflect the higher costs of providing public services to more dispersed locations.

Although these policies may individually seem justified, their impacts are cumulative and synergistic, creating a self-reinforcing cycle of automobile dependency and sprawl, as illustrated in Figure 9. They create automobile dependent communities where most trips (often over 90%) are made by automobile, active transport is difficult and uncommon, households spend relatively large amounts of time and money on driving, non-drivers are significantly disadvantaged, and high-risk motorists continue to drive due to inadequate alternatives (Mackett and Brown 2011). This exacerbates health problems including crash risk, pollution, sedentary living, and inaccessibility (MacMillen, Givoni and Banister 2010; Tranter 2010). Correcting these distortions is essential for achieving public health objectives, and can help achieve other planning objectives such as congestion reduction, housing affordability and habitat preservation.

Figure 9 Cycle of Automobile Dependency and Sprawl



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

Shift from Mobility- to Accessibility-Based Planning

A shift is occurring from *mobility-* to *accessibility-based* planning that has important implications for creating more efficient, equitable and healthier communities.

Mobility refers to physical travel. Mobility-based planning assumes that society's goal is to maximize the distances people can travel within their time and financial budget. It assumes that faster travel is better than slower travel, and so favors automobile travel over walking, cycling and public transit. It assumes that "transportation problem" refers to motorists' delays and costs, and "transportation improvement" refers to policies that increase vehicle travel speeds or reduces costs. These assumptions are incorporated in conventional planning which evaluates transport system performance based primarily on roadway *level-of-service* (LOS), an indicator of vehicle traffic speeds and delay, and in transport finance practices which dedicate a major portion of transport funding to roads and parking facilities.

But mobility is not generally an end in itself. The ultimate goal of most travel activity (except the small portion of travel that has no destination) is *accessibility* (or *access*), which refers to people's ability to reach desired goods, services and activities (together called *opportunities*). For example, the ultimate goal of commuting is to access employment and education activities, the ultimate goal of driving to a store is to access shopping opportunities, and the ultimate goal of a holiday trip is to access recreation activities.

Mobility is an important factor in overall accessibility – in general, the faster and cheaper people can travel – but other factors are also important, including roadway connectivity, land use patterns, modal options, and mobility substitutes such as telecommunications and delivery services that reduce vehicle trips. For example, increasing roadway connectivity and land use mix can reduce the distances people must travel to access services and activities, and improving walking, cycling, public transit service, telecommunications and delivery services can improve non-automobile accessibility.

Transport planning decisions often involve trade-offs between different types of accessibility. Expanding roadways to accommodate more and faster vehicle travel, and increasing parking requirements to increase driving convenience, often reduces pedestrian access, and since most transit trips involve walking links they also reduce transit access. Land use decisions that favors automobile access, such as locating services at major highway intersections, tends to reduce access by other modes. Money spent on roads and parking facilities is unavailable for other modes. Road space devoted to on-street parking is unavailable for sidewalks, bike and bus lanes.

Accessibility-based planning expands the scope of solutions that can be applied to transport problems. For example, with conventional, mobility-based planning, virtually the only solution to traffic or parking congestion is to expand facilities to accommodate more vehicle travel. Accessibility-based planning allows consideration of other solutions, including improvements to alternative modes, improved roadway connectivity, pricing reforms, and smart growth development policies, all of which can improve accessibility without increasing mobility.

Accessibility-based planning supports healthy community transport. It recognizes the value of slower alternative modes, such as walking, cycling and public transit; the value of mobility management strategies that discourage economically excessive motor vehicle travel; and the value of creating more accessible and multi-modal communities where residents drive less and rely more on alternative modes. Shifting from mobility- to accessibility-based planning is therefore an important contribution toward improving public health.

Impacts of Reforms

How much would travel activity change if planning were less biased and pricing more efficient? Probably a lot. Current planning significantly under-invests in non-motorized travel, and fails to give public transit roadway priority when justified for efficiency. Nationwide, about 12% of total trips are made by non-motorized modes, and more in cities, yet in most jurisdictions only 1-3% of total transport funding is devoted to non-motorized facilities (ABW 2010). Only a tiny portion of urban arterials have HOV or bus lanes although they can carry far more peak-period travelers than a general purpose lane and they support other planning objectives such as basic mobility for non-drivers. More multi-modal planning can significantly increase walking, cycling and public transit travel, and reductions in automobile travel (Gotschi 2011; Guo and Gandavarapu 2010). For example, walking and cycling more than doubled in nine U.S. cities that invested in active transport programs (Pucher, Buehler and Seinen 2011), and urban regions with high quality public transit systems tend to have 10-30% less per capita driving, with comparable reductions in per capita traffic deaths and pollution emissions (Litman 2004; Liu 2007). International comparisons show even greater effects: wealthy countries with multi-modal planning and high fuel prices have much more walking, cycling and public transport travel than in the U.S. (Millard-Ball and Schipper 2010; Pucher and Buehler 2009).

Economic theory can also help identify optimal transport patterns. A basic economic principle is that efficiency is maximized if *prices* (what consumers pay for a good) reflect the marginal cost of producing that good, including indirect and external costs. Efficient transport therefore requires that motorists pay directly for using roads and parking facilities, for congestion and accident risk imposed on others, plus any economic or environmental impacts associated with vehicle fuel production. Currently less than half of U.S. roadway costs and a tiny portion of non-residential parking costs are borne by user fees, and congestion, accident risk and fuel costs are under-priced (Litman 2010; Parry and Small 2004). Efficient pricing would significantly increase road, parking and fuel costs, and vehicle insurance and registration fees would be distance-based; the additional costs would be offset by reductions in building rents and general taxes. Although it is difficult to predict exactly how much such reforms would reduce vehicle travel and associated public health risks, reductions are likely to be large (Litman 2005).

Conventional transport planning evaluation tends to overlook many of these impacts. Cities such as Davis, California and Eugene, Oregon invested in cycling facilities because local officials intuitively recognized that improving cycling conditions and encouraging cycling activity can provide significant community benefits. Similarly, public transit projects and smart growth development policies are often implemented despite, rather than supported by, conventional transport economic evaluation because most benefits they provide, including reduced accidents and pollution emissions, and improved physical fitness and mobility for non-drivers, are overlooked and undervalued in conventional transport planning. These planning biases and market distortions reduce public health.

Incorporating Health Impacts into Economic Evaluation

One important policy reform is more comprehensive health impact analysis. Roadway projects are often justified based on *monetized* (measured in monetary units) estimates of travel time and vehicle operating cost savings (Litman 2010). Researchers have started to develop similar values for health benefits (Grabow, et al. 2011; Gotschi 2011; Fishman, et al, 2011; Kahlmeier, et al. 2010). The *Active Transport Quantification Tool* (ICLEI 2007) describes how to value the vehicle cost savings, reductions in heart disease, diabetes risk, congestion, pollution and crash

risk, and increased happiness from more active transport. The New Zealand Transport Agency's *Economic Evaluation Manual* provides the following values for active transport benefits:

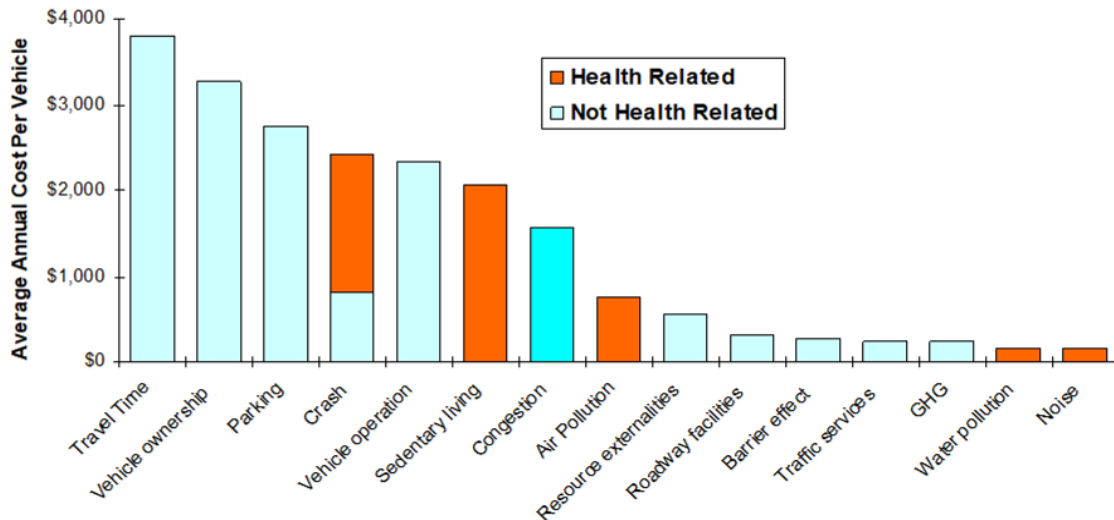
Table 8 Active Transportation Health Benefits (NZTA 2010, Vol. 2, p. 8-11)

	2008 \$ NZ/km	2008 USD/mile
Cycling	\$1.40	\$1.60
Walking	\$2.70	\$3.00

This table indicates New Zealand's estimated value of increased walking and cycling.

Figure 10 compares the estimated magnitude of various transport costs, assuming that automobile-oriented transport planning reduces walking and cycling by one mile per day. As previously mentioned, air pollution damage probably causes a similar number of deaths as traffic accidents but causes smaller reductions in longevity and little property damage.

Figure 10 Costs of Motor Vehicle Use in the U.S. (Litman 2010)



This figure illustrates the estimated magnitude of various transportation costs. Health-related impacts are significant but seldom fully recognized in transport project economic evaluation.

This has important implications for healthy community planning. Health-related costs, including most crash costs (excluding property damages), sedentary living costs, local air pollution, water pollution and noise, are large but often overlooked in transport economic evaluation. Conventional planning tends to focus on congestion costs (the additional travel time and vehicle operating expenses associated with traffic congestion), although that is actually modest overall. This analysis indicates that a congestion reduction strategy that causes even small increases in crashes, sedentary living or pollution exposure is probably not cost effective. For example, if roadway capacity expansion reduces congestion by 10% but increases crash costs 2% by increasing traffic volumes and speeds, its incremental costs exceed its incremental benefits. However, a congestion reduction strategy becomes more cost effective if it provides even small reductions in crash or pollution costs, or small increases in physical activity.

Best Planning Practices

Below are healthier community planning practices (CDC 2009; PFP 2011; Tam 2017):

Comprehensive Evaluation

Transport policy and planning analysis should consider all significant planning objectives and impacts, including indirect impacts. It should include health impact analysis, which considers how planning decisions affect crash risks, pollution exposure, physical activity and basic access (Ball, et al. 2009). Table 9 lists impacts that should be considered.

Table 9 Comprehensive Planning Evaluation

Indirect Travel	Economic	Social	Environmental
<ul style="list-style-type: none"> • Induced travel • Leverage effects of walking, cycling and public transit improvements • Land use accessibility 	<ul style="list-style-type: none"> • Congestion • Road and parking facility costs • Vehicle costs • Fuel externalities • Accident costs • Hydrologic impacts 	<ul style="list-style-type: none"> • Basic mobility for non-drivers • Transport and housing affordability • Public fitness and health 	<ul style="list-style-type: none"> • Air pollution • Noise • Water pollution • Openspace and habitat • Heat island effects

Comprehensive transport project evaluation should consider all these impacts.

Multi-modal Planning

Transport planning should apply comprehensive multi-modal planning, which recognizes the diverse benefits provided by different travel modes, including safety and health benefits. Multi-modal planning tends to increase investments in walking, bicycling and public transit.

Mobility Management

Mobility management should be implemented whenever cost effective compared with roads and parking facility expansions. Money currently devoted only to roads and parking should be available to alternative modes and demand management programs. As much as possible, motorists should pay directly for road and parking facility costs, and any fuel production costs. This should include the following pricing reforms: efficient parking pricing or cash out, increased fuel prices to recover roadway costs, and distance-based insurance and registration fees.

Smart Growth Development Policies

Land use development policies should encourage more compact and mixed development, more connected roadways, better coordination between transport and land use (for example, encouraging new schools to locate where they are accessible to students by walking and cycling, and new businesses to locate where they are most accessible to employees and customers by walking, cycling and public transport), reduced development and utility fees for more accessible locations that have lower costs for providing public services, reduced and more flexible parking requirements, and improved public realm.

Consumer Education

It is important to educate planning practitioners, real estate professionals and consumers concerning how to design and select healthier communities. The *Healthy Location Checklist* identifies features to consider.

Table 10 Healthy Community Checklist

Healthy Community Features	
Sidewalks and crosswalks on most streets	
Sidewalks accommodate wheelchairs and other mobility aids	
Moderate to low traffic speeds on local streets	
Streets are safe for cycling	
Well-connected paths and roadways provide multiple routes to destinations	
Most commonly-used services (shops, healthcare, parks) within convenient walking distance (less than a half-mile of homes), with good sidewalks and crosswalks	
Public parks are available nearby	
Streets have trees and other public greenspace	
High quality public transit (at least half-hour frequency) available within convenient walking distance	
Region has high quality public transit and high transit mode share	
Parking is efficiently priced and managed, so residents only pay for parking spaces they want	
Relatively high (at least 20%) non-automobile mode share	
Good air quality	

This checklist identifies specific features that indicate a healthy community

Tools for Transportation Health Impact Analysis

The following tools are designed to evaluate health impact for transportation and land use planning.

America’s Health Rankings (www.americashealthrankings.org) provides state by state data on national indicators of health, environmental and socioeconomic characteristics aimed at establishing national health benchmarks and state rankings.

Building Healthy Places Toolkit (<http://uli.org/wp-content/uploads/ULI-Documents/Building-Healthy-Places-Toolkit.pdf>) by the Urban Development Institute, identifies opportunities to enhance health through changes in approaches to buildings and projects. It outlines 21 “Gold Star” evidence-based recommendations for promoting health at the building or project scale. These recommendations are organized according to three categories: physical activity, healthy food and drinking water, and healthy environment and social well-being. A list of practical implementation strategies and best practices, grouped according to their available evidence base, supports each of the 21 overarching recommendations.

Built Environment and Public Health Clearinghouse

(www.planning.org/nationalcenters/health/bephc). This is a resource for training and relevant news about the intersection of health and place. It was developed by APA, APHA, Georgia Tech, and the National Network of Public Health Institutes.

California Health Assessment Models (<http://urbandesign4health.com/projects/california-statewide-public-health-assessment-model>) is a comprehensive activity-based public health model that uses detailed inputs (land use, socio-demographic, transportation) and outcome (physical activity and health conditions) data to evaluate how transportation and land use factors affect health outcomes.

County Health Rankings (www.countyhealthrankings.org). Measures the health of nearly all counties in the nation and ranks them within states using a variety of national and state data sources.

EPA Smart Locations Database (www.epa.gov/smartgrowth/smartlocationdatabase.htm). The SLDB is a nationwide geographic data resource for measuring location efficiency. It summarizes characteristics such as housing density, diversity of land use, neighborhood design, destination accessibility, transit service, employment, and demographics. It is coupled with a second data system that allows users to examine the accessibility of a region to jobs by transit and automobiles as well walkability scores.

Healthy Community Design Checklist Toolkit (www.cdc.gov/healthyplaces/toolkit). The Toolkit was developed to help planners, public health professionals, and the general public consider health in community planning.

Health Economic Assessment Tool (HEAT) for cycling and walking (<https://bit.ly/1q5KzLZ>) calculates the economic value of the health benefits from increased walking and bicycling.

Health Transportation Shortage Index (<http://docplayer.net/2072716-The-health-transportation-shortage-index.html>) helps identify areas and communities where transportation shortages create barriers to health care access. The HTSI uses a scoring protocol to identify the most important factors associated with transportation barriers to child health care access.

Integrated Transport and Health Impact Modeling Tool (www.cedar.iph.cam.ac.uk/research/modelling/ithim). ITHIM provides integrated health impact assessment of transport through changes in physical activity, road traffic injury risk, and urban air pollution. ITHIM can either be used as a stand-alone model, or linked to other transport and health models. It can be used for development of scenarios, for estimation of changes in exposures, and for modelling health outcomes.

Metrics for Planning Healthy Communities (<https://bit.ly/2tSaCXh>) by Ricklin and Shah (2017) provides specific guidance on ways to measure these impacts. Developers, owners, property managers, designers, investors, and others involved in real estate decision making can use the strategies described in this report to create places that contribute to healthier people and communities and that enhance and preserve value by meeting the growing desire for health-promoting places.

National Public Health Assessment Model (<http://urbandesign4health.com/projects/hia-plugin-scenario-planning>) is a public health and activity plug-in module that empowers communities to evaluate relative health impacts of contrasting land use and transportation scenarios. It is the first health assessment tool that can connect to multiple existing scenario planning platforms utilizing nationally available data and can be consistently applied nationally. It leverages nationally available built environment data from the EPA Smart Location Database and the Robert Wood Johnson Foundation National Environment Database. It can empower communities to choose investments that have the greatest potential to improve public health and quality of life, reduce health care costs, and address environmental justice related disparities.

National Environmental Database (<http://urbandesign4health.com/projects/ned>) establishes a nationally consistent, standardized, and centrally located set of individual and composite metrics that characterize the built, natural and social environment. It contains over 200 variables which have been demonstrated to best predict health outcomes. It provides planners, public health officials, and researchers with a single source of high quality, high resolution, environmental variables with uniform, nationwide coverage. It is updated periodically to include a robust set of environmental variables known to predict health outcomes and is designed to help researchers, health officials and others assess how neighborhood context can support or hinder public health.

Sleep, Leisure, Occupation, Transportation, and Home-based activities (SLOTH) model (<https://www.ncbi.nlm.nih.gov/pubmed/15450624>). This model provides guidance regarding interventions that might increase physical activity in each of four non-sleep domains (economic efficiency, equity, effectiveness, and feasibility).

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Transportation Health Tool (www.transportation.gov/transportation-health-tool). This online tool developed by the USDOT and USEPA allows users to understand how specific communities or states compare in terms of key transportation and health indicators.

Walk Score (www.walkscore.com). This tool assigns a numerical walkability score to any address in the United States, Canada, and Australia. It also serves up data on travel time, food deserts, apartments, and neighborhoods.

Adolescent Mobility Health Consortium (<https://blogs.otago.ac.nz/amc>)

The concept of [adolescent mobility health](#) which bridges health, safety and sustainable mobility issues by creating communities where young people drive less and rely more on active and public transport.

Youth are a critical population to target mobility health strategies for many reasons:

- They are a very high risk group for crashes and injury. However, efforts to address this have plateaued out in many developed countries and youth driver education has not been very effective.
- Because many of the victims of teen crashes are occupants of other vehicles, reducing teen crashes has a large beneficial multiplier effect on all road users.
- They lack strong status quo bias compared to older adults and may be less likely to exhibit cognitive dissonance. Most youth do not own a car and younger youth are still non-drivers. Therefore, they have not yet formed car-use or car dependent habits as drivers (though they may have as passengers), which might otherwise make them more resistant to change.
- Adolescents are less likely to have physical barriers to increasing active transport
- Healthy mobility habits learned at this stage may be engrained for many years.
- They are at a stage when many make decisions about whether to learn to drive, how much and how far to drive, and whether to buy a car, not just whether to drive safely. Hence, they also have the stimulus at this important juncture to consider their choices, and “may be more receptive to new ideas and information”
- They may not yet have been exposed to the variety of objective information needed in order to help make the best decisions for themselves so information may be just the nudge they need.
- They may be more sensitive to cost considerations due to limited means.
- Simultaneously, they may be vulnerable to advertising glorifying the appeal of car use but ignoring the drawbacks of safety, costs, activity levels, and so on.
- Parents and peers can play a special role in influencing youth attitudes and behaviours.
- The school setting that most youth are in allows for a dynamic range of mobility health education and programs involving both teachers and students as leaders
- The generation of today’s youth are those that will very likely live long enough to experience for themselves very serious consequences of climate change so they have a strong personal stake in addressing the environmental issues.

The Adolescent Mobility Health Consortium’s goal is to encourage, develop and support research and interventions that facilitate voluntary adolescent transportation modal shift from motor vehicles to active and public transport using transportation demand management (TDM) strategies. TDM is potentially more beneficial to adolescents than traditional road safety efforts aimed at making a costly, risky and unhealthy activity (driving) marginally safer. These efforts aim to promote the consideration and adoption of alternatives to the cultural and generational expectations of ubiquitous driving in private automobiles. It is about the freedom for youth to choose their mobility options with full knowledge of the benefits and drawbacks of each alternative.

Conclusions

Transport policy and planning decisions affect public health in various ways, including traffic crash risks, physical activity, pollution exposure, affordability, mobility for non-drivers, mental health, and access to healthcare services, as summarized in the table below. These impacts are large, and in many situations, growing. The U.S. has one of the highest per capita traffic fatality rates among peer countries, most children and adults fail to achieve physical activity targets, and vehicle pollution is a major health risk. New research can help identify transport strategies that support public health objectives, as summarized in Table 11.

Table 11 Transportation Health Impacts

	Description	Transport Impacts	Transport Policies for Health
Crash Risks	Risk of traffic accidents, particularly for vulnerable modes (walking, bicycling and motorcycles).	Increased vehicle travel and higher traffic speeds tend to increase per capita crash risks.	Targeted traffic safety programs and vehicle travel reduction strategies.
Physical Activity	People’s physical activity (target is at least 22 daily minutes of moderate activity).	Active transport (walking and bicycling) is one of the most practical ways to exercise.	Improve and encouraging walking, bicycling and public transit (since most transit trips include active links). Smart Growth development policies.
Noise Exposure	Amount of noise people are exposed to.	Motor vehicles are major sources of noise.	Traffic noise reduction policies. Building design and location.
Air Pollution	Amount of air pollution people are exposed to.	Motor vehicles are major sources of air pollutants.	Vehicle air emission reduction strategies. Separate people from vehicle traffic.
Affordability	Portion of household budgets that must be spent on transport.	Motor vehicle travel is costly and often unaffordable to lower-income households.	Improve affordable travel modes (walking, bicycling, ridesharing and public transit) and increase affordable housing options in accessible locations.
Mental health	Insecurity, physical inactivity, and social isolation and inaffordability tend to increase mental stress and unhappiness.	Transportation can affect mental health in many ways.	Create safer, more walkable (for exercise and community cohesion), and more affordable communities.
Access to services and activities needed for health	Ability to access healthcare services.	Inadequate transport can be a barrier to healthy food and healthcare for physically and economically disadvantaged people.	Improve affordable travel options. Better housing options in walkable neighborhoods. Identify and address barriers to healthy food and healthcare.

Transportation policies and planning decisions affect public health in several ways.

Conventional planning tends to consider some of these health impacts, particularly traffic accidents and pollution emissions measured per vehicle-kilometer, but generally ignores the additional crashes and pollution emissions caused by increased vehicle mileage, and the health

problems caused by degraded walking and cycling conditions. As a result, public officials tend to ignore the health risks of planning decisions that stimulate automobile dependency and sprawl, and undervalue improvements to alternative modes and mobility management strategies.

These often-overlooked health impacts are often greater in magnitude than impacts that dominate the planning process, such as traffic and parking congestion. A congestion reduction strategy that causes even small increases in crashes, pollution or physical inactivity is probably not cost effective overall, but a congestion reduction strategy that supports safety, environmental and health objectives can provide far greater total benefits. More comprehensive health impact analysis could significantly change planning decisions to favor alternative modes, mobility management and smart growth policies.

Conventional planning is biased in various ways that stimulate automobile dependency and sprawl, creating communities where driving is convenient and cheap and other forms of travel are inconvenient, uncomfortable and even dangerous to use. This exacerbates transport-related health risks including per capita traffic casualties, pollution emissions, sedentary living, and inadequate access to essential goods and services. There are many justifications for planning reforms that create more efficient and diverse transport systems, of which improving public health is among the largest.

This study identified numerous win-win strategies that provide public health benefits and help achieve other planning objectives. This analysis indicates that integrating health objectives into transport planning can be one of the most cost-effective ways to improve public health. Improved public health can be among the greatest benefits of a more efficient and diverse transport system.

Information Resources

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