» Promoting public health through Smart Growth

Building healthier communities through transportation and land use policies and practices

Lawrence Frank, Sarah Kavage + Todd Litman

PREPARED FOR:
SmartGrowthBC

Photography courtesy of Gordon Price

Preface

This report explains how our built environment shapes our transportation choices, and in turn, human health. It reviews the existing research for a range of transportation-related health impacts on seven public health outcomes: Physical Activity and Obesity, Air Quality, Traffic Safety, Noise, Water Quality, Mental Health, and Social Capital.

As part of Smart Growth B.C. efforts to help foster transportation investments and land development decisions that promote a synergy between public health and environmental sustainability, this report will provide guidance for developing transportation and land use policies and practices that support public health objectives. It also offers general recommendations for how land use policies, investments and actions can help to achieve healthy communities.

Land use patterns, because they relate with transportation behaviour, subsequently affect public health in a number of ways: through physical activity levels, availability of healthy food choices, exposure to crashes, air pollution and noise, and community interaction and mobility. Last year Canada's Heart and Stroke Foundation released its annual report card highlighting that "the suburban dream has gone sour," further documenting that public health is associated with auto dependency and lack of opportunities for active transportation.

The same basic smart growth principles that provide environmental, energy, and economic benefits can also help to support healthier communities. Compact land use patterns with high-quality pedestrian environments and a mix of land uses can improve public health by promoting active forms of transportation, reducing per capita air pollution and associated respiratory ailments, and lowering the risk of car related accidents.

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Taken collectively, research to date shows that over the long term, land use and transportation policies can provide significant health benefits. Although current approaches to building are well-entrenched, local, provincial and federal actions can all significantly change the prevailing land use pattern to one that is more supportive of healthier communities.

Cheeying Ho
Executive Director
Smart Growth B.C.

Lawrence Frank
Bombardier
Transportation Chair
University of British Columbia

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Executive Summary

Smart growth communities are healthier places to live. This is an important story to tell to elected officials, transportation and land use planners, health professionals and the general public. Smart growth communities – those that are compact with a mix of land uses, well-connected street and sidewalk networks, and a supportive pedestrian environment – can help to achieve various health objectives primarily by affecting people's travel behaviour.

Research has documented that all else being equal, residents of smart growth communities walk and bicycle more and drive less than residents of more isolated, automobile-dependent locations. This results in measurably better physical fitness, reduced likelihood of obesity and traffic crash risk, and fewer air pollutants per capita than residents of more automobile-oriented communities.

The current evidence on the influence of the built environment on public health can be distilled into some guiding principles that can be applied in a variety of different settings such as small villages, developing suburbs, old town centres and central cities.

- Land uses – retail, office, residential, open space, and schools – should be integrated rather than separated from one another, so that people can easily accomplish basic utilitarian needs on foot or bicycle.
- In the case of retail development, more small shops and services near to where people live will attract more walking trips than a few large shopping centres or a mall.
- Compact residential development puts more people within walking distance of parks, schools, transit, shops and services, and provides the vital market for those services.
- Streets and buildings that are built from a pedestrian perspective create places that are safe, vibrant and interesting for walkers, bicyclists, and transit users.
- Street and trail networks that are highly interconnected reduce the time and distance needed for pedestrians and cyclists to get from one place to another.

However, one size does not fit all. Different places and different populations, whether they are young, old, rich or poor, have different needs and sensitivities to the built environment.

For example, youth may be most responsive to having parks and recreation spaces close to where they live, while working age adults respond to having shops and services within a walkable distance from home and work. Elderly people are likely to be most sensitive to the presence or absence of a high quality sidewalk system with safe street crossings and having services within a very short distance of where they live.

People with lower incomes tend to walk more and drive less than their wealthier counterparts. However, these same populations also tend towards low cost, high-carb food choices that increase body weight. This makes them more likely to be obese overall, and infers the additional importance of access to healthier food choices. Those that use public transportation may get more physical activity through walking to and from transit to access work and other destinations.

There is much that can be accomplished by educating policymakers, planners and consumers about how to create, evaluate, and select healthier communities. This report identifies numerous policy and planning strategies that can help to do so. No single strategy is sufficient - it will be necessary to implement a variety of integrated actions to create a healthier urban form. Although the impact of an individual strategy may seem modest, their effects are cumulative and synergistic. Over the long term, smart growth policies can have considerable impact on urban form, travel behaviour and health.

There is much that can be accomplished by educating policy-makers, planners and consumers about how to create, evaluate, and select healthier communities.

In addition to helping create healthier communities, smart growth planning practices can help achieve other economic, social and environmental objectives for the community at large, such as:

- Reduced costs of providing public services and infrastructure on a per capita basis.
- Less air pollution and greenhouse gases created per person.
- The potential for offsetting transportation problems, such as traffic and parking congestion, accidents and exposure to pollution emissions.
- Increasing access to nearby destinations and independence for disadvantaged groups, people with disabilities, and elderly people.
- Increased convenience for caregivers and reduced cost of providing assistance to people with disabilities and the elderly.

- Providing opportunities for lower energy costs per capita.
- Stimulating community economic development.
- Increased design flexibility and new solutions to planning problems.

Smart growth policies can also directly benefit consumers. Just as most consumers have become increasingly sophisticated about home design details, they will also want to learn more about factors such as accessibility, convenience, and walkability in order to make more informed decisions about home location, community and lifestyle.

Research indicates that there is latent demand among homeowners for more compact, mixed, multi-modal neighbour-hoods and more active transportation environments. One study in the Atlanta region documented that approximately a third of the population living in auto dependent environments would prefer to be in a more walkable environment that supports active trans-portation. The same study suggests that the supply of environments that support active transportation is much less than the demand (Frank, Chapman, and Levine 2004).

As more detailed information about these linkages unfolds, it is a high priority to translate results into practical guidance for transportation investment and land develop-ment decisions. This report is an important step in this direction.

For planners and policy makers, health is just one of many factors to consider in the planning process. Fortunately, policy reforms that promote public health are generally consistent with smart growth planning principles – and can also provide important environmental, energy, and economic benefits.

Implementing smart growth principles will require overcoming decades of automobile-oriented transportation and land use planning that favours mobility over accessibility, dispersion over compactness, homogeneity over diversity, and standardization over complexity. Changing these entrenched practices requires time, creativity and persistence. By improving the options available and increasing people's understanding of the health impacts of their choices, we believe that more families will choose healthier communities.

Introduction

What is a healthy

All over the world, people are asking that same question and taking steps to make their own community healthier.

Although specific solutions vary a great deal from one place to the next, generally, in a healthy community the citizens feel safe and secure, have access to vital services and nutritious food, air and water, are active, are engaged with others, and feel empowered to create change.

Although most people are able to live comfortably in Canada and in many other industrialized countries, community networks are often weak. People complain of feeling isolated from their neighbours. Frazzled from hours spent driving on congested roads, they may have little time for community involvement or even to enjoy a stroll in the neighbourhood.

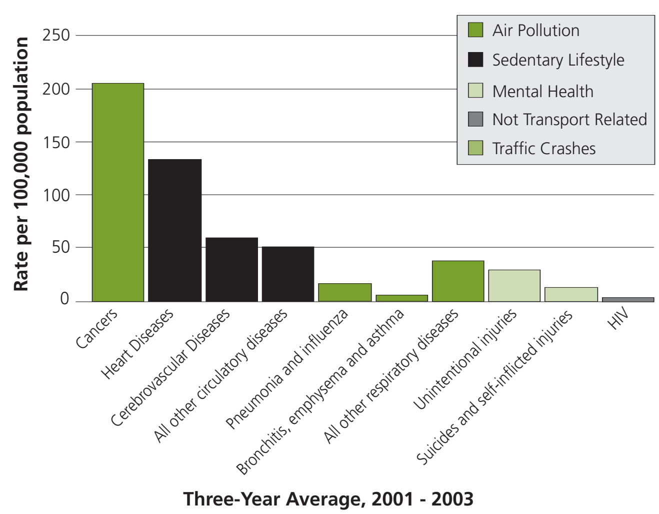
Diseases such as heart attacks and strokes, brought on by a lack of physical activity and an over-reliance on convenience food, prevail. Resources are consumed at an alarming rate, leading to polluted air and water, depleted farmland and open space.

This report looks at community health through the lens of urban design and planning. Although the majority of the evidence is based on research from the U.S., the implications are equally relevant for Canadian communities. In each of the sections that follow, we examine how land use and transportation policy, investment and design can support or undermine different aspects of public health.

> This report looks at community health through the lens of urban design and planning.

In Canada, and in much of the industrialized world, the tendency to build our cities around the car has contributed to a wide range of transportation-related health impacts. Of the leading causes of death in Canada, eight are potentially affected by sedentary lifestyles, air pollution or traffic crashes, as illustrated in Figure 1. Of course, not all of these deaths result entirely from transport activities. For example, other factors contribute to heart and respiratory diseases, and there are other causes of injuries besides motor vehicles.

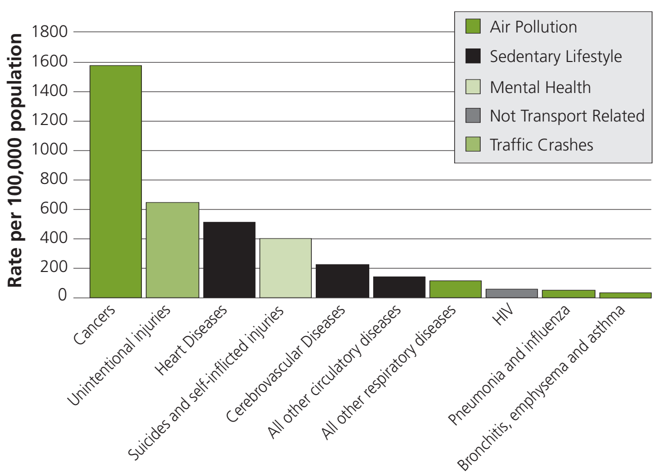
Figure 1. Potential transport impacts on the leading causes of death (source: Statistics Canada)



community?

The potential impacts are even larger for the leading causes of Years of Potential Life Lost (YPLL), which takes into account age at death, as shown in Figure 2. Injuries and suicides have a greater impact than other risks such as heart disease or cancers, which are generally associated with aging.

Figure 2. Potential transport impacts on leading causes of years of potential life lost (Source: Statistics Canada)



Three-Year Average, 2001 - 2003

Many health experts now recognize that basic urban planning practices – specifically, transportation and land use policies – can help to achieve population health objectives (Sallis et al. 2004; Litman, 2003; Frank and Engelke 2001; Saelens et al., 2003b; Frumkin et al 2004; Lyons, 2004).

In fact, zoning, subdivision regulations and building codes were originally intended to enhance the health, safety and welfare of the public. The legal precedents to zoning descended from the English common law of public nuisance.

Nuisance law was used to justify building requirements to reduce crowding and increase light and air circulation (New York City's Tenement House Act of 1901 is one early example), as well as the "Euclidian" approach to zoning which kept certain land uses away from others, separating the more noxious industrial uses from the places people lived (Schilling and Linton 2005).

Ironically, the failure to adapt zoning standards over time as our cities, industries and priorities changed has resulted in land use patterns that actually undermine population health in a number of ways – decreased physical activity levels and shocking increases in obesity, increased rates of asthma and other respiratory illnesses, high rates of traffic-related injuries, and so on.

Transportation and land use policies and planning practices that affect urban form include:

- Development regulations - building codes, zoning codes and subdivision regulations
- Land use planning, site design and land development processes
- Transportation infrastructure planning, funding and prioritization practices
- Public facility location and design decisions
- Taxes and utility fees
- Roadway design and management

Many current policies and practices, such as generous minimum parking requirements and dedicated highway funding, tend to favour lower-density, automobile-oriented, urban fringe development, generally referred to as sprawl (Frumkin et al. 2004).

Many experts believe that this type of development pattern, and high levels of vehicle ownership and use that result, impose a number of economic, social and environmental costs on society (Burchell et al. 1998; Litman 2004). Alternative policies and practices, often called smart growth, encourage more compact infill development and support more efficient usage of existing transportation, water, sewer, schools, and social services as well.

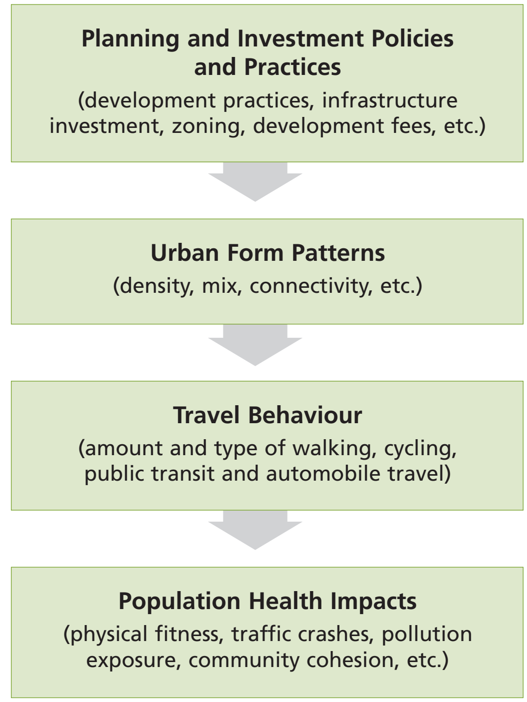


Figure 3. From land use to travel behaviour to health

The Connection between Land Use, Transportation and Public Health

A central focus of the relationship between health and urban form is attributable to the transportation choices that result from different development patterns (Sallis et al 2004; Saelens et al 2003b; Handy et al 2002; Frank et al 2004).

There are several steps between a particular planning policy, its implementation, changes in the built environment, resulting changes in the behaviour, and its ultimate health effects, as Figure 3 illustrates. For example, a policy that increases land use density, mix and walkability can result in increased levels of active transportation (walking and bicycling) in a population.

Increased amounts of physical activity result in lower rates of obesity and associated health conditions, such as diabetes. Although research has documented a connection between land use and transportation investment policies and travel choices, the additional impact of people's preferences on their travel patterns makes it difficult to predict exactly how much change in behaviour might accrue from specific physical changes to the built environment.

Many health objectives, such as physical fitness and community cohesion, are affected primarily by the amount of nonmotorized travel that occurs. Others, such as traffic fatalities and pollution emissions, depend primarily on the amount of automobile travel. Although it is uncertain exactly how much substitution occurs between vehicular and active forms of travel (the green area in Figure 4), policies that can shift travel from private vehicles to nonmotorized transportation and transit would provide multiple benefits in the form of increased physical activity, less sedentary time in cars, less air pollution and reduced accident risk.

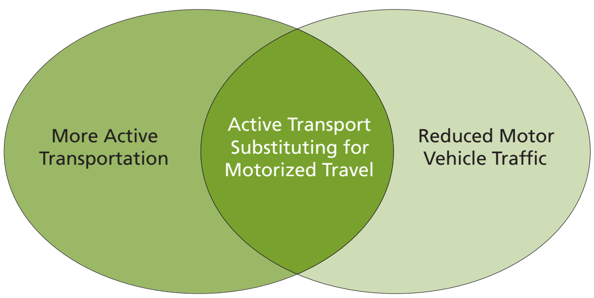


Figure 4. Overlap between active transport and vehicle use

About this Report

This report is the second in a series of reports commissioned by Smart Growth B.C., a nongovernmental organization devoted to fiscally, socially and environmentally responsible land use and development. The first report, titled "Population Health and Urban Form: A Review of the Literature," (Yates, Thorn & Associates 2004) looked at a number of transportation-related health impacts. This report follows the above format to a large degree.

In the short time since the first report was finished, a number of studies have been published that lend further clarity to this topic, including several Canadian studies. This report builds upon the first one, updating the literature review and making a number of policy recommendations for the local, regional, and federal levels that can help create healthy communities. This second report further expands the range of health impacts that are evaluated.

The intent of both reports is to look at how smart growth policies can best support population health objectives overall, rather than looking at any one impact in isolation. This allows decision-makers to identify planning practices that can achieve multiple health benefits, and avoid those that support one objective but undermine other health objectives. For example, smart growth calls for more compact, mixed-use development. However, it is likely that the more compact urban centres have higher concentrations of air pollution which can be health adverse to "at risk" populations such as elderly and youth (Frank and Engelke 2005; Frank et al 2006).

What the Research Says

Researchers have been studying the relationship between land use and transportation for years. Because many of the conclusions can be applied to the public health realm, and because there is a much larger body of research, a literature review is presented here alongside those more recent studies that assess public health outcomes specifically.

Even given the amount of research available, it is important to note that quantifying or predicting the transportation or health impacts associated with changes in land use patterns is challenging for a number of reasons:

Urban form measures are spatially correlated More compact areas typically also have a greater mix of land uses and a more connected street network, along with a higher-quality pedestrian environment. This makes it hard to disentangle the effects of each factor on travel patterns and public health.

Many urban form measures are tough to quantify Many urban design factors that relate with the choice to walk, such as level of interest, attractiveness, tidiness, visibility into buildings, perceived safety and security from crime, are seen as difficult to quantify.

The incremental nature of land development Changes in land use tend to be incremental, so it may take decades before the ultimate health effects of a policy change fully occur.

Some urban form factors have mixed impacts For example, increased land use density tends to reduce the amount of per-capita vehicle travel but can increase the number of vehicle trips in a given area – which may increase exposure to harmful pollutants (Frank and Engelke 2005). As a result, it is difficult at present to predict how density affects overall exposure to air pollution and health impacts.

Questions of causality and self-selection To date, the vast majority of the research on urban form / travel behaviour relationships is cross-sectional, meaning that it draws conclusions based on a statistical comparison of groups of individuals at a single point in time, rather than longitudinal studies, which examine changes in a single group of individuals' behaviour over time. Longitudinal studies can more often assert causation where cross-sectional studies cannot.

This is important because a person's transportation behaviour and physical activity levels are likely to partially reflect their attitudes and preferences. People who prefer not to drive are more likely to live in walkable environments, and people who enjoy driving (or are willing to tolerate the extra driving for a cheaper house, a better school, or a larger backyard) tend to choose more automobile-oriented locations. As a result, some differences in travel behaviour between walkable and automobile-oriented locations may reflect self-selection rather than the pure effects of land use.

By tracking a set of households from one location to the next over time, it would be possible to separate the effects of self-selection from the effects of urban form. Unfortunately, studies of this nature are quite lengthy and complicated undertakings.

A number of studies have attempted to control for self-selection biases by incorporating attitudinal factors, including attitudes about transportation and lifestyle preferences (Kitamura et al. 1997, Boarnet and Sarmiento 1998, Bagley and Mokhtarian 2002, Giles-Corti and Donovan 2002, Greenwald and Boarnet 2001, Schwanen and Moktarian 2005).

These studies have had mixed results – in some, attitudinal and lifestyle variables emerge as more influential on transportation behaviour than urban form factors, while others found the reverse – that urban form factors are more influential than one's personal predisposition to a certain travel mode.

Krizek (2003) and Handy et al. (2005) attempted to estimate the influences of self-selection using quasi-longitudinal research designs – that is, both studies followed people who changed household locations. Handy found that, while a cross-sectional analysis of the same sample showed attitudes to be more influential in explaining travel behaviour, the longitudinal analysis revealed the physical environment to be more so, although more influential on the amount of walking than the amount of driving.

Krizek found that, although Vehicle Miles Traveled (VMT) and number of stops per trip decreased when people moved from a less to a more walkable location, effects on other transportation modes were not statistically significant.

The author suggests that the VMT reductions could be because the new locations are closer to more destinations, not because walking trips are substituting for driving trips.

The research suggests that both preferences and physical environment affect travel behaviour. Regardless of the cause, the outcome is the same – people who prefer a more walkable environment will be more active in environments that support walking than those that prefer auto-oriented environments or sprawl. However, even those that prefer sprawl will walk more if they live in a walkable environment. (Rodriguez and Frank 2005). Further, recent evidence of latent demand for more walkable environments suggests that simply accommodating the existing demand would allow those who are currently located in auto-oriented environments to choose a more walkable one (Levine 1999).

Some research has documented that a significant proportion of residents in sprawl would prefer to be in more walkable environments, but trade it off for reasons including spousal preferences, work location, and cost (Belden Russenello & Stewart 2004, Levine and Frank, under review, 2006). This, combined with a significant undersupply of walkable environments relative to the demand for such places, explains why housing in walkable environments costs a premium.

Questions of Social Sorting

There are also confounding factors such as the concentration of poverty in older urban neighbourhoods (Downs 1999; Shaeffer and Schlar; 1975).

For example, increased development density is sometimes said to cause social problems such as poverty and crime. As can be seen in places like Vancouver with prosperous, safe-in-city neighbourhoods, density does not cause crime and poverty – nor does sprawl increase overall wealth and security. This actually reflects sorting where wealthier people can afford the larger, single-family homes and automobile-dependent transportation system of suburbs, while poor people tend to concentrate in older urban neighbourhoods, in part because of the presence of affordable housing, public transportation and social services. While density and poverty may be correlated in some cases, the relationship is not causal.

Land Use, or urban form, refers to various factors such as density, land use mix, street connectivity (grids versus culs-de-sac) and the quality of the pedestrian environment, as shown in Figure 5. These factors may apply at various geographic scales. For example, density may be measured at the building, block, census zone, neighbour-hood/district, jurisdiction or regional level.

Land Use Impacts on Travel Behaviour

This section discusses the published research on the relationships between land use and travel behaviour. Since land use patterns influence the modes of transportation people use, they have an indirect, but crucial impact on physical activity, respiratory illnesses, per capita crash rates, and other public health outcomes.

There is a huge collection of literature on urban form relationships with travel behaviour, which precedes the more recent research specifically examining public health variables. Reviews have been conducted by Ewing and Cervero (2001), Boarnet and Crane (2001), USEPA (2001), Kuzmyak and Pratt (2003), Bento et al. (2003), Frank (2000), and VTPI (2005). As discussed previously, with only a couple of exceptions the available research is cross-sectional, and so measures correlations between travel behaviour in different study areas rather than directly measuring changes in behaviour in response to a change in urban form.

Figure 5. Urban form factors that can affect transportation behaviour

Factor	Definition
Density	People or jobs per acre or hectare.
Mix	Degree to which residential, commercial and institutional land uses are located close together. Can be mixed vertically within a single project or horizontally across several different developments.
Connectivity	Degree to which roads and paths are connected and allow direct travel between destinations.
Centredness	Degree to which commercial and other public activities are located in downtowns and other activity centres.
Pedestrian/ Cycling Environment	Quality of walking and cycling conditions such as sidewalk presence, continuity, separation from vehicular rights of way, safe crossings, building setbacks.
Parking supply and management	Number of parking spaces per building unit or hectare. Parking management includes pricing and regulations.
Street design and management	Scale and design of streets, and how various uses are managed. Traffic calming refers to street design features intended to reduce traffic speeds and volumes.
Transit accessibility	Degree to which destinations are accessible by quality public transit.

Density, Mix and Connectivity

In the published literature, three aspects of the built environment – density, land use mix, and connectivity – have been consistently found to be important predictors of travel behaviour and walkability.

Urban form relates to travel patterns primarily by impacting proximity between destinations and directness of travel between these destinations. Proximity is a function of both the **density or compactness** of activities and the level of **land use mix**. Both help to determine how many routine tasks – going to work, grocery shopping, visiting friends, etc – are within a convenient distance (Frank 2000; Sallis et al 2004; Frank and Engelke 2001).

Connectivity determines how directly one can travel between activities. Figure 6 illustrates how these factors impact neighbourhood walkability. Where these distances are sufficiently short (within 1 kilometre) some walking trips will substitute for driving trips (Sallis et al., 2004, Handy and Clifton 2001, Bagley & Mokhtarian 2002).

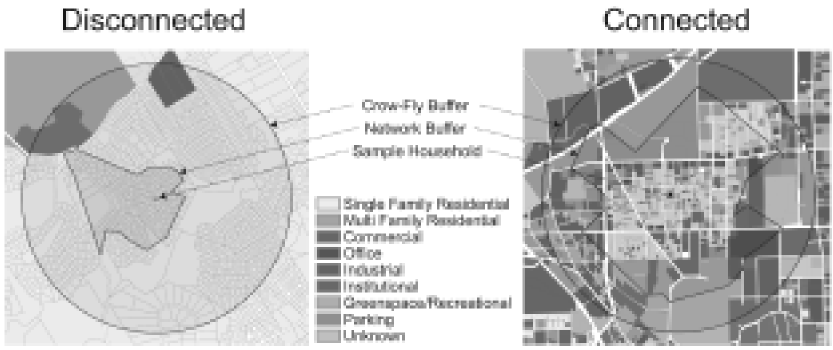


Figure 6. Comparing smart growth and sprawl
This diagram contrasts a household located in a typical low-density, disconnected suburban neighbourhood with separated uses on the left, with a household located in a more compact, connected, mixed use neighbourhood on the right. The circle represents a 1-kilometre radius (the 'crow-fly' distance) from each household, while the asymmetrical 'network' buffer inside the circle captures the 1-km area actually walkable on the street network. This diagram shows not only how a disconnected street network pattern can impact walking accessibility (directness), but also how a low-density, single use land use pattern restricts the number of accessible destinations within walking distance (proximity). From Frank et al., 2004.

This is particularly the case with non-work travel, where trips are much shorter in length and most often organized around where people live (Frank et al., 2000).

Transportation investments that make driving more convenient can make walking, biking, and transit less attractive alternatives. A recent Seattle-area study found that reducing travel time and congestion levels for cars results in a lower proportion of trips on foot and transit. This suggests that roadway expansions that alleviate congestion attract trips from other active and more sustainable modes and may actually undermine the health related benefits of smart growth (WSDOT, 2005).

To study the combined impact of these factors, the LUTAQH (Land Use, Transportation, Air Quality & Health) study in Seattle integrated these basic measures – residential and retail **density**, street **connectivity**, and **land use mix** – into a walkability index. The index was found to be a statistically significant predictor of five major transportation, health, and air quality outcomes (Frank et al 2006).

Density

Density relates with travel behaviour by affecting distances between destinations and the portion of destinations that can be reached by active modes (walking and cycling). A concentration of jobs and households makes transit more viable and provides the critical mass necessary for supporting retail development.

As density increases, per capita hours and miles of automobile travel tend to decline (Ewing and Cervero, 2001; Holtzclaw 1994; Frank et al 2006), and walking, bicycling and transit tend to increase, all else being equal.

A recent study in Seattle found that each quartile increase in residential density corresponded with a 23 per cent increase in the odds of walking for non-work travel. (King County ORTP, 2005).

An earlier Seattle-area study by Frank and Pivo (1995) also found that nearly all travel was done by car until residential density levels reached 13 persons per gross acre, and that the work environment is also important in determining peak-hour travel and transit viability.

This same study also found that employment density levels greater than 75 employees per gross acre were necessary before there was a substantial increase in transit and pedestrian travel for work trips (Frank and Pivo 1995).

Many current planning practices limit density. In particular, zoning and subdivision regulations often allow no more than one household per every acre or a maximum effective density level of four dwellings per acre. These same regulations also "zone out" multi-family housing and secondary suites, and complementary land uses, such as office, retail, and institutional uses (Levine 2005).

Additional development requirements such as minimum building setbacks, parking requirements, and roadway dimensions corroborate to form an environment where density is effectively, if not directly, undermined. To counter these forces, smart growth policies generally allow for more compact development.

Land Use Mix

The original impetus of zoning was to separate noxious smokestacks and other industrial uses from where people lived. However, this resulted in a segregated approach to land use planning – where the scale of separation is so great between residential, retail and office uses that walking is no longer a viable option.

Not only is this paradigm out of date (given current patterns of industrial development), it runs counter to many public health objectives (Frumkin et al. 2004). Increased land use mix is a common smart growth objective, and many policy reforms increase land use mix by removing barriers, providing incentives, and locating public facilities where they are more accessible to neighbourhoods.

A mixed land use pattern is correlated with increased walking and reduced automobile travel, all else being equal. A number of studies have documented increased levels of walking in mixed-use places (Cervero and Kockelman 1997; Frank and Pivo 1995; Handy 1996; Moudon et al 1997). However, only a handful of studies have used actual detailed land use data where the distances between different types of activities such as residential, office, retail, entertainment, parks, and other uses are objectively assessed (Lee and Moudon 2004; Moudon and Lee 2003; Hess 2001; Frank et al. 2006).

Mixing land uses is most effective where habitual activities (home, work, school) are co-located with uses that are used less habitually, such as entertainment or retail.

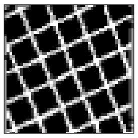
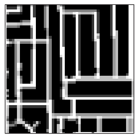
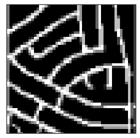
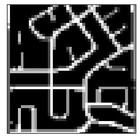
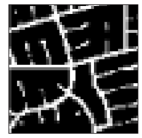
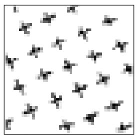
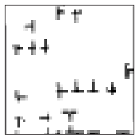
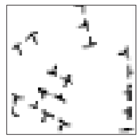
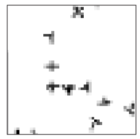
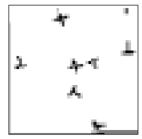
The King County LUTAQH study also found that the land uses most strongly linked to the percentage of household walking trips in the Seattle area were educational facilities, commercial office buildings, restaurants and taverns, parks and neighbourhood scale retail establishments, with civic uses and grocery stores following closely.

The ***number*** of retail establishments (rather than the total retail square footage) was found to be important in the decision to walk for non-work purposes. With each quartile increase in the number of retail locations, walking for non-work trips increased 19 per cent (King County ORTP, 2005).

Connectivity

A more connected roadway, walkway and bikeway system reduces the distances that must be traveled to reach a destination. Well connected walking and cycling networks are crucial to encouraging active transportation. Even a single barrier in a sidewalk and pathway system can be a deterrent.

Over the course of the 20th century, street networks evolved from a connected to disconnected design. Southworth and Owens (1993) convey the evolution from a gridiron network to a disconnected "Lollipops on a Stick" cul-de-sac network in Figure 7. Each change that occurred was associated with a reduction in the number of intersections and an increase in the number of cul-de-sacs over time.

	Gridiron (c. 1900)	Fragmented Parallel (c. 1950)	Warped Parallel (c. 1960)	Loops and Lollipops (c. 1970)	Lollipops on a Stick (c. 1980)
Street Patterns					
Intersections					
Linear feet of streets	20,800	19,000	16,500	15,300	15,600
Number of blocks	28	19	14	12	8
Number of intersections	26	22	14	12	8
Number of access points	19	10	7	6	4
Number of loops and culs-de-sac	0	1	2	8	24

Source: Southworth, M. and P. Owens. 1993. The Evolving Metropolis: Studies of Community, Neighbourhood, and Street Form at the Urban Edge. Journal of the American Planning Association 59(3): 271-87, Figure13.

Figure 7. The evolution of neighbourhood street patterns

These results are also supported by evidence from the Atlanta, Georgia based SMARTRAQ project (Frank et al. 2005). Collectively, these studies suggest that intersection density needs to reach around 50 intersections per kilometre before pedestrian travel becomes more commonplace.

Because of their lower travel speed and shorter achievable distances, walking trips are more significantly impacted by street network patterns than are vehicle trips. Figure 8 illustrates how a short trip on a highly connected street network can become unwalkable in a cul-de-sac environment.

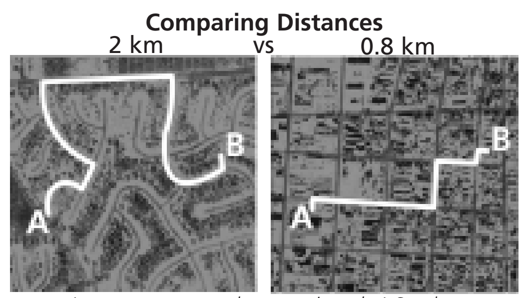
Efforts to increase connectivity must overcome the common practice of building cul-de-sac street networks.

Newer network designs also tend to have wider roadway widths that are difficult for pedestrians to cross, and few sidewalks with limited separation from the roadway edge.

In recent years many urban planning experts have begun advocating a return to more connected road and pathway networks. However, cul-de-sac designs are still much more common, especially in suburban areas or in new development.

Both Kitamura et al. (1997) and Greenwald and Boarnet (2001) found significant relationships between connectivity variables and walking. The LUTAQH study noted above showed that the odds of someone reporting that they walked for non-work purposes rose by 14 per cent for each quartile increase in the level of street connectivity where they live (King County ORTP 2005).

Figure 8. Walking distances in smart growth and sprawl neighbourhoods



Images are same scale, approximately 1.6 sq km

The impact of a disconnected street network is conveyed in the above diagram. While the same straight line, or crow fly distance, is shown between points A and B; the actual travel distance is only walkable in a connected network. The hierarchical road system, illustrated on the left, has many dead-end streets and requires travel on arterials for most trips. A connected road system, illustrated on the right, allows more direct travel between destinations, offers more route options, and makes nonmotorized travel more feasible (Source: Sallis et al., 2004. Transportation Research - Part A).

Culs-de-sac are popular not only because they increase profits for developers (by reducing the amount of total acreage devoted to streets and increasing the acreage that can be sold), but because they limit cut-through traffic, as well as overall volumes and speeds.

Traffic calming and street design strategies, such as narrower street widths, direct pedestrian connections and safe street crossings can be used instead of culs-de-sac to control vehicle traffic speeds and create more walkable environments.

Road and walkway connectivity is generally determined when communities are first planned. However, a street or sidewalk network can be 'retrofitted' incrementally by the addition or removal of links and barriers, improved maintenance, and reducing traffic volumes and speeds.

New development can also present opportunities to build a finer-grained street or sidewalk network. Street design standards for new development should emphasize connectivity, particularly for walkway networks.

Streetscape Design: Streets, Sidewalks and Safety

During most of the 20th century, transportation professionals generally prioritized vehicles. The result – wider streets, huge parking lots, increased traffic volumes and higher traffic speeds – negatively impacted transit, bicycling and walking.

In recent years planners have begun to appreciate the need to balance street design objectives, accommodate alternative modes and activities, and to create safer, more convenient conditions for walkers, cyclists, and transit users.

Generally, research has shown that alternative approaches to street design can increase walking, cycling and public transit use, and reduce potential conflicts with vehicles related with traffic volume and speeds. Presence of sidewalks, the amount of on-street and surface parking, building placement and site design, transit accessibility, and visual quality not only improve the actual safety and appearance of the streetscape, but the perception of an area's safety and walkability. However, these aspects of the built environment are seldom measured and their impact can be difficult to quantify. They also tend to occur in conjunction with compact, mixed use environments, making it hard to discern their true impact.

The LUTRAQ (Land Use, Transportation, and Air Quality) study in Portland, Oregon was a landmark study that calculated subjective measures of the built environment, or Pedestrian Environment Factors (PEFs) – ease of street crossing, sidewalk continuity, street connectivity, and topography. These factors were quantified on a scale, and used in the development of statistical models. From this the researchers found that "a 10 per cent reduction in vehicle miles traveled (VMT) can be achieved with a region-wide increase in the quality of the pedestrian environment" comparable to Portland's most pedestrian-friendly areas (PBQD el al. 1993a). The PEF was subsequently incorporated into studies by Greenwald and Boarnet (2001) and the USEPA (Ewing and Greene 2003).

In a study in the Seattle region, the mean age of development was significantly correlated with household non-auto trip generation – the newer the development, the lower the non-auto share of trips. This suggests that the age of residential development may be a proxy that captures the overall quality of the pedestrian environment, including sidewalk provision and building setbacks (Frank et al. 2000).

The LUTRAQ study in Portland performed a similar analysis using age of buildings as a proxy for building placement, and found that VMT drops where more buildings are oriented towards the sidewalk rather than towards a parking lot (PBQD et al. 1993b), as was found in pre-World War II development.

Evaluating qualitative features of the built environment can be difficult to do objectively and consistently, since multiple observers over a number of days or weeks is typically necessary to perform the evaluations.

Gauvin (2005) attempted to account for some of these inherent difficulties in her survey of the built environment in 112 Montreal census tracts. Observers evaluated 18 highly qualitative aspects of the built environment, including the ease of bicycling and walking, safety, and destination density/appeal. Using an econometric modeling analysis, Gauvin was able to reduce variation between observer and location, resulting in a list of independent variables that were both highly qualitative and reliably measured.

The impacts of streetscape design elements on overall travel behaviour and population health are complex and depend on specific circumstances and the integration of these changes with other smart growth policies.

Buildings can be designed to encourage more walking, cycling and public transit use by orienting buildings close to the sidewalk, with parking behind or underneath (rather than locating buildings behind large parking lots). Windows on the ground floor, and awnings above, will increase comfort and interest, and varied, complex rooflines will add to the visual appeal of someone walking by.

The Connection Between Physical Activity and Transit

Research suggests that transit use also promotes physical activity, since most transit trips involve walking or cycling links. Analysis of U.S. travel survey data indicates that 16 per cent of all recorded walking trips were part of transit trips, and these tended to be longer than average walking trips (Weinstein and Schimek 2005).

A different U.S. study, based on nationwide travel survey data, found that transit users spend a median of 19 minutes daily walking to transit – over half the 30 daily minutes recommended by the Heart and Stroke Foundation.

Twenty-nine per cent of U.S. transit users walked more than 30 minutes daily on their transit trip alone (Besser and Dannenberg 2005). Approximately 75 per cent of Atlanta, Georgia passengers arrive and depart from rail stations on foot (Chapman et al. 2004).

High quality transit services may also leverage land use changes called Transit Oriented Development, or TOD, and reductions in per household automobile ownership, which further reduce per capita vehicle travel and increase nonmotorized travel.

The Seattle based LUTAQH study found a highly synergistic relationship between transit use and neighbourhood walkability. Urban form – at both the home and work ends of a trip – directly influences the time differential between transit and auto travel, making transit more viable.

Seattle-area neighbourhoods with a greater mix of land uses, better street connectivity, and high densities supported both transit use for regional mobility and walking for nearby destinations.

» The LUTAQH study found that every 1/4-mile increase in distance from a transit stop to home, odds of taking transit decreased 16%.

Whereas the **number** of non-residential or commercial destinations did the most to influence walking rates, the **total square footage** of commercial destinations had the greatest relationship to transit use. Land uses at the work end of a trip, rather than those surrounding the home end, were better predictors of work trip transit use (King County ORTP 2005).

For people walking to transit, short distances are crucial. The LUTAQH study found that for every quarter mile increase in distance from a transit stop to home, the odds of taking a transit trip to work decreased by 16 per cent. A quarter mile increase in distance from transit to work reduced the likelihood of taking transit to work by 32 per cent (King County ORTP, 2005).

The ability to access secondary trip destinations also factors importantly into the decision to use transit.

In another Seattle-area study commissioned by the Washington State Department of Transportation, working in a walkable environment with a mix of uses, high retail density, and a well connected street network was found to be associated with reduced auto use for the trip to and from work, and increased walking for mid-day trips (WSDOT 2005).

These results suggest that transit and pedestrian-supportive land use patterns where we live **and** work are important, and can also enhance the viability of transportation demand management strategies to further encourage modal shifts.

Facilitating pedestrian access to transit may have the greatest health benefits to low-income individuals. Not only are they more likely to be transit users, Besser and Dannenberg (2005) found low-income and non-white groups to be more likely to be walking to transit, and more likely to spend more than 30 minutes on their trip to transit.

Other Ways to Influence Behaviour: TDM, Pricing and Parking

Although these strategies are not technically land use strategies, they can still have health benefits by encouraging active modes of transportation – transit, bicycling and walking. They can also work synergistically with land use strategies and provide the extra "push" to get people to try new ways of getting around.

Most importantly, land use solutions are long-term solutions – even if the relevant policy and regulatory changes are made quickly, it can take decades to see significant changes in development patterns. Because they can be implemented relatively quickly, TDM, pricing and parking management strategies can be crucial interim solutions and help to educate the general public about the importance of healthy transportation.

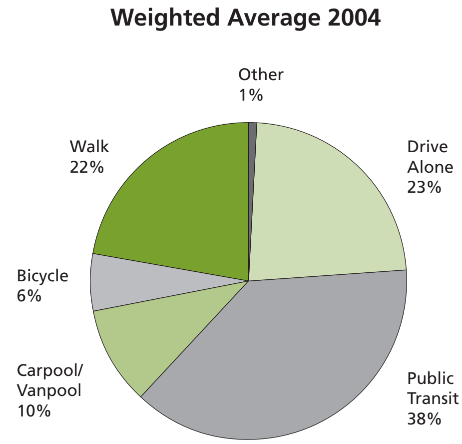


Figure 9. 2004 Mode Split, University of Washington (Seattle)

Transportation Demand Management Policies and Programs

Transportation Demand Management (TDM, also called Mobility Management) includes various programs and strategies that encourage transit, walking and cycling, and carpooling. Examples of TDM strategies include worksite-based programs, financial incentives (subsidized parking) or disincentives (parking fees), and facilities to support bicycling and walking to work, such as secure bike parking or lockers and showers at the workplace. TDM can also incorporate marketing that encourages people to try non-auto transportation modes.

TDM strategies and smart growth strategies work together synergistically – each can have an impact on travel behaviour, but they work best when paired together. A recent research report for the Washington State Department of Transportation found that work trips were more likely to be transit trips when the employment end of the trip is in a walkable (compact, connected and mixed) environment – meaning that when people are able to accomplish mid-day errands by walking, they are more able to commute without a car. This is a strong indication that TDM programs will have the most impact in smart growth areas (WSDOT 2005).

Many of these TDM strategies and programs can significantly change the population affected – for instance, employer trip reduction programs with financial disincentives such as parking pricing tend to reduce automobile commutes by 15-25 per cent and increase the portion of commutes involving walking and cycling by 50-100 per cent (VTPI 2005).

Although this is a large impact for one worksite, it is not likely to translate to a large overall impact on air quality or the transportation system. Larger-scale mandatory programs, such as Washington State's Commute Trip Reduction program, do have measurable impacts on transportation – in terms of air quality, congestion relief, and increasing the share of active transportation modes.

School and university-based programs, such as UBC's TREK program and U-Pass programs at Simon Fraser University and the University of Washington, combine parking fees for single-occupant drivers with a number of benefits – including transit passes – for walkers, transit users, bicyclists and carpoolers. These programs have been stunningly successful.

In the case of the University of Washington, the percentage of students, faculty and staff driving alone to campus has decreased from 33 per cent in 1989 to 23 per cent in 2004, as shown in Figure 11. Despite increases in student population, area traffic remains below 1990 levels (UW Transportation Office 2005).

Mode	Before U-Pass (2002)	After U-Pass (2004)
Single-Occupant Vehicles	43%	37%
Carpools and Vanpools	26%	19%
Transit	26%	41%
Bicycling	3%	1%
Walking	1%	1%
Other	1%	1%
Total	100%	100%

Adapted from Urban Systems, 2005

Figure 10. Change in travel patterns at UBC with the U-Pass program

In the two short years since its inception, UBC's TREK program, with a U-Pass of its own, has increased transit use from 26 per cent in 2002 to 41 per cent in 2004, as shown in Figure 10 (cycling trips, which have declined slightly, have probably been replaced by transit trips) (Urban Systems 2005).

Individual marketing programs are a fairly new TDM strategy that offer individual transportation advice to residents of an area. These programs use a more holistic handholding approach and seek to change all trips – not just the work trip. Although they are largely in the pilot stage in North America, they have been implemented all over Europe and Australia with universal success – with reductions in car use ranging from 6-14 per cent among participants (Socialdata Inc. 2003).

A recent pilot for the City of Portland resulted in 9 per cent less car travel and an 8 per cent increase in walking, cycling, and public transit (Socialdata America 2004). In all cases, follow-up surveys have shown that changes in travel behaviour continue in the long term.

Pricing

Road pricing, such as London's congestion charging program, has reduced automobile traffic volumes by 20 per cent and increased use of alternative modes including public transit, ridesharing, cycling and walking (VTPI 2005; MTE 2005). Other pricing efforts – such as HOT (high-occupancy toll) lanes – allow single-occupant drivers to buy their way in to an HOV (high-occupant vehicle) lane to bypass congestion in the general purpose lanes. However, these strategies are mostly focused on congestion relief and/or generating revenue, and do little to encourage walking, cycling or transit.

Parking Supply and Management

Current zoning codes and development practices tend to require generous amounts of parking. Excessive parking supply tends to increase driving by reducing parking prices and creating more dispersed, large-scale, automobile-oriented development patterns.

Parking requirements are often a limiting factor for infill development, and a constraint on density and the financial viability of infill projects. Buildings with large parking lots create longer walking distances from residential destinations or transit stops.

Parking management includes various strategies to use available parking more efficiently and reduces the amount of parking required by new development. Parking supply and price can have a significant effect on per capita vehicle travel and mode split.

Shifting from free to cost-recovery parking, which charges commuters the full cost of providing parking facilities typically reduces automobile commuting by 10-30 per cent, particularly if implemented with other complementary TDM strategies (Litman 2006; Comsis Corp. 1993; Hess 2003).

Land Use and Transportation Impacts on Health Objectives

Physical Activity & Obesity Impacts

Our health is significantly affected by our behaviour, and our behaviour is affected by the environment. When we choose whether to use active (walking, bicycling, transit) or sedentary (driving) transportation modes it plays an important role in determining our overall level of physical activity. This, in turn, impacts our health.

Given each individual's genetics, body weight results from the balance between what we eat and how active we are – or calories in versus calories expended. The combination of sedentary lifestyles and more fatty, high-calorie foods has created an imbalance, and in much of the industrialized world, the consequences have been alarming.

In Canada, the prevalence of obesity has more than doubled in the last 20 years, seen most clearly in the series of maps in Figure 11.

The most extreme forms of obesity, where body mass index (BMI)* exceeds 40 or more, increased the most dramatically – 225 per cent between 1990 and 2003 (Katzmarzyk and Mason 2006).

The Heart and Stroke Foundation of Canada has identified obesity as a major population health concern. Although some research has found consistent increases in physical activity among Canadians through the 1980s and 1990s (Craig et al. 2004), the fact remains that in 2003, about 15 per cent of Canada's population was considered obese, and a full one-third was classified as overweight (Vanasse et al. 2005).

» Health Problems Associated With Inadequate Physical Activity:

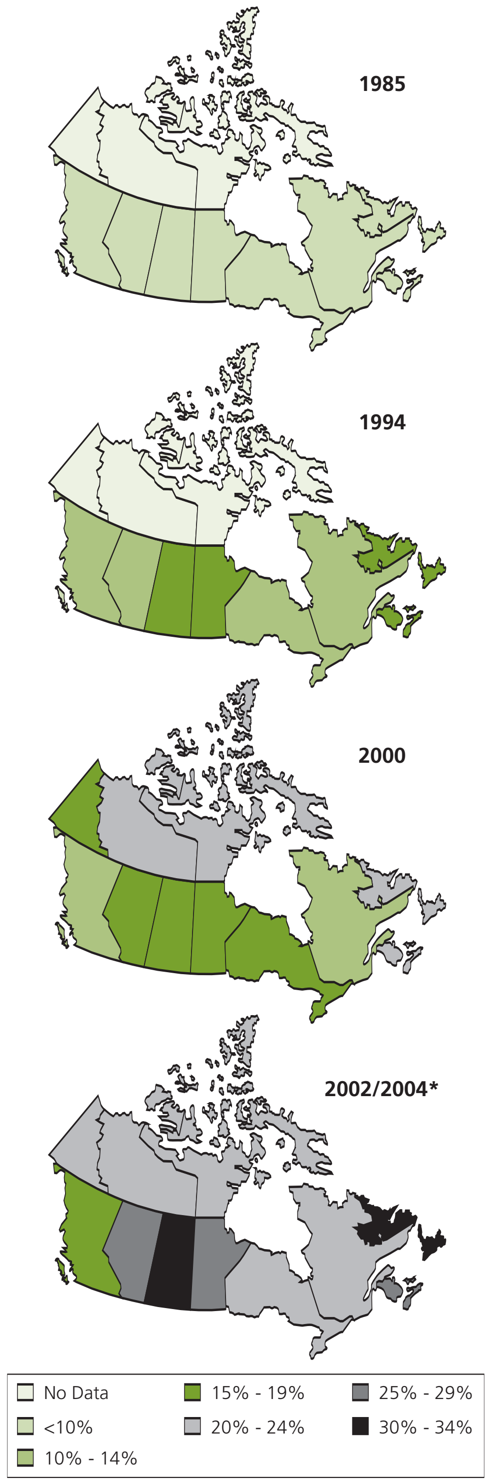
- Heart disease
- Hypertension
- Stroke
- Diabetes
- Obesity
- Osteoporosis
- Depression
- Some types of cancer

Diseases associated with sedentary lifestyles are among the leading causes of disability and death. Katzmarzyk et al. (2004) estimated that in the year 2000, nearly 10 per cent of all deaths among 20 to 64 year old adults could be attributed to overweight and obesity.

In a different study, Katzmarzyk and Jenssen (2004) estimated Canada's economic burden of obesity to be $4.3 billion in 2001.

** The Body Mass Index is a ratio of weight to height, and is a common measure of obesity/overweight status. A BMI of over 25 is classified as overweight, and 30 is generally considered obese.*

Figure 11. The prevalence of obesity in Canada, 1985-2004 (from Katzmarzyk 2006; Provided by Dr. Kim Raine, University of Alberta)



*Provincial data from 2004; territorial data from 2002

Regular, life-long physical activity can help increase overall wellness and reduce illnesses. Even modest increases in physical activity tend to reduce mortality rates for both older and younger adults (Sallis et al. 2004).

The U.S. Surgeon General's 1996 Report on Physical Activity announced that moderate levels of physical activity achieved through short bouts can have significant health benefits. This was a landmark moment in health promotion history because it lead to the realization that walking to and from the bus, to work, or to a nearby store can help people achieve the Heart and Stroke Foundation's recommendations of 30 minutes of moderate activity per day.

Programs to promote physical activity through gym memberships and in school activities and other interventions have only met with limited success. Many experts believe instead that building the opportunity to be physically active into daily routines, through active transport and access to recreational opportunities, is the most effective way to improve community fitness.

Walking and cycling are among the most popular physical activities, particularly by those most at risk of inadequate exercise (who are overweight and inactive).

One major study concluded, "Regular walking and cycling are the only realistic way that the population as a whole can get the daily half hour of moderate exercise which is the minimum level needed to keep reasonably fit" (Physical Activity Task Force 1995). Smart growth policies can increase public fitness and health both by increasing daily walking and cycling activity and reducing time spent being sedentary in cars.

To date, a number of scientific studies have been conducted that investigate relationships between urban form, transportation, and obesity, physical activity, and associated diseases. This research has consistently found that sprawled land use patterns are correlated with increased time spent in cars, and a higher likelihood of sedentary, overweight and obese residents (Lopez 2004).

Numerous studies indicate that urban form affects the total amount of active transport that occurs in an area. One study found that people who live in walkable neighbourhoods report about 30 minutes more walking for transportation each week compared to those who live in less-walkable sprawling neighbourhoods (Saelens 2003b).

Where utilitarian destinations (stores, schools, parks, etc.) are located within convenient walking distance, nonmotorized travel has been found to substitute for a portion of auto trips (Sallis et al 2004; Saelens et al 2003b; Handy et al 2001; Frank and Engelke 2001; TRB/IOM 2004).

Research also suggests that residents of smart growth communities achieve more of their recommended minimum requirement for physical activity through daily walking and cycling.

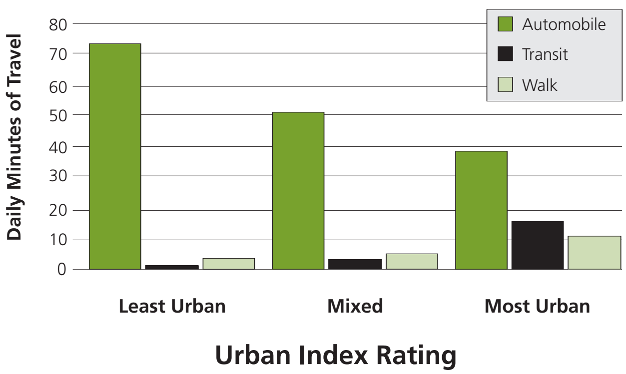


Figure 12. The impact of urbanization on walking

Lawton (2001) compared average daily minutes of travel by automobile, transit and walking by residents of Portland, Oregon neighbourhoods, as shown in Figure 12. Although the total average time spent traveling is similar for the three neighbourhood types, residents of the most urban neighbourhoods walked an average of 11.8 daily minutes, over three times more than the 3.3 average daily minutes by residents of the least urban neighbourhoods.

Not only has urban form been found to be associated with the amount of active transport that occurs, it has been correlated with total amount of physical activity (King et al 2003, Saelens et al. 2003b).

To date, only one study has linked objectively measured physical activity with objectively measured urban form and showed compelling results. This Atlanta-based study used accelerometers, which objectively measure total physical activity.

The study found a measure of walkability that comprised mixed use, residential density, and street connectivity to be a significant factor in explaining the number of minutes per day of moderate physical activity (Frank et al. 2005).

Residents of the most walkable areas of the Atlanta region were found to be 2.4 times more likely to get the recommended amount of moderate physical activity per day prescribed by the U.S. Surgeon General and the Heart and Stroke Foundation of Canada. On average, residents of the most walkable environments in Atlanta got approximately 37 minutes of moderate activity per day whereas residents of the least walkable environments got only 18 minutes – less than half as much.

Sprawl has been correlated with higher body weights, obesity, and their associated chronic diseases (Ewing et al. 2003, Frank et al. 2004, Giles Corti et al. 2003, Saelens et al. 2003a, Frank et al. 2005, Sturm and Cohen 2004).

One early U.S. study conducted at the county level found a significant positive relationship between a sprawl index and physical activity, obesity, and hypertension (Ewing et al. 2003).

Looking at 100 metro areas across the U.S., Sturm and Cohen (2004) correlated the same sprawl index with 16 different chronic diseases, including overweight-related conditions (e.g. hypertension), respiratory ailments (e.g. emphysema and asthma), and other conditions such as abdominal problems and severe headaches. The sprawl index was found to be a significant predictor of the number of chronic medical conditions in a population.

Another study based in Atlanta, Georgia also as part of the SMARTRAQ program, found that residents of the most mixed-use environments are less likely to be obese.

The same study also found that each additional hour per day spent driving was associated with a six per cent increase in the odds of obesity, while each additional kilometre walked per day was associated with a 4.8 per cent reduction in the odds of obesity (Frank et al. 2004).

The study's 10,898 participants were divided into four equal groups (quartiles) of those that lived in the least to those that lived in the most mixed use environments. Each quartile increase in land use mix was associated with a 12 per cent reduction in the odds of obesity.*

The LUTAQH study in the Seattle area integrated four basic walkability measures – retail and residential density, street connectivity, and mix of land uses – into an index which was subsequently tested against five transportation, health, and air quality outcomes.

**The results from this study that assess the likelihood of obesity are based on the full sample and not of specific populations selected based on race and gender. Results that are focused on specific gender and race sub-populations can reveal some important distinctions of how the built environment may or may not influence specific outcomes for different groups. For example, the study found disparate relationships between the built environment and health related outcomes across race and gender. After adjusting for income, age, and educational attainment, it was found that mixed use, residential density, and street connectivity were significant predictors of body mass index, time spent in cars, and distance walked for white but not for black participants. One possible explanation is the lack of access to healthy food choices for non-white populations in the Atlanta region.*

A five per cent increase in the overall range of walkability was associated with a 32.1 per cent increase in minutes of active transport and about a quarter point reduction in BMI (Frank et al. 2006).

Programmatic and promotional approaches have had some success at increasing physical activity, including programs that encourage children to walk or bicycle to school, walking and cycling promotional campaigns, prescriptions for walking written by physicians for sedentary patients, and special walking clubs for at risk groups. However, Sallis (1998) cautions that:

> "Environmental interventions should be put in place before educational interventions are attempted. Health promotion programs sometimes encourage impossible or unrealistic behaviours. For example, media campaigns that encourage people to walk in their neighbourhoods may be irrelevant to people in low-income neighbourhoods with poorly maintained sidewalks, parks controlled by drug dealers, no free recreational programs, and limited transportation to activity programs in other locations. Such campaigns can be seen as blaming the victim of an unfortunate environment and fail to change behaviour. First, policies should be adopted to reduce crime and provide opportunities for safe recreation and active living. Then, educational programs are more likely to be effective."

He adds that the effectiveness of programmatic approaches could be increased if accompanied by changes to the physical environment. Canada's "Go For Green" and the Robert Wood Johnson Foundation's "Active Living by Design" programs are two examples of a multi-pronged approach to educate the public and promote physical activity in conjunction with working towards environmental and policy changes.

A few studies have linked school siting and children's travel patterns (Ewing and Greene 2003; Boarnet et al. 2005). There is some evidence that the provision of open space and other recreational amenities in a community also affects residents' physical activity, although more research is needed to better understand their impacts.

One recent study showed that proximity to open space, and more specifically distance to larger parks with more amenities, was a significant predictor in the likelihood of being more physically active (Giles-Corti et al. 2005). The LUTAQH study found that the odds of walking increased by 20 per cent for each additional park, and 21 per cent for each additional educational facility within a kilometre distance from residential locations in Seattle (King County ORTP 2005).

Traffic Safety Impacts

Traffic crashes are a major health risk and impose large economic costs on society (Wang et al. 1999), and are a leading cause of death for people between one and 40 years of age. Because they tend to injure and kill people at a relatively young average age, their costs are larger still when measured by *Potential Years of Life Lost*, rather than just deaths (WHO 2004).

Sprawl, automobile dependence and traffic safety affect each other in a number of ways. As people spend ever more time in cars, their risk of being in an accident increases.

Additionally, sprawling urban forms, which are designed to move vehicles as efficiently as possible, mean accidents happen at higher speeds, and thus are more severe.

For pedestrians and bicyclists, the combination of fast-moving traffic and designs hostile to non-motorized transport create an environment that is unpleasant as well as unsafe.

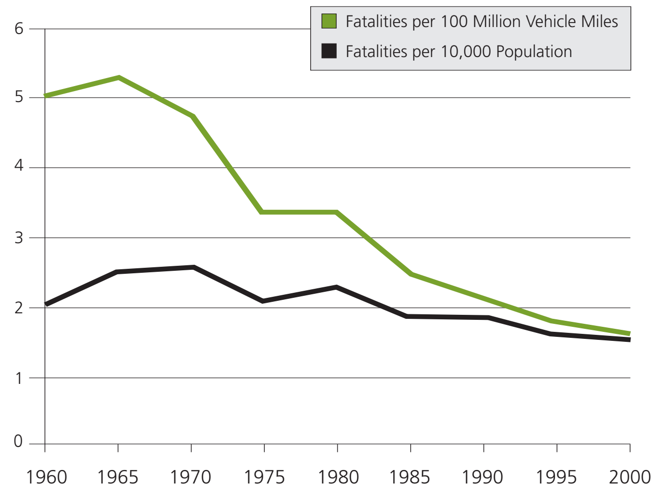


Figure 13. Two ways of looking at traffic fatalities (Litman and Fitzroy 2005)

In a negative feedback loop, as walking and bicycling decline, driver awareness of these modes declines as well, making the conditions even more dangerous for pedestrians.

How crash risk is measured can affect how it is perceived. Transportation professionals have generally measured traffic risk per unit of vehicle travel rather than per capita, which ignores the increased risk associated with planning decisions that stimulate sprawl and therefore increase per capita vehicle travel. When measured *per-vehicle-mile*, U.S. crash rates appear to have declined significantly over time, but when measured per capita, as with other health risks, there is little decline in fatalities, as illustrated in Figure 15 (Litman and Fitzroy 2005).

When measured per vehicle-kilometre, planning practices that increase vehicle travel can be overlooked as risk factors, and may actually appear to reduce risk if they stimulate relatively lower-risk kilometres.

For example, building grade-separated highways tends to increase low-risk vehicle-kilometres. However, when measured per capita, such policies turn out to increase crash risk, since even those relatively low-risk vehicle-kilometres cause deaths and injuries.

On the other hand, increased congestion and higher densities tend to increase total crash frequency, but reduce crash severity, as measured by fatalities by capita. Similarly, when measured as fatalities per person-kilometre, walking or cycling appear to be higher-risk activities, since those modes entail fewer kilometres than vehicle modes.

When measured per capita, total risk tends to decline due to reduced total distance driven, reduced risk to others, and increased caution by other drivers (Jacobsen 2003).

Research has shown that per capita traffic fatality rates tend to be higher in sprawling communities than in compact, mixed use communities, as indicated in Figure 14 and documented in a major U.S. study by Ewing et al. (2003).

Another study by Lucy et al (2003) looked at a number of U.S. cities and suburbs, and found that in sprawling areas, the risk of death by driving was much greater than the risk of death by homicide. This is likely to result from increased per capita vehicle travel, higher travel speeds, and more driving by higher-risk motorists due to poor travel options for non-drivers. A 1998 study in Colorado found that out of a number of variables, street width was by far the strongest predictor of crash risk (Swift and Associates 1998).

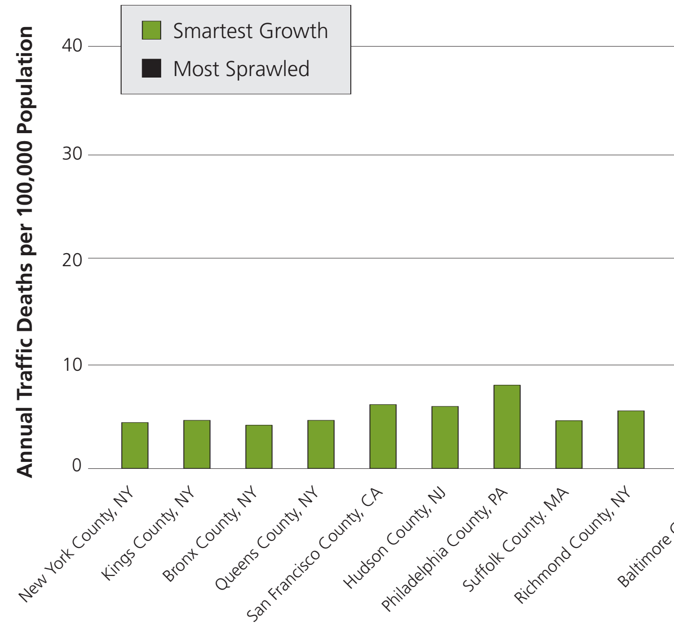
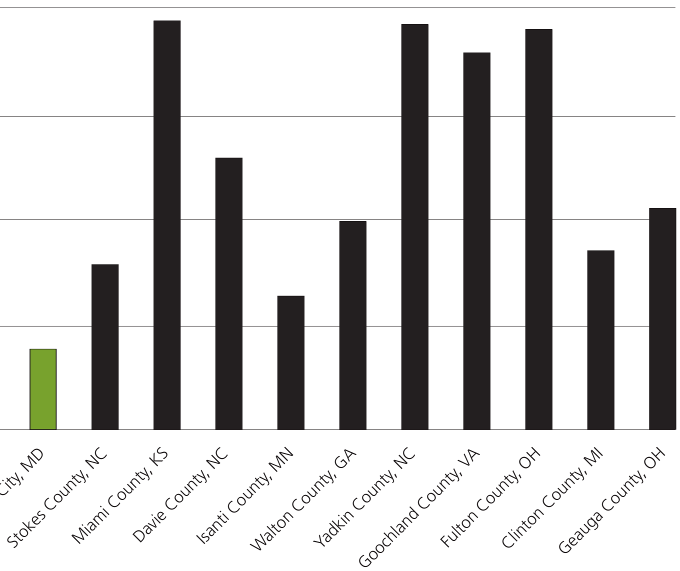


Figure 14. Traffic death rate in sprawl and smart growth communities (adapted from Ewing et al. 2003)

In a study that compared different sections of an Orlando state highway, Dumbaugh (2005) found lower rates of traffic crashes and fewer crash-related fatalities on the section of highway that included narrower lanes, street trees and landscaping, and on-street parking, despite similar traffic volumes and speed limits.

A study by Hess et al. (2004) for the Washington State Department of Transportation looked at pedestrian-vehicle collisions along state highways in Washington and found them to have the strongest relationship to bus stop usage.

Significant associations were also found with retail location and size, traffic volume, and number of traffic lanes. This study is an important reminder that it is necessary to accommodate pedestrians on arterials as well as neighbourhood streets.



Auto-oriented arterials are often the primary transit routes, and thus attract pedestrians – many of whom may need to cross the street to catch the bus, and may take extra risks to do so.

Traffic calming strategies, such as narrower lanes, street trees, and consolidating driveways (i.e. "access management") can slow traffic while still maintaining efficient vehicle movement. Increasing the number of safe crossing points will make it easier for pedestrians to cross arterials safely and quickly.

Many factors influenced by local planning decisions affect per capita crash rates in a community, including per capita vehicle mileage, traffic speeds, the amount of driving by higher risk motorists (such as teenagers and people older than 70 years of age), roadway design and management factors, the quality of traffic law enforcement, and the quality of emergency medical response.

Smart growth policies and practices can increase traffic safety by reducing per capita motor vehicle mileage, slowing traffic, increasing the number of bicyclists and pedestrians, and reducing the exposure of pedestrians and cyclists to unsafe conditions (Litman and Fitzroy 2005).

More compact, walkable land use patterns will both reduce per capita vehicle miles and increase the amount of active transport in an area. Traffic calming and other facility design strategies can reduce crash frequency and severity. Well-designed walking and cycling facilities can reduce pedestrian and cyclist risks.

Significant work needs to be done to reduce conflicts between pedestrians, cyclists, and vehicles. Many intersections and street environments are hostile to walking and biking. Resulting exposure to risk from cars makes it possible to assert that one should walk and bike less to be safer – or even healthier. However, less walking and biking equals less physical activity, and increased odds of obesity, increased air pollution, and so on. Therefore, a holistic model of community design that maximizes population health benefits would make active transportation both desirable and safe.

Strategies to achieve this goal require more corridors where vehicle travel is calmed or slowed, and where pedestrians can easily make it across even the busy roads – which otherwise act as barriers.

Air Pollution Impacts

High per capita vehicle miles of travel and number of vehicle trips are also associated with higher levels of several air pollutants that have adverse respiratory health impacts.

These harmful pollutants include fine particulates, toxins, carbon monoxide, NOx and VOCs.

By reducing the amount of vehicle travel, smart growth strategies can reduce pollution emissions and exposure. While there is no research directly testing the link between land use, pollutant exposure, and health impacts, there is a clear evidence base that links the built environment to travel behaviour and per capita air pollution, which can be linked to pollution exposure in a population.

Local	Air Toxics (benzene, Xylenes, etc.) Carbon Monoxide (CO) Oxides of Nitrogen (NO2) Particulates (ONLY LOCAL) Lead
Regional	Fine particulates Volatile Organic Compounds (VOCs) NOx Ozone
Global	Ozone depletion (CFCs) Climate change

Figure 15. Geographic scale of air pollutant impacts (Litman and Fitzroy 2005)

The geographic scale of air pollution impacts ranges from local to global, as Figure 15 illustrates. Localized air pollutant risks are affected by both the amount of emissions and their location – that is, the proximity between the emission sources and human lungs. Regional and global pollutant risks are affected by the volume of emissions, but not their location.

Localized air pollutants concentrate along roadway corridors (Brauer 2001). Their health risks are affected by traffic conditions (vehicle mix, speed, congestion), the amount of time people spend along the roadway, and micro-environmental factors such as the proximity of buildings and walking/cycling routes to high-traffic roadways.

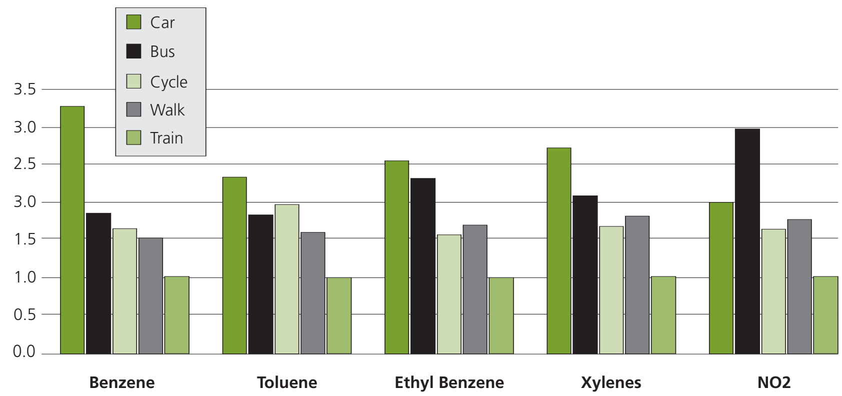
» The geographic scale of air pollution impacts ranges from local to global.

Cyclists and pedestrians may face additional air pollution health impacts due to their elevated breathing rates, although generally motorists face the highest exposure rates, as shown in Figure 16, from a Sydney, Australia study (Chertok et al. 2004).

Regional pollutants, such as fine particulates and ozone (formed by the combination of NOx and VOCs), can be extremely harmful (Peters et al. 2004; Pope et al. 2000; Frank et al. 2006).

While ozone is a secondary pollutant and is a regional airshed problem, particulates vary in concentration in small areas (Kleeman et al 2000). High ozone concentrations can trigger shortness of breath and asthma (Bell et al. 2004; Friedman et al. 1998, Gauderman et al., 2004, Hoek et al. 2002, Areskoug et al., 2000).

Investigations on the relationships between land use and exposure to air pollutants suggest that exposure to harmful ground level ozone may be somewhat mitigated through increased walkability (Frank and Engelke 2005).



People's exposure to localized air pollutants varies by mode, pollutant, and specific local conditions. (adapted from Chertok et al, 2004)

Figure 16. People's exposure to localized air pollutants varies by mode. However, motorists tend to experience greater exposure than travelers by other modes. For example, in the chart above, benzene exposure is about 3.25 times greater in a car than in a train, and over twice as great as walking. (adapted from Chertok et al. 2004).

Recent research documents that heart attacks can be triggered through increased exposure to fine grain particulates (PM 2.5) for at risk populations (Pope et al. 2000). A recent report for the BC Lung Association estimated that a 10 per cent improvement in PM 2.5 and ozone emissions in the Vancouver, BC area would produce $195 million (CAN) in health benefits (from decreased mortality, emergency room visits, and occurrences of asthma, bronchitis and cardiac incidents) in 2010.

The report also notes that "the potential benefits associated with reducing ambient PM2.5 concentrations are an order of magnitude greater than the benefits associated with reducing ambient ozone concentrations." The report goes on to note that such reductions (10 per cent or more) "will not be achieved in a business-as-usual scenario." (RWDI Air 2005).

Additionally, although particulates concentrate along major roadways, sampling methods are yet unable to evaluate variation of fine particulates in detail. Studies are now underway in the Vancouver and Seattle Regions to assess the spatial variation in concentrations of fine particulates (PM 2.5) in more and less walkable areas of each region.*

Because the relationships between land use, vehicle travel, emission rates, exposure, and human health impacts are so complex and dynamic, it is difficult to predict exactly how a particular land use policy will affect air pollution exposure. Additionally, different land use factors affect different pollutants differently, so a particular policy may reduce risks from some pollutants and increase risks from others.

In general, anything that reduces per capita motor vehicle travel (particularly short, cold engine start trips), makes vehicle traffic smoother, favours less polluting vehicles (such as alternative fuels), and increases the physical separation between vehicle traffic and people is likely to reduce vehicle pollutant human health risks. As population density increases, so do the benefits of these interventions (Friedman et al 2001; Frank and Engelke 2005).

Short motor vehicle trips in urban conditions tend to have relatively high per-kilometre pollution emission rates due to cold engine starts and congestion, so reductions in such trips tend to provide relatively large emission reductions.

These short trips are also the same trips most likely to be replaced by walking and cycling trips if land use patterns become more walkable. However, increased land use mix, density, and street connectivity is associated with reduced per capita levels of volatile organic compounds and oxides of nitrogen which react in sunlight and form harmful ozone (Frank et al 2000).

Moreover, benefits from reduced distances traveled associated with increased proximity between destinations overwhelmed the effect of increased levels of pollution from cold starts.

Emissions per vehicle mile tend to be minimized at moderate traffic speeds (30-50 kilometres-per-hour) with minimum stops. Although extreme traffic congestion increases emission rates, moderate congestion may reduce emission rates compared with higher freeflow speeds, depending on specific conditions.

The LUTAQH study in the Seattle region looked at the relationships between urban form and air quality. A quartile (25 per cent) increase in the overall range of walkability within King County, Washington was associated with 6.5 per cent fewer vehicle miles traveled (VMT), 5.6 per cent fewer grams of oxides of nitrogen (NOx) and 5.5 per cent fewer grams of volatile organic compounds (VOC) per capita (Frank et al. 2006).

When looking at the tradeoffs between more walkable land use patterns and pollutant exposure, the walkable environments may be the same places where exposure to particulates is greater.

** The Border Air Quality Study (BAQS) being led by Dr. Michael Brauer at the University of British Columbia will help to determine how exposure to pollutants varies over space and time and will address this question.*

This does not mean that we should forego more walkable environments – the cumulative benefits of such approaches to community design, when measured across transportation, environment, and health, appear to be significant in the near term and even greater in the long term – especially in light of other more global, long-range issues, such as energy supply and consumption or climate change.

In conjunction with more compact development, however, policymakers should encourage alternative fuels and engine technologies, especially in commercial fleets and transit vehicles.

Core areas should be buffered from the movement of goods. Housing facilities for at-risk populations, such as the elderly and people with respiratory illnesses, should be located in places where particulates are less concentrated.

Noise Pollution Impacts

Noise impacts human health in various ways, including speech and sleep disturbance, startle and defense reactions, increased stress, reduced productivity in the workplace and school, and if very loud, discomfort and hearing impairment (WHO 1999).

Motor vehicles cause various types of noise, includes engine acceleration, tire/road contact, braking, horns and vehicle theft alarms. Buses, trucks and motorcycles tend to produce high noise levels.

As with air pollution, it is difficult to predict the human noise impacts of a particular land use or transport policy.

Smart growth polices can help reduce total noise by reducing total motor vehicle traffic, but exposure may increase with increased land use density, bus traffic, and walking and cycling activity along high volume roads.

Some traffic calming strategies, particularly speed humps, can actually increase vehicle noise. Streetscape features such as plants and berms can provide sound barriers, and buildings can be designed with noise reduction features such as double-pane windows. Improved bus design and maintenance practices, and shifts from bus to rail transit, can reduce transit vehicle noise.

Where possible, pedestrian and cycling routes should be separated from traffic by trees or sound walls. Traffic calming plans should incorporate noise factors, favouring strategies that avoid sudden braking or increased accelerations.

Water Quality Impacts

Just like the air we breathe directly affects our health, the health of our water supplies closely mirror our own well-being.

Fresh water is precious – although 78 per cent of the earth's surface is covered by water, over 97 per cent of that water is too salty for humans to drink and over two per cent is ice or deep underground – leaving about one thousandth of one per cent for human consumption.

If the world had only a gallon of water, then the available fresh water would amount to just a few tablespoons.

Water quality can be contaminated a by number of sources – from the biological (bacteria, viruses, parasites, fecal coloform) to the chemical (oil, gas, antifreeze, lead, solvents, PCBs, pharmaceuticals).

These contaminants can be spread through drinking water, eating food (such as seafood or irrigated produce) or swimming (Craun 1992; Rose et al. 2001). The result can be acute illness – cholera, diarrhea, typhus, and Hepatitis A – in addition to increased risk for conditions like birth defects, immune disorders, and cancer.

Like air quality, drawing conclusions about water quality can be difficult. Not only are there many different pollutants with varying levels and geographic scales of impacts, but differences in climate and geology make it difficult to draw conclusions from place to place, or to compare varying levels of urbanization.

However, the research around urban water quality generally supports the concept of concentrating a population rather than spreading the zone of impact into undeveloped forest areas and watershed.

In tests of a hypothetical long-term model that they developed, Purdue University researchers found the runoff generated by fringe development to be approximately 10 times greater than that produced by infill (Bhaduri et al. 1997; Harbor et al. 2000).

Avoiding greenfield development is especially important when these lands feed the local water supply, as they often do. A joint World Bank/WWF report makes this point clearly, noting that,

"Unfortunately, the links [between watershed protection and urban water quality] often come into focus when something goes wrong – most commonly when resource management upstream has downstream impacts in terms of changes in water supply, increased flooding and reduced water quality" (Dudley and Stolton 2003).

Any disruption to a watershed, even at very minor levels, has relatively large impacts – rom construction sediment, loss of trees, topsoil and ground cover, increased impervious surfaces and disruption of the natural water flows – all of which degrade water quality.

Using data from western Washington state watersheds, Booth (1994) found "remarkably clear and consistent thresholds of aquatic-system degradation" that showed that if even only 10 per cent of an area is covered with impervious surfaces, the watershed's functions degrade substantially, with even lower thresholds for more sensitive water bodies. He notes that these impacts are difficult, if not impossible, to mitigate.

Another study that compared two watersheds in the Lower Fraser River Valley found statistically significant increases in streamflow in the developed watershed, even given its relatively low levels of urbanization (Leith and Whitfield 2000) Other empirical data (Klein 1979) and hydrologic modeling (Brun and Band 2000) support these conclusions.

When sprawling land use patterns are compared with more concentrated, mixed-use development scenarios, one might think that sprawling land use patterns, with lower levels of impervious surfaces, are better for water quality than smart growth development. However, a few lawns do not make a healthy watershed – large parking lots and wider roads, the greatest source of water pollution in urban areas (USGS 1999, Bannerman et al. 1993), combined with high volumes of lawn care chemicals, point to higher pollutant and runoff loads in suburban areas (Van Metre et al. 2000; Callendar and Rice 2000; Dierberg 1991).

A recent multiyear study in Queensland State, Australia compared several watersheds that were geologically similar but with varying levels of urbanization and found the low-density residential area to have the most impact on water quality (Goonetilleke et al. 2005). The researchers conclude that this was because of the pollutants generated from lawncare and the greater road area in the suburban residential area.

Private wells and septic systems, as often found in low-density or exurban development, are an additional source of groundwater contamination not found in more urban areas (Solley et al. 1998; Levin et al. 2002; USGS 1999; Young and Thackston 1999; Scheuler 2000).

Finally, because sprawl increases the amount of driving that we do, it can be linked to additional pollutants that negatively impact our water supplies.

The gasoline additive MTBE has leaked from thousands of underground gasoline storage tanks and contaminated ground water. Vehicle exhaust, because it contaminates the air, also contaminates the water.

Exhaust contains nitrogen and petroleum compounds (Whipple et al. 1983; Carpenter et al. 1998) which subsequently contributes to eutrophication of lakes and harmful algal blooms. Polycyclic aromatic hydrocarbons (PAH's), petroleum compounds in exhaust, are cancer-causing agents.

In a study of six reservoirs near major American cities, the U.S. Geological Survey found that PAH concentrations in the sediments increased with traffic volume and were up to 100 times higher than levels set to protect aquatic ecosystems (Van Metre et al. 2000).

Smart growth practices and careful watershed planning are necessary to protect our water quality for future generations.

The preservation of watersheds is crucial, which means that any action that concentrates development and preserves watershed areas, such as urban growth boundaries, downzoning in rural areas, conservation easements, and mandatory watershed buffers, would be effective.

In redeveloping urban and suburban areas, decreasing street widths, replacing asphalt driveways with pervious pavers, adding green roofs to buildings, and replacing traditional curb and gutter systems with bioswales can all help to decrease and/or filter runoff.

Mental Health Impacts

Smart growth policies and programs can support mental health objectives primarily by increasing physical activity, decreasing stress (especially vehicle-related stress and road rage), and improving independence for non-drivers.

However, sprawl can offer mental health benefits of its own – a chance to "get away from it all", to de-stress and make contact with nature. The drive itself, although it may mean road rage to some, for others is a rare opportunity for time alone and quiet reflection. The research on the relationship between sprawl and mental health is somewhat inconclusive, which can make the mental health impacts of land use patterns difficult to anticipate.

Some experts have found that access to nature contributes to mental health (Louv 2005; Kaplan et al. 1998; Frumkin 2001).

Views of nature can decrease infirmary visits (Moore 1981-82), speed healing after surgery (Ulrich 1984), and help control pain during invasive medical procedures (Diette et al. 2003).

Even if it is just a backyard, suburban areas often offer more regular, accessible contact with nature. Of course, this all depends on the type of "nature" – whether it means maintaining views, preserving greenspace and farmland, access to parks, or having a lawn or garden – and whether the nature access that sprawling environments provide outweigh the added driving stress! It may be more feasible to design more natural elements into denser, mixed use environments.

Some studies have found no link between mental health and sprawl. Sturm and Cohen (2004), in a study that looked urban form in relation to a number of physical and mental health variables, found significant relationships between urban form and the occurrence of physical ailments, but they found no such relationship with mental health and urban form.

However, sprawl can isolate people socially, increasing their chances of depression (Murphy 1982; Champion 1990). The lack of transportation options in sprawling areas means that anybody who is unable or unwilling to use an automobile will be less able to access health services, jobs, and other basic necessities, further increasing their sense of isolation and day-to-day stress.

In addition, time spent driving has been linked to a number of conditions that impact mental health, including driving-related stress, anxiety, and road rage. Driving frustrations often revolve around unpredictability and loss of control with respect to traffic conditions, other drivers, and time pressures.

The link between driving and physical signs of stress has been documented for the last half of the twentieth century (Hoffman and Reygers 1960; Hoffman 1965, Taggart et al. 1969, White and Rotton 1998; Hennessy and Wiesenthal 1997; Platt 1969; Burns et al. 1966; Tomasini 1979).

In studies of commuters, traffic congestion and delays have been linked to high blood pressure (Stokols et al. 1978; Novaco et al. 1979), more sick days out of work (Novaco et al. 1990), more days in the hospital (Stokols and Novaco 1981), and decreased job performance (Schaeffer et al. 1988).

A few studies have mentioned that some people do actually appreciate their driving time (Kluger 1998), and train and bus commuting have been linked to similar stress indicators (Lundberg 1976; Singer et al. 1979; Evans et al. 2002). But all in all, the research suggests that automobile commuting is more stressful, for more people, than other forms of travel (Taylor and Pocock 1972; Koslowsky and Krausz 1993).

A connected and supportive community can both prevent and mitigate the impact of mental health disorders.

Evidence that shows that built form which enhances the sense of community, and provides areas of solace and opportunities for safe physical activity, can reduce the burden of mental disease. This effect on prevention and mitigation does not even take into account the influence of social networks on mental health, which can be further supported or undermined by land use patterns.

Although these characteristics can be found in either sprawl or smart growth communities, because of the decreased activity and increased driving associated with sprawling neighbourhoods, the balance begins to tip in favour of smart growth communities.

Social Capital Impacts

Social capital can be defined as the degree of citizen involvement in a community, the degree to which people know and trust their neighbours, and the numerous social interactions and transactions that people have as we go about our daily business.

A high degree of social capital can contribute to population health in several ways (Yates, Thorn & Associates 2004; Bray et al. 2005).

Some studies indicate that friendly interactions improve health directly (that is, people who spend time with friends have fewer illnesses). Increased community cohesion can help increase personal security, allowing people (particularly vulnerable residents such as seniors and people with disabilities) more opportunities to walk and participate in social activities. It may also help reduce unhealthy activities such as crime, drug use and alcoholism, because neighbours watch out for and help each other.

Urban form impacts on social capital are difficult to quantify due to the complexity of these issues, their highly specific nature, and their confounding effects. Not only can the degree of community cohesion vary greatly between neighbourhoods (even ones with similar urban form), but its highly subjective and personal nature can mean one person's perception is likely to be very different from another's.

In the research, social capital benefits have been found in both sprawl and smart growth conditions, and in places with characteristics that do not necessarily correspond to either sprawl or smart growth development.

Appleyard (1981) found that residents of less auto-traveled streets were more likely to know their neighbours than residents of streets with more traffic. A study in Atlanta found that tenure in residence and places where kids have the ability to play safely in the street are associated with increased familiarity with neighbours (SMARTRAQ 2003).

Nasar (1995) surveyed residents of three suburbs in Columbus, Ohio to assess their sense of neighbourhood community. The researcher found significantly more sense of community in the mixed-use neighbourhood compared with a nearby area that has single-use (residential only) land use.

Research by Gilbert and O'Brien (2005) and Hertzman (2002) suggest that children's emotional and intellectual development accelerates in more walkable, mixed use communities, probably due to a combination of increased opportunities for physical activity, independence and community cohesion.

However, the relationship to time spent behind the wheel might be more straightforward. In his popular book "Bowling Alone", Robert Putnam (2000) found commute time to be the strongest predictor of civic involvement. In fact, every 10 additional minutes commuting was associated with a 10 per cent drop in community involvement.

For a given particular group or neighbourhood, smart growth policies that improve walkability and land use mix probably increase overall community cohesion, all else being equal. Practices that decrease time spent driving and increase pedestrian activity, social interactions and commercial activity in a neighbourhood can probably also increase social capital.

Many suburban areas are areas where people may be more likely to own their home and know their neighbours. And even though they may reduce an area's walkability, cul-de-sac street designs do offer places for kids to play. Planners should also strive to incorporate these positive characteristics of the suburbs into infill and smart growth development. To attract families into a city, or encourage them to stay there, there will need to be plenty of safe access to open space and schools, and opportunities for home ownership among young or low-income families.

Healthy Communities Planning Policies

A set of specific recommendations for policy and planning reforms is outlined below in four subject areas: Urban Design, Infrastructure and Capital Investment, Development Regulations and Processes, and Taxing and Financing Structures.

These actions can be implemented by federal, provincial and local governments, and by other policy-makers. Although most transportation and land use planning decisions are made at the local level, such decisions are significantly influenced by policies made by other levels of government. As a result, federal and provincial policy changes – for example, flexible transportation funding practices, or special funding to improve walking and cycling connectivity – can trigger a cascade of innovation and reforms.

» The point of cities is multiplicity of choice.

- Jane Jacobs

Generally, most smart growth planning strategies will also benefit public health, although there are also actions that can be specifically targeted towards healthy communities.

Some smart growth actions should be coupled with additional measures to make sure public health objectives are achieved. Virtually all of these strategies provide multiple health benefits, although impacts will vary depending on specific conditions.

URBAN DESIGN

Urban design is the way our cities, communities and neighbourhoods incorporate design details to make them more walkable, vibrant, aesthetically appealing and livable.

- Design and orient buildings to favour walking for internal circulation, and alternative modes for building access. Provide convenient and visible stairs, rather than expecting all travel between floors to be by elevator and escalator. Provide lockers and showers for those walking and bicycling to work.
- Make sidewalk, intersection and streetscape improvements and transit access conditions of new development.
- Require bicycle facilities in all neighbourhoods with commercial and business activities.
- Consider reduced parking requirements and shared parking spaces.
- Increase density in order to make transit feasible.
- Change zoning codes to allow mixed use development on site through vertical and horizontal mixing of uses and through the introduction of complementary land uses (e.g. residential uses in employment centres and conversely commercial uses in residential areas) in places which are currently single use in nature.
- Plan for transit-oriented development along transit routes and around transit stations.
- Change street design practices and standards to reduce automobile traffic speeds, support alternative modes, and create more attractive urban environments.
- Utilize creative roadway/pathway designs in the planning and site design processes, such as connected cul-de-sacs and fused grids.
- Strengthen traditional downtowns by making them interesting and walkable, incorporating public art and heritage.

INFRASTRUCTURE AND CAPITAL INVESTMENT

How we invest our tax dollars into infrastructure can determine the form and design of our communities – and how walkable they are – for many decades to come. Smarter infrastructure planning can have a major impact on how livable and healthy our communities are.

- Prioritize funding for transit and nonmotorized improvements, including projects such as sidewalks, traffic calming, bike lanes, and better transit service or access.
- Prioritize public facility improvements in well-connected, compact urban areas (such as schools, government buildings).
- Target infrastructure development and the location of public facilities to encourage urban redevelopment and infill.
- Require road improvements to include provisions for all modes of travel - bike lanes, sidewalks, transit shelters, etc.
- Provide transit stops in safe, pedestrian-friendly locations.
- Incentivize infill and brownfield redevelopment.
- Where trails do not already exist, create a network of walking and cycling trails that offer both a functional alternative to automobile travel, and an opportunity for exercise and recreation.

DEVELOPMENT REGULATIONS AND PROCESSES

Too often, regulations and processes surrounding development applications tend to favour sprawling neighbourhoods due to their ease of application and conventional natures. Revising regulations and providing incentives for smart growth can change the way development occurs to result in more smart growth communities.

- Calculate the health impacts of development and planning decisions.
- Provide formal avenues for citizens to be actively engaged in the consideration of the health impacts of both policy and project initiatives. These avenues should focus on opportunities for health promotion, with health hazards and mitigation being secondary.
- Incorporate health into the development of comprehensive plans.
- Change planning practices to better count active transportation (for example, by improving analysis of nonmotorized modes in travel surveys) and value its benefits (for example, by taking into account benefits such as roadway and parking cost savings, consumer cost savings and improved health).
- Revise zoning codes, development cost charges, and development permit approval processes to support smart growth objectives.
- Identify priority street connections during the comprehensive planning process, and mandate that those connections be established as a condition of redevelopment. This way the opportunity to make a connection is not lost when parcels are redeveloped.
- Restrict development on farmland, green spaces and environmentally sensitive areas.
- Establish comprehensive local and regional land use plans that identify where development will be encouraged and limited.
- Implement urban containment boundaries to limit development to existing developed areas and to encourage infill.

TAXING AND FINANCING STRUCTURES

Some current tax policies favour suburban development over smart growth (Voith, 1999). For example, Canada offers a 36 per cent Goods and Services Tax (GST) tax rebate for new homes that is not available for renovations, thereby favouring greenfield development over renovation of existing houses.

Equalizing tax treatment of new and renovated housing could encourage better use of urban land and diverting pressure from greenfields.

- Structure local taxes, development cost charges and utility fees to reflect the costs of proving services to specific locations. For example, development fees for an urban-fringe location should be higher than the same development located within the existing urban area, to reflect the higher costs of road, water and sewage lines, and emergency services.
- Offer lower tax rates for development that reflects smart growth principles. For example, reduce sales and property taxes on new construction and redevelopment projects within existing urban areas.
- Apply relatively high taxes on parking facilities and transactions.
- Encourage financial institutions to provide Location-Efficient Mortgages (LEMs), which increase the loan amount for those who buy in neighbourhoods that are close to amenities, walkable and well-served by transit. The theory behind LEMs is that those who live in less autodependent areas will have more total income for a mortgage, because they will be spending less money on car transport.
- Introduce a special tax on greenfield development or provide tax breaks for infill and brownfield development.

INTERIM ACTIONS

Proper land use planning and design is the best means to support healthy communities with active citizens and transportation choices. However, retrofitting existing and building new smart growth neighbourhoods takes time. In the interim, the following actions are short-term measures that can increase active transport or reduce driving.

- Institute parking management strategies that encourage more efficient use of existing parking facilities, improve the quality of service provided to parking facility users and improve parking facility design. It includes pricing and cashing out currently free parking, unbundling parking from building space (so building occupants only pay for the amount of parking they want, rather than having it automatically included with rents), improved parking price structures, and various support strategies.
- Implement Commute Trip Reduction (CTR) programs and by-laws that encourage or require developers, employers, and building managers to provide incentives for occupants or employees to use alternative modes.
- Encourage or require insurance companies to offer 'pay as you drive' pricing. This is particularly appropriate in BC, since ICBC has a mandate to support social objectives such as congestion reduction, crash reductions and improved population health.
- Change planning priorities and practices to support parking management and reduce minimum parking requirements, particularly in growing urban areas.

Conclusion

Planning for Healt

A particular community's urban form tends to result from the abilities and needs that existed when it was first developed, modified over time as new abilities and needs arose.

Public health goals helped to justify zoning and land use controls in the early 1900s. However, those same land use controls that separated houses from smokestacks were applied indiscriminately, facilitating an auto-oriented, homogeneous land use pattern that, ironically, is undermining public health today.

Our priorities, technologies and needs should change to reflect new planning objectives such as population health, livability and affordability.

Compact neighbourhoods with a mix of residential, retail and office activities, in addition to interconnected street networks that provide direct connections between destinations, increase the likelihood that people will walk and take public transportation.

Building placement, safe walkways and street crossings, and streets designed to slow traffic also matter. The more of these characteristics that exist in a community, the more people will use active transportation and transit instead of driving. Because they support physical activity, cleaner air, and safe streets, smart growth communities are healthy communities.

hy Communities

The policy actions described in this report can all make strong contributions to healthier communities. These reforms reflect changing needs and preferences, including the need to respond to changing public health objectives and new consumer preferences. Per capita vehicle travel demand has reached saturation in most communities. Few people want to drive more than they currently do, and many would prefer to drive somewhat less. These people are willing to rely more on alternative modes if they are made more safe and convenient.

Market research also indicates that many people prefer smart growth neighbourhoods - more than are currently able to afford them. These people want to walk and bicycle more for both transportation and recreation, and would become more physically active if they lived or worked in walkable areas.

Many current policies that stimulate sprawl are arguably market distortions that reduce consumer options, waste land and resources, discount or ignore the health and environmental costs of motor vehicle travel, and reflect planning and investment practices that were developed over a half of a century ago.

The smart growth reforms described in this report can help to correct these distortions – benefiting not only the health of our communities, but individual citizens, the economy and the environment.

In addition to helping to create healthy communities, smart growth policies can support other objectives such as environmental benefits, economic development and cost savings, and energy conservation. Although the impacts of individual policies may seem modest, their effects are cumulative and synergistic.

Over the long term, an integrated smart growth program can have considerable impacts on urban form, travel behaviour and health.

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» The goal is not just to promote recreation… but to design physical activity into the daily routine, to build a city so compelling that people will leave their cars at home, strap on a backpack and take up walking as their primary mode of travel.

- Steve Berg, Star Tribune (Minneapolis/ St. Paul 2005).

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SmartGrowthBC

314, 402 West Pender Street
Vancouver, British Columbia V6B 1T6

T 604.915.5234 **F** 604.915.5236

www.smartgrowth.bc.ca

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