Health and the Built Environment: A Review

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With additional references to the social determinants of health
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INTRODUCTION

Why this report?

This report provides a brief foundation on the interaction between social and the built environment, health and wellbeing through a summary of the key research and evidence. Several pathways have been identified in the research linking built environments with travel patterns, activity levels, vehicle emissions, body weight, and associated health outcomes. The report draws on this literature and best practices occurring elsewhere and to a limited extent suggests general areas for policy and regulatory opportunities for disease and illness prevention and mitigation.

A community that promotes good health is also likely to be one that promotes well-being and security. Social and environmental features of such communities facilitate access to vital services, healthy food, clean air and water. Citizens of these communities will be more likely to be active and engaged in their community, and feel empowered to create change. In industrialized countries, although the higher overall level of material comfort has had undeniable health benefits, we are now becoming aware of its negative impacts. Sedentary lifestyles, a lack of physical activity, and an over-reliance on convenience food contribute to heart disease, heart attacks and strokes, which are some of the most common causes of death in these countries. Increasingly, these diseases cause a greater burden on people at lower level in the socio-economic hierarchy.

Developing countries, on the other hand, grapple with how to provide even basic levels of infrastructure – water, sewers, housing and food – for large and rapidly growing urban populations. In these places, health concerns focus on sufficient nutrition and sanitation. Traffic crashes, exposure to air and water pollution, depletion of farmland and forests, and large scale auto focused developments are issues for both developing and industrialized countries. While many of these issues transfer across nations, the solutions may be much different.

Although this report focuses on industrialized countries, particularly the U.S. and Canada, we have brought in evidence and discussion from international sources and developing countries where possible.

What is the built environment, and how does it shape health?

'Built environment', as used in this report, refers to the transportation investments and land use patterns that make up our surroundings – the arrangement of buildings, roadways, trails, transit networks and parks.

The Built environment interacts with the social environment, according to socio-economic status. The inequitable distribution of power, money and resources in society has direct impact on the green environment and ultimately on health. There is a social gradient on the ways people have access to green space: the lower the economic status, the lower the environment quality.[1]

The built environment relates with public health indirectly, largely through individual transportation choices and environmental exposures that result from different built environment patterns. These choices (for example, whether to use a car or walk between

[1] Marmot, M (2010). *Fair Society, Healthy Lives: The Marmot Review.* Available at: http://www.instituteofhealthequity.org/projects/fair-society-healthy-lives-the-marmot-review

destinations) and exposures (such as proximity to traffic noise or fast food outlets) impact our health as a population and as individuals. Variations in built environment characteristics where we live, work, and play– from compact and walkable places serviced by efficient transit to dispersed and auto-oriented – all help to shape the travel choices we make and environments we are exposed to.

Of course, there are many other important factors that converge to determine individual health – genetics, socioeconomic status, one's attitudes and preferences, and others. These factors moderate the built environment – health relationship. From a policy perspective, however, the built environment is an important factor, as it is one – amongst others - that decision-makers can change to be more health-supportive. Major transportation and land use investments are being made on a regular basis that shape new and change existing communities. However, the health impacts of these actions are seldom considered.

What built environment characteristics are most important in shaping health?

The connection between built environment patterns and transportation behaviour works at two geographic scales: regional and local.

Regional Scale – Where Growth Goes

At the regional scale, the relative location of major population and employment centers in a region influences travel behaviour by making certain modes of travel more or less convenient or 'costly' than the others,[2] and has been shown to be strongly correlated with travel.[3] The location and size of a region's centers is influenced by numerous factors such as housing availability and affordability, school district and neighbourhood quality, private investment and jobs growth, transportation investments and access to other centers. Commute distances are a function of regional growth patterns and associated with per capita sedentary time spent in cars which has been shown to be a predictor of obesity and vehicle emissions.

Development that is located within already established urban or suburban areas of a region, preferably in areas well-served by transit, is more likely to become more compact over time and support transit use and reduced auto dependence. Many positive public health outcomes can result from a more compact urban form. Developments on the fringe of urban areas (greenfield or exurban development), even those that have pedestrian-friendly design elements, are going to be linked to more driving and less walking, bicycling and transit use.

Local Scale – How Our Communities Are Designed

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2 Boarnet M, Crane R (2001a). *Travel by design: The influence of urban form on travel*. Oxford, UK: Oxford University Press.

Cervero R and Kockelman K (1997). "Travel demand and the 3Ds: density, diversity, and Design." Transportation Research Part D 2(3), 199-219.

Handy SL (1996). "Understanding the link *between urban form and nonwork travel behavior." Journal of Planning Education and Research* 15, 183-98.

Frank LD, Bradley M, Kavage S, Chapman J and Lawton TK (2007). Urban form, travel time, and cost relationships with tour complexity and mode choice. *Transportation,* Volume 35, No. 1: pp. 37-54.

3 Ewing R, Cervero R (2001). Travel and the Built Environment-A Synthesis. *Transportation Research Record* 1780. TRB, National Research Council, Washington D.C., pp. 87-114.

Holtzclaw J, Clear R, Dittmar H, Goldstein D, Haas P (2002). Location efficiency: Neighborhood and socio-economic characteristics determine auto ownership and use; Studies in Chicago, Los Angeles and San Francisco. *Transportation Planning and Technology*, *25* (1), 1–27.

Frank L, Stone B Jr, Bachman W (2000). "Linking Land Use with Household Vehicle Emissions in the Central Puget Sound: Methodological Framework and Findings." *Transportation Research Part D* 5, 3: 173-96.

Ewing R, Pendall R, Chen D. *Measuring Sprawl and Its Impact* Volume I. October 2002.

The design of development at the neighbourhood scale predicts both local and regional travel behaviour. A walkable neighbourhood environment, by definition is one where residents can walk or bicycle for short trips (these are often errand or social trips, such as trips to the bank or to a restaurant). Neighbourhood-scale walkability also factors into the decision to take transit for longer regional trips (such as work trips) because it facilitates and supports transit access. It also groups many different types of "complementary" destinations together making it possible to forgo the need for a car in many instances. Walkable areas are required both where people live and work or at the trip origin and destination for transit to be viable. Most research has only focused on the built environment at the residential end of the trip, yet it is logical that the design of employment centers and other destinations would also impact travel choices.

Neighbourhood design relates to travel patterns primarily by impacting proximity of destinations and directness of travel between these destinations, as shown in Figure 1 on the following page. **Proximity** is a function of both the **density** of development and the **mix of land uses**. Density (compactness) and land use mix (the spatial distribution of different land use types such as residential, office, retail, industrial, educational, and recreational) work in tandem to determine how many activities are within a convenient distance.[4] **Directness** of travel is determined by **street network connectivity**. As proximity and directness between destinations increases, distance between those destinations decreases. As the distance between destinations decreases, so does vehicle kilometers traveled (VKT).[5] Where distances between destinations are sufficiently short, walking trips will substitute for some driving trips.[6]

Residential density, land use mix, and street connectivity have all been consistently associated with multiple outcomes related to health: per capita vehicle miles, per capita air pollution emissions, physical activity rates, and obesity and body weights.[7] By making neighbourhoods more walkable, we not only can create converging health benefits, but environmental benefits and more equal access to jobs and opportunities. Although less studied, emerging research on the presence of sidewalks, [8] cycling infrastructure, [9] street design, [10] and

4 Frank L (2000). Land Use and Transportation Interaction: Implications on Public Health and Quality of Life. Journal of Planning, Education, and Research 20, 1: 6-22.

Frank L, Engelke P (2001). "The Built Environment and Human Activity Patterns: Exploring the Impacts of Urban Form on Public Health." Journal of Planning Literature 16, 2: 202-18.

Sallis JF, Frank LD, Saelens BE and Kraft MK (2004). "Active Transportation and Physical Activity: Opportunities For Collaboration On Transportation and Public Health Research." Transportation Research A Vol. 38, Issue 4, pp. 249-268.

5 Boarnet M, Crane R (2001b). The influence of land use on travel behavior: Specification and estimation strategies. *Transportation Research A, 35* (9), 823–845.

Ewing R, Cervero R (2001).

Holtzclaw et al. (2002).

6 Bagley MN, Mokhtarian PL (2002). The impact of residential neighborhood type on travel behavior: A structural equation modeling approach. Annals of Regional Science, 36, 279–297.

Handy SL, Clifton KJ (2001). "Local Shopping as a Strategy for Reducing Automobile Travel." *Transportation* Vol. 28, No. 4, pp. 317–346.

Sallis et al. (2004).

7 Frank L, Sallis JF, Conway T, Chapman J, Saelens B, Bachman W. Multiple Pathways from Land Use to Health: Walkability Associations With Active Transportation, Body Mass Index, and Air Quality. *Journal of the American Planning Association* Vol. 72 No. 1. 2006.

8 Sallis JF, Bowles HR, Bauman A et al. (2009). Neighborhood Environments and Physical Activity Among Adults in 11 Countries. Am Jour Prev Med 36 (6); 484-490.

9 Dill J, Carr T. Bicycle Commuting and Facilities in Major U.S. Cities: If you build them, Commuters will use them – Another Look. 2003. TRB Annual Meeting.

10 Parsons, Brinkerhoff Quade and Douglas, Inc., Cambridge Systematics, Inc., and Calthorpe Associates (1993). *Building Orientation: A Supplement to The Pedestrian Environment: Volume 4B*. Portland, OR: 1000 Friends of Oregon.

Greenwald M, Boarnet M (2001). "Built Environment as Determinant of Walking Behavior: Analyzing Nonwork Pedestrian Travel in Portland, Oregon." *Transportation Research Record 1780.* TRB, National Research Council, Washington D.C., 33-41.

building placement and site design[11] have been linked to various health and health-related travel behaviour outcomes.

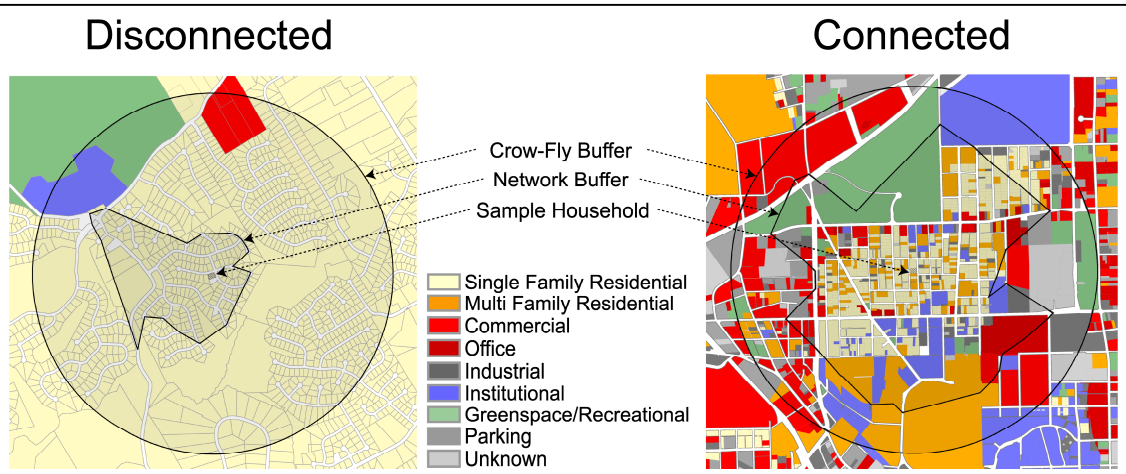
According to US figures, the cost of owning a car for a family in the bottom 5% of income constitutes 40 % of its income: the lack of good public transport make them buy cars and ultimately make them poorer, whereas the family could make use of this money for better food, sports, etc.[12]

Ewing, Reid and Greene W (2003). Travel and Environmental Implications of School Siting. U.S. Environmental Protection Agency.

[11] Parsons, Brinkerhoff Quade and Douglas, Inc., Cambridge Systematics, Inc., and Calthorpe Associates (1993b). *The Pedestrian Environment:* Portland, OR: 1000 Friends of Oregon.

Frank, Lawrence, Stone Brian Jr and Bachman, William (2000). "Linking Land Use with Household Vehicle Emissions in the Central Puget Sound: Methodological Framework and Findings." *Transportation Research Part D* 5, 3: 173-96.

[12] Marmot, M (2010). *Fair Society, Healthy Lives: The Marmot Review.* Available at: http://www.instituteofhealthequity.org/projects/fair-society-healthy-lives-the-marmot-review



This diagram contrasts a household located in a typical low-density, disconnected suburban neighborhood with separated uses on the left with a household located in a more compact, connected, mixed use neighborhood on the right. The circle represents a 1-kilometer 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 how a low-density, single use land use pattern restricts the number of accessible destinations within walking distance* ***(proximity)****.* From Frank et al. 2004.

Figure 1. How Proximity and Directness Impact Travel Behaviour

OVERVIEW OF IMPACTS

What do we know about built environment impacts on health?

This section often refers primarily to North American research findings, as well as some European studies. Where available and appropriate, we discuss evidence from developing countries. Both developing and industrialized countries suffer from impacts of traffic crashes and air pollution. Developing countries often confront an entirely different set of health issues. As noted in the introduction, health priorities for developing countries revolve around nutrition, disease control, access to clean water, and the provision of basic infrastructure for rapidly urbanizing populations.

Obesity and Associated Chronic Disease Conditions

Sedentary lifestyles combined with increasingly high-calorie, high-fat, high-sugar diets have contributed to doubling of obesity rates in Canada in the last twenty years,[13] with most other industrialized countries also seeing large increases.[14] Diseases associated with lack of activity and obesity are also on the rise, and are among the leading causes of disability and death. Connections between the built environment, sedentary vs. physically active modes of

13 Katzmarzyk PT, Mason C (2006). "Prevalence of class I, II and III obesity in Canada." *Canadian Medical Association Journal* January 17 174(2) | 156-157.

14 Edwards P, Tsouros A (2006) Promoting Physical Activity and Active Living in Urban Environments: The Role of Local governments. WHO Europe.

transportation and individual overweight/obesity levels have been observed.[15] Less walkable, auto-dependent built environments have been correlated with higher body weights and obesity[16] – as well as their associated chronic diseases.[17]

Research Highlights

- Analysis across 450 counties and 80 metropolitan areas in the United States found a significant relationship between a "sprawl index" and physical activity, obesity, and hypertension.[18]

- A subsequent county level analysis of 100 US metro areas found the same "sprawl index" to be significantly associated with the number of chronic medical conditions in a population.[19]

- Connections between time spent in cars and obesity have been observed. In a 2004 Atlanta-based study, spending over 60 minutes daily in a car was found to increase the odds of being obese by 6 percent. Additionally, as residential density increased from under two to over eight dwelling units per acre, mean BMI declined from 27.13 to 25.91 for white males - about a 10 pound difference for a man of average height.[20] These findings have since been replicated in subsequent independent studies.[21]

Physical Activity

Physical activity follows social gradient: the lower the socio-economic status, the lower the physical activity and the sense of control on life.[22] Modest increases in physical activity reduce mortality rates in older and younger adult[23] and youth populations.[24] Moderate physical activity gained through walking or bicycling for errands, to work or to school can be an important part of an integrated strategy to promote physical activity and improve health. Compact, walkable, transit-supportive built environment patterns have been consistently associated with higher amounts of **active transport (bicycling and walking)** and more overall **physical activity.**[25] **Transit service** may also act to encourage physical activity and walking.[26]

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15 Townsend T, Lake AA (2009). Obesogenic urban form: theory, policy and practice. *Health & Place 15*, 909-916.

16 Papas MA, Alberg AJ, Ewing R, Helzlsouer KJ, Gary TL, Klassen AC. (2007). The built environment and obesity. *Epidemiologic Reviews, 29* (1), 129-143.

Frank et al (2004).

Giles-Corti B, Macintyre S, Clarkson JP, Pikora T, Donovan RJ (2003). Environmental and lifestyle factors associated with overweight and obesity in Perth, Australia. American Journal of Health Promotion, 18, 93-102.

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17 Sturm R, Cohen DA (2004). "Suburban Sprawl and Physical and Mental Health." Public Health, Journal of the Royal Institute of Public Health, 118(7): 488-496.

18 Ewing et al. (2003).

19 Sturm and Cohen (2004).

20 Frank et al. (2004).

21 Wen LM, Orr N, Millett C, Rissel C (2006). Driving to work and overweight and obesity: findings from the 2003 New South Wales Health Survey, Australia.. Int J Obes 30(5):782-6.

22 Marmot, M (2010). *Fair Society, Healthy Lives: The Marmot Review.* Available at: http://www.instituteofhealthequity.org/projects/fair-society-healthy-lives-the-marmot-review

23 Physical Activity and Health: Report of the Surgeon General on Physical Activity. U.S. Department of Health and Human Services, Centers for Disease Control and Prevention; National Center for Chronic Disease Prevention and Health Promotion, and the President's Council on Physical Fitness and Sports. Washington D.C: 1996. Access online at: http://www.cdc.gov/nccdphp/sgr/contents.htm

24 Strong WB, et al. (2005). Evidence based physical activity for school-age youth. *The Journal of Pediatrics, 146* (6), 732-737.

25 Frank et al. (2005).

King WC, Brach JS, Belle S, Killingsworth R, Fenton M and Kriska AM (2003). "The Relationship Between Convenience of Destinations and Walking Levels in Older Women." American Journal of Health Promotion, 18, 74-82.

Research Highlights

- Individuals living in walkable neighborhoods (compact, with a mix of land uses and an interconnected street network) were found to be 2.4 times more likely than individuals in the least walkable neighborhoods to meet the US Surgeon Generals' recommendation of 30 minutes of moderate physical activity per day, 5 days a week.[27]

- Studies that have examined land uses objectively and in detail collectively suggest that the land use mix that generates the most walk trips is where daily activities (home, work, school) are located near those that are used less regularly (movie theatres, shops, restaurants).[28]

- One study found that transit riders were nearly 3 and a half times more likely meet the U.S. Surgeon General's physical activity recommendations.[29] Transit users spend a median of 19 minutes per day walking to transit, and 29 percent walked more than 30 minutes daily on their transit trip alone. [30]

Cities with more bicycle infrastructure have been found to support higher rates of bicycle commuting.[31]

- Other urban design characteristics demonstrated to be associated with higher physical activity rates and / or higher rates of walking, cycling and public transit include: enjoyable scenery and attractive neighbourhoods,[32] pedestrian-oriented street

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Saelens BE, Sallis JF, Black JB and Chen D (2003b). "Neighborhood-based differences in physical activity: An environment scale evaluation." American Journal of Public Health 93, 1552-1558.

26 LaChapelle U, Frank LD (2009). "Mode of Transport, Employer Sponsored Transit Program and Physical Activity." *Journal of Public Health Policy* **30,** S73–S94.

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28 Lee C and Moudon AV (2004). "Physical activity and environment research in the health field: Implications for urban and transportation planning practice and research." Journal of Planning Literature, 19(2), 147-181.

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Frank et al. (2006).

29 LaChappelle and Frank (2009).

30 Besser LM and Dannenberg AL (2005).

31 Dill J, Carr T. Bicycle Commuting and Facilities in Major U.S. Cities: If you build them, Commuters will use them – Another Look. 2003. TRB Annual Meeting.

32 Wilcox S, Castro C, King AC, Housemann R, Brownson RC (2000). Determinants of leisure time physical activity in rural compared with urban older and ethnically diverse women in the United States. *J Epidemiol Community Health* 54; p. 667-72.

King AC, Castro C, Wilcox S, Eyler AA, Sallis JF, Brownson RC (2000). Personal and environmental factors associated with physical inactivity among different racial-ethnic groups of US middle-aged and older aged adults. *Health Psychol* 19; p. 54-64.

Ball K, Bauman A, Leslie E, Owen N (2001). Perceived environmental and social influences on walking for exercise in Australian adults. *Preventive Medicine* 33; p. 434-40.

Ellaway A, Macintyre S, Bonnefoy X. Graffiti, greenery, and obesity in adults: secondary analysis of European cross sectional survey. *British Medical Journal*, 2005, 331: 611–612.

and site design[33], parks, trails, playfields, and other recreational facilities within walking distance[34], and the presence of sidewalks.[35]

Pedestrian / Cyclist Safety and Traffic

Built environment patterns and pedestrian safety interact in a number of ways. As people drive more (especially relevant if the built environment is not supportive of non-driving modes), their risk of being in a collision increases.[36] Wide roads designed to move vehicles as efficiently as possible mean collisions happen at higher speeds, and thus are more severe - a number of studies have shown traffic speeds and volumes to be strongly linked to the number and severity of pedestrian collisions.[37] Traffic volumes seem to have a closer connection with collision frequency,[38] while speeds are more closely linked to crash severity. Road widths have been also correlated to higher crash rates.[39] Together, these factors may partly explain why sprawling communities have higher per capita traffic fatality rates than walkable ones.[40] In developing countries, roads are even more dangerous for pedestrians and cyclists, often lacking even minimal infrastructure to separate cyclists and pedestrians from motorized vehicles. Large and rapidly growing / urbanizing populations increase the likelihood of traffic injuries and fatalities.

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33 Parsons, Brinkerhoff Quade and Douglas, Inc., Cambridge Systematics, Inc., and Calthorpe Associates (1993). *Building Orientation: A Supplement to The Pedestrian Environment: Volume 4B*. Portland, OR: 1000 Friends of Oregon.

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35 Sallis JF, Bowles HR, Bauman A et al. (2009). Neighborhood Environments and Physical Activity Among Adults in 11 Countries. Am Jour Prev Med 36 (6); 484-490.

36Jovanis P, Chang HL (1986) MODELING THE RELATIONSHIP OF ACCIDENTS TO MILES TRAVELED. Washington, DC: Transportation Research Board. Transportation Research Record 1068, 42-51.

Khan, S ; Shanmugam, R ; Hoeschen, B (1999). INJURY, FATAL, AND PROPERTY DAMAGE ACCIDENT MODELS FOR HIGHWAY CORRIDORS. Washington, DC: Transportation Research Board. Transportation Research Record 1665, 84-92.

37 Ewing R, Dumbaugh E (2009). The Built Environment and Traffic Safety: A Review of Empirical Evidence. *Journal of Planning Literature* 23: 347-367

38 LaScala EA, Gerber D, Gruenewald PJ. 2000. Demographic and environmental correlates of pedestrian injury collisions: a spatial analysis. Accident Analysis and Prevention 32:651-658

Roberts I, Norton R, Jackson R, Dunn R, Hassall I. Effect of environmental factors on risk of injury of child pedestrians by motor vehicles: a case-control study. BMJ 1995;310(6972):91-4.

39 Swift P, Residential Street Typology and Injury Accident Frequency, Swift and Associates (Longmont), 31 March 1998.

40 Ewing R, Schieber R, Zegeer CV (2003b). "Urban Sprawl As A Risk Factor In Motor Vehicle Occupant And Pedestrian Fatalities," American Journal of Public Health, Vol. 93, No. 9, pp. 1541-1545.

Lucy WH (2003). "Mortality Risk Associated With Leaving Home: Recognizing the Relevance of the Built Environment" *American Journal of Public Health*; v.93,n.9; pp.1564-1569.

As a result, low and middle income countries, with only 48 percent of the world's vehicles, have over 90% of global traffic crash fatalities.[41]

Research Highlights
The fatality rate for pedestrians struck by a vehicle travelling under 30 kph is only five percent. At 50 kph, the fatality rate increases to 45 percent and at 60 kph to 85 percent.[42]

Traffic-calming measures, such as on-street bicycle facilities, roundabouts and sidewalks have been found to reduce collision frequencies and severities. Pedestrian and bicycle safety measures, such as sidewalks and pedestrian signal phasing, have been found to improve the safety of roadways.[43] One study concluded that traffic calming could reduce the number of traffic injuries by 15%.[44]

- With the world's least developed road network, Africa also has the world's highest traffic fatality rate (28.3 per 100,000 people). A case study in Nairobi estimated that an array of basic infrastructure strategies such as separated footpaths, lane delineation and safety barriers to be incredibly cost effective in preventing untimely pedestrian and cyclist deaths.[45]

- A study conducted by the San Francisco Department of Health citywide found that the following factors were significantly associated with higher pedestrian crash rates:[46]
    - Non-highway traffic volume
    - Proportion of arterial streets without transit
    - Proportion of land area zoned for neighborhood commercial
    - Proportion of land area zoned for mixed residential/neighborhood commercial use
    - Total employees
    - Total residents
    - Proportion of people living in poverty

Social interaction / social capital

The term "social capital" is multifaceted and defined by feelings of belonging, trust and reciprocity, strong social networks and ties, a psychological sense of community, and contact with nature, among other attributes.[47] Although it has been linked to significant health benefits - reduced mortality, reduced morbidity, cardiovascular health, improved mental health, and faster recovery from illness[48] - the evidence connecting social capital and the built environment

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[41] World Health Organisation (2009), Global Status Report on Road Safety: Time for Action, WHO Press, Geneva.

42 U.K. Department of Transport, Killing Speed and Saving Lives, London, 1997.

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43 Knoblauch RL, Tustin BH, Smith SA, and Pietrucha MA (1988). Investigation of exposure-based pedestrian accident areas: Crosswalks, sidewalks, local streets, and major arterials. Washington , DC: Federal Highway Administration.

44 Elvik R. (2001). Area-wide urban traffic calming schemes: A meta-analysis of safety effects. Accident Analysis and Prevention, 33, 327-336.

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46 Wier M, Weintraub J, Humphreys E, Seto E, Bhatia R (2009). An area-level model of vehicle-pedestrian injury collisions with implications for land use and transportation planning. Accident Analysis & Prevention 41:137-145.

47 Putnam RD. (2000). *Bowling Alone*. New York: Simon & Schuster.

48 Frumkin H, Frank L, Jackson R. (2004). *Urban Sprawl and Public Health*. Island Press.

is less clear. Although there is some evidence that auto-oriented suburban environments can increase the likelihood of depression, [49] it cannot be said decisively that a walkable environment is empirically "better" for social capital than an auto-oriented one. For example, while some walkable neighbourhoods may help to foster a greater sense of community, people also report similar ties in low-density residential neighborhoods where tenure in residence is greater.

One clearly documented social impact of auto-oriented environments is the additional stress that comes with more time in cars. The link between driving and stress has been documented for the last half of the twentieth century.[50] In studies of commuters, traffic congestion and delays have been linked to high blood pressure,[51] more days in the hospital,[52] and decreased job performance.[53] Driving-related stress seems to most often stem from the unpredictability and loss of control traffic conditions, other drivers, and time pressures. Although some people actually appreciate their driving time[54] - and transit commuting has been linked to similar stress indicators[55] - the research still suggests that automobile commuting is more stressful for more people than other forms of travel.[56] Although low-density suburban settings may provide access to nature, these connections may clearly be undermined by a stressful commute – and walkable communities with park or open space access can also provide similar benefits.

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Research Highlights

- A seminal study by Donald Appleyard found that residents of less auto-traveled streets were more likely to know their neighbors than residents of streets with more traffic.[57]

- Whether social capital is observed to be weak or strong largely depends on a set of factors other than walkability such as tenure in residence,[58] access to green space,[59] or neighbourhood crime levels.[60]

  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.[61] Increased levels of land use mix (often due to auto oriented strip commercial) was found to be associated with less social capital. However, having retail set close to the curb with less parking was found to be associated with more social capital.

- Time spent alone in cars translates directly to reduced social capital. In Atlanta, Boston, and Los Angeles, every 1 percent increase in the proportion of individuals driving to work in a neighbourhood was associated with a 73 percent decrease in the odds of having a neighbourhood social tie.[62]

- Perceived neighbourhood walkability has been associated with neighbour cohesion. In Galway, Ireland a 1-unit increase in perceived neighbourhood walkability score was linked with an increase of 1.28 (95% confidence level: 1.14-1.44) in the odds that a resident knows his or her neighbours.[63]

- Diminishing social capital has been associated with a loss of public space. A Scandinavian study found visible open space near home, availability of semiprivate and open places like porches, gardens and parks to be strong predictors of "neighboring", hypothesizing that such places promote outdoor time which in turn promote social interaction. [64]

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57 Appleyard, Donald (1981). *Livable Streets*, University of California Press.

58 Frank L, Chapman J (2004). INTEGRATING TRAVEL BEHAVIOR AND URBAN FORM DATA TO ADDRESS TRANSPORTATION AND AIR QUALITY PROBLEMS IN ATLANTA. Final report prepared for the Georgia Department of Transportation and Georgia Regional Transportation Authority. Deliverable # V.30, GDOT Research Project No. 9819, Task Order 97-13. April 2004.

59 Louv, Richard (2005). Last Child in the Woods: Saving Our Children from Nature-Deficit Disorder, Algonquin Books.

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60 Kawachi I, Kennedy BP, Wilkins RG. 1999. Crime, social disorganization and relative deprivation. Social Science and Medicine 48:719-731.

Kelling G, Coles C. Fixing Broken Windows: Restoring Order and Reducing Crime in Our Communities, New York : Simon & Schuster, 1996.

61 Wood, L, Frank LD, Giles-Corti, B, 2010. Sense of Community and its Relationship With Walking And Neighborhood Design. *Social Science and Medicine.*

62 Freeman L. (2001). The effect of sprawl on neighborhood ties. *Journal of the American Planning Association 67* (1), 69-77.

63 Leyden KM. (2003). Social capital and the built environment: the importance of walkable neighborhoods. *American Journal of Public Health 93* (9), 1546-1551.

64 Skjaeveland O, Garling T. (1996). Effects of interactional space on neighboring. *Journal of Environmental*

- Physical activity and social support systems can form a positive and self-reinforcing cycle. That is, not only can participation in sports and outdoor physical activity contribute to social capital and cohesion[65], but social and community networks help people become more active. One review found that social and community support can increase the duration of physical activity by 44 percent and frequency of physical activity by 20 percent.[66]

Air pollution generation and exposure

Vehicle emissions are a major contributor to outdoor air pollution and are associated with many negative health impacts – largely respiratory and cardiovascular. Vehicle pollutant types are numerous, and include fine particulate matter (PM), air toxins, volatile organic compounds (VOCs) and carbon monoxide (CO) and oxides of nitrogen (NOx), which combine to form ozone. Each pollutant comes from different sources, has its own patterns of dispersion, and therefore different health impacts and associations with the built environment and transportation behaviour. Particulate matter and nitric oxide, for example, are found in recently emitted traffic exhaust from gasoline and diesel vehicles. Higher density and more walkable areas, although linked to lower levels of emissions per capita, may create higher exposures to these pollutants because of higher overall traffic levels and congestion. This is directly linked to the social gradient. Ground-level ozone is a secondary pollutant, forming in the atmosphere and not emitted directly. It is typically found downwind of higher density urban areas, commonly in outlying, low-density and auto-oriented places. Dispersion and concentration is additionally affected by regional wind and weather patterns, and the performance of individual vehicles.

Air pollution exposure is a serious problem in developing countries. Again, urban areas in developing countries are experiencing skyrocketing population growth, and most are also experiencing a rapid growth in vehicle ownership. The prevalence of older vehicles, diesel fuels, two/four stroke engine vehicles, and leaded gasoline compound these issues. Air pollution in developing countries is estimated to cause tens of thousands of deaths and billions of dollars in healthcare costs. These burdens fall heavily on the most impoverished.[67] In addition to the need to increase sustainable transport options, developing countries will also need to focus on phasing out leaded / high sulfur fuels, promoting biofuel alternatives, and encouraging the transition to more efficient, less polluting vehicles. Other strategies include imposing setback requirements between major transportation corridors and residential areas and incentives for elderly to locate in places where the concentrations of particulates is the lowest. These include interior streets away from major congestion and on higher floors of buildings.

Research Highlights

- Short motor vehicle trips in urban conditions tend to have relatively high per mile emission rates due to cold engine starts and traffic congestion[68]. Reducing these trips can bring relatively large net emission reductions. These short trips also have the most potential to be substituted with walking and cycling.

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[67] Faiz A and Sturm PJ (2002). New directions: Air pollution and road traffic in developing countries. **Developments in Environmental Sciences** Volume 1, 2002, Pages 241-243

68 De Nazelle A, Morton BJ, Jerrett M, Crawford-Brown D. (2010). Short trips: an opportunity for reducing mobile-source emissions? *Transportation Research Part D, 15*, 451-457.

- When encouraging walkable neighborhoods, it will be important to consider other interventions that can reduce emissions exposure – making vehicle traffic smoother, encouraging low/zero-emissions vehicles and increasing the physical separation between vehicle traffic and people. Land uses associated with vulnerable populations – medical centers, schools, senior centers – should be sited carefully to avoid sources of pollutant exposure. Freight and goods movement needs to be separated from pedestrian oriented corridors.

- The California Air Resources Board recently developed health-based standards to avoid exposing vulnerable populations to elevated air pollution exposure levels.[69] CARB defines "sensitive uses" as residences (houses, apartments, and senior living complexes), schools, day care centers, playgrounds, and medical facilities (hospitals, convalescent homes, and health clinics). CARB recommends avoiding siting sensitive land uses within 500 feet of a freeway, urban roads with 100,000 vehicles/day, rural roads with 50,000 vehicles/day; or within 1,000 feet of a major service and maintenance rail yard.

- Increased walkability can be associated with increased exposure to small particulates know to impact respiratory function in older adults. A recent Vancouver based study found very high correlations with the same walkability factors associated with reduced per capita generation of vehicle emissions to be associated with increased exposure to NO which is a marker for small particulates.[70] The same study also found that lower income populations tend to be located in the most polluted areas where exposure to both NO (particulates) and ozone is greatest.

- For many pollutants (such as particulate matter and CO), exposure to transport-generated air pollution is greatest close to roadways, will increase with the amount of traffic, and will decrease as distance from the roadway increases. A European study found that some pollutant levels are about 2 – 5 times higher inside cars than at the roadside – and further, that drivers have higher pollution exposure levels than users of other modes on the same road.[71]

Noise exposure

Noise – be it from transport, industry, neighbours, or construction – is a prominent feature of the urban environment. Prolonged exposure to environmental noise has been directly linked to physical and psychosocial health outcomes, including hypertension, high blood pressure and heart disease, hearing impairment, stress levels, and sleep.[72] There is some evidence linking noise to reduced ability to concentrate and more aggressive behavior.[73]

In general, denser neighbourhoods have higher levels of ambient noise through the concentration of more people, traffic, and activities. However, as with air pollution, noise exposure is extremely site-specific and not necessarily exclusive to walkable or auto-oriented

69 California Environmental Protection Agency / California Air Resources Board (2005). Air Quality and Land Use Handbook: A Community Health Perspective.

70 Marshall JD, Brauer, M, Frank, LD. 2009. Healthy Neighborhoods: Walkability and Air Pollution Environmental Health Perspectives Volume 117, Number 10.

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72 Stansfeld SA, Matheson MP. (2003). Noise pollution: non-auditory effects on health. *British Medical Bulletin, 68*, 243-257.
Clark C, Stansfeld SA. (2007). The effect of transportation noise on health and cognitive development: a review of the evidence. *International Journal of Comparative Psychology, 20*, 145-158.

73 Stansfeld SA, Matheson (2003).

neighbourhoods. The orientation and siting of buildings, sound walls, and trees may help to refract and reflect traffic or activity noise. Buildings can be designed with noise reduction features such as double-pane windows. Improved bus design and maintenance practices, shifts from bus to rail transit and shifts away from diesel buses can reduce bus noise. Truck and bus idling should be strictly limited and enforced, particularly in residential neighbourhoods. Some traffic calming strategies, particularly speed humps, can actually increase vehicle noise because they tend to result in sudden changes in speed.

Research Highlights

- As with air quality, noise impacts will vary by intensity, frequency and duration. Noise can be intermittent (as in the case of airports, heavy-duty vehicles, car alarms and accelerating traffic) or ambient (as with highway traffic or industrial machinery). In general, intermittent noise, low-frequency noise or noise with accompanying vibrations creates stronger reactions, annoyance and health impacts than ambient noise. [74]

- Monotonic increases in exposure to an objective sound level measurement were observed with increasing levels of car and heavy truck traffic at over 100 sites in the Metro Vancouver region.[75]

- Myocardial infraction (cardiovascular disease) was 1.8 times more likely to occur in men exposed to outdoor traffic noise of more than 70 decibels a day compared to those where the sound level did not exceed 60 decibels.

Vulnerable populations

Conventional low-density, disconnected development patterns that necessitate driving present more health risks for some people than for others. The health of youth, the elderly, people with limited incomes, and disabled individuals, are all disproportionately affected by certain built environment characteristics. Especially in the case of women, youth, the disabled and the elderly, safety and security from crime and traffic is absolutely crucial, and has in turn been linked to physical activity rates.[76]

The gradient phenomenon occurs here as well. The access to green space improves mental health and reduces the social gradient in cardio-vascular mortality.[77]

Youth

- Youth have been found to derive physical activity benefits from better non-motorized access to schools,[78] parks and recreation areas[79] within walking distance. However, youth mobility

74 Berglund et al. (1999).

75 Davies HW, Vlaanderen JJ, Henderson SB, Brauer M. (2009). Correlation between co-exposures to noise and air pollution from traffic sources. *Occupational and Environmental Medicine 66*, 347-350.

76 Weinstein A, Feigley P, Pullen P, Mann L, Redman L (1999). Neighborhood safety and the prevalence of physical inactivity -- Selected states, 1996. MMWR 48(07):143-46.

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[78] Boarnet MG, Anderson CL, Day K, McMillan T, Alfonzo M (2005). Evaluation of the California Safe Routes to School Legislation: Urban Form Changes and Children's Active Transportation to School. Am J Prev Med 28(2S2): p. 134-140.

[79] Babey, Susan H., E. Richard Brown and Theresa A. Hastert. "Access to Safe Parks Helps Increase Physical Activity Among Teenagers." UCLA Health Policy Research Brief, December 2005.

Frank L, Kerr J, Chapman J, Sallis J (2007). Urban Form Relationships with Walk Trip Frequency and Distance among Youth. *American Journal of Health Promotion* Vol. 21 I4 Supplement, p. 305.

and activities are often limited to their immediate surroundings and constrained by parents or guardians.[80] For this reason, barriers such as crime or traffic are more significant for youth.[81]

- Longer distances to school and perceived lack of safety along routes, for example, may be a contributing factor to over half of children age 5-17 relying solely on inactive modes of transportation (e.g. being driven or bussed) for travel to and from school across Canada.[82]

- Children spent more time outside than most other population cohorts, thereby increasing their exposure to harmful air pollutants.[83] Schools and playgrounds that are close to sources of elevated air pollution (such as rail yards, highways, and high-traffic roads or intersections) are likely to have greater impacts on the health of children and youth.

- Noise interference has been linked to learning difficulties in children such as degraded memory functions and concentration, and delayed cognitive development.[84] Children are also more vulnerable to noise-induced hearing impairment.[85]

Elderly and the disabled

- Elderly and disabled populations often have reduced access to private vehicles, thereby having the potential for drastically reduced mobility in areas without adequate public transportation, pedestrian facilities, or nearby destinations. In low density areas, for example, 61 percent of older non-drivers stay home on a given day, as compared to 43 percent in more compact areas.[86] Focusing on mobility and accessibility interventions that will benefit the aging demographic should include transportation alternatives that provide a sense of independence, security and mobility.[87]

- Because they move more slowly and may be using a walker, cane, or wheelchair, persons with disabilities and elderly are quite sensitive to the safety of their walking environment, including traffic, curb cuts, lighting, street crossing times, and sidewalk quality.[88] Injuries to elderly pedestrians, however minor, are more likely to result in serious injuries or fatalities. Senior residential or long term care facilities, medical facilities and hospitals that are near high-traffic and polluting locations may have disproportionate impacts on elderly populations due to chronic respiratory and other illnesses.

The poor

- Low-density, single use land use patterns have a disproportionate impact on low-income individuals and families as higher percentages of income or time are required to travel long

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Kerr J, Frank L, Sallis J, Chapman J (2007). Urban form correlates of pedestrian travel in youth: Differences by gender, race-ethnicity and household attributes. Transportation Research Part D Vol. 12(3); 177-182.

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[81] Transport, environment and health. Carlos Dora and Margaret Phillips, eds. World Health Organization report, European series. No. 89.

[82] Craig CL, Cameron C, Russell SJ, Beaulieu A. (2001). Increasing physical activity: supporting children's participation. Ottawa: Canadian Fitness and Lifestyle Research Institute.

[83] Etzel RA, Balk SJ, Eds. *Pediatric Environmental Health, 2nd Edition.* Elk Grove Village IL: American Academy of Pediatrics Committee on Environmental Health, 2003.

[84] Evans (2006), Stansfeld et al (2005), Stansfeld and Matheson (2003).

[85] Berglund et al. (1999).

[86] Surface Transportation Policy Project. *Aging Americans: Stranded Without Options: Executive Summary.* Surface Transportation Policy Project April 14, 2004 Available on the web at http://www.transact.org/library/reports_html/seniors/exec_sum.asp

[87] Alsnih, R., Hensher, D. (2003) The mobility and accessibility expectations of seniors in an aging population. *Institute of Transport Studies*.

88 Frumkin et al. *Urban Sprawl and Public Health.* Pages 192-193.

distances to jobs or schools. Because such land use patterns are difficult to serve with transit, living in such locations can mean lengthy and inconvenient commutes or the economic burden of a car.

- Facilitating pedestrian access to public transit may have greater health benefits for low-income individuals. One study found that not only are low-income populations more likely to be transit users, low-income and non-white people are also more likely to walk to public transit, and more likely to spend more than 30 minutes on their trip to transit.[89] The stock and location of affordable housing, too, is also crucial for promoting health equality in low-income populations.

- Even though low-income populations walk more, obesity and its associated health conditions (diabetes, heart disease, high blood pressure) are still more prevalent among low-income populations,[90] including children.[91] There is some evidence that this may be because of the low-nutrition, low-cost convenience / fast-food restaurants that often prevail in low-income neighborhoods[92] – and with less mobility it can be difficult for low-income populations to access healthy food.

Ethnocultural and Aboriginal Populations

- For different ethnocultural groups, relationships between physical activity and the built environment are quite complex, cutting across issues of healthy food choices, cultural traditions and norms, and income.
- When one study broke out survey populations into sub-groups by race and gender, after adjusting for income, age, and educational attainment, built environment variables were significantly associated with physical activity and body mass index for white but not for black participants. One possible explanation is poorer access to healthy food choices for non-white populations in the Atlanta region.[93]

- Non-English speaking individuals are especially vulnerable to noise impacts because of the disruption to comprehension and concentration.[94]

What do we still need to know?

Fiscal Impacts of built environments

Research demonstrates that compact, walkable built environments with significant investments in transit, bicycle and pedestrian infrastructure can produce cost benefits (savings) when compared with sprawling, auto-oriented development.[95] Negative health impacts of the built

89 Besser LM and Dannenberg AL (2005).

90 American Obesity Fact Sheets (2005). Obesity in Minority Populations. http://obesity1.tempdomainname.com/subs/fastfacts/Obesity_Minority_Pop.shtml

91 Centers for Disease Control and Prevention. Prevalence of Overweight and Obesity Among Children and Adolescents: United States, 1999-2002. Oct. 6, 2004.

92 Block JP, Scribner RA, DeSalvo KB (2004). Fast food, race/ethnicity, and income: A geographic analysis. American Journal of Preventive Medicine, 27, 211-217.

Horowitz CR, Colson KA, Hebert PL, Lancaster K (2004). Barriers to buying healthy foods for people with diabetes: Evidence of environmental disparities. American Journal of Public Health, 94, 1549-1554.

Lewis LB, Sloane DC, Nascimento LM, Diamant AL, Guinyard JJ, Yancey AK, Flynn G, & REACH Coalition of the Americans Building a Legacy of Health Project (2005). African Americans' access to healthy food options in south Los Angeles restaurants. American Journal of Public Health, 95, 668-673.

93 Frank et al. (2004)

94 Berglund et al. (1999).

95 Burchell, R et al. The Costs of Sprawl – 2000. Transit Cooperative Research Program TCRP Report 74. Report for the Transportation Research Board / National Research Council. Washington, D.C.: National Academy Press. 2002.

environment have economic implications as well, largely in the form of higher healthcare costs, lost work days and reduced overall productivity. One estimate puts the economic burden of physical inactivity in Canada at $5.3 billion (2.6 percent of total healthcare costs) and that of obesity at $4.3 billion (2.2 percent).[96] In a recent estimate of the full costs of transportation, Transport Canada estimated the transportation-related costs of traffic crashes (all crashes, not only pedestrian / vehicle crashes), air pollution and noise for the year 2000.[97] These estimates are shown in the table below.

Table 1. Cost Estimates of Transport-Related Impacts, by Mode (billions)

Mode	Crashes	Air pollution	Noise	Total
Road	15.78	4.73	0.22	**20.73**
Rail	0.30	0.44	0.00	**0.74**
Marine	0.06	0.54	Not covered	**0.60**
Air	0.10	0.03	0.03	**0.16**
TOTAL	**16.24**	**5.74**	**0.25**	**22.23**

Calculating health impacts and their associated costs are no more difficult to assess than the projected ridership on a train or congestion levels on a road. For any health condition for which an impact can be quantified, the costs of that impact can be accounted for - particularly for conditions for which there is a sufficient evidence base such as physical activity, obesity, traffic crashes and air pollution exposure.[98] At this point many of those costs are still hidden, or *externalized* – unaccounted for, discounted or omitted – in the transportation decision-making process and policy framework.

Causation

Research to date has not been able to determine whether or not the relationship between the built environment, travel choices, environmental exposures, and health is causal in nature. It is possible that the built environment may reflect underlying preferences for neighbourhood type and/or travel choice, as opposed to actually influencing those travel choices.[99] Emerging research that has controlled for neighbourhood and / or travel preference, however, confirms the importance of the built environment and suggests that both preferences *and* the built environment impact travel behaviour.[100] Researchers have also observed a substantial latent

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Sacramento Region Blueprint: see http://www.sacregionblueprint.org/sacregionblueprint/home.cfm

96 Katzmarzyk, P.T.; and Janssen, I. (2004). The economic costs associated with physical inactivity and obesity in Canada: An update. Can. J. Appl. Physiol. 29(1): 90-115. Estimates include both direct and indirect costs (the loss of economic productivity through illness, disability and premature death).

97 Estimates of the Full Cost of Transportation in Canada. Synthesis report. Economic Analysis Directorate of Transport Canada in collaboration with the Full Cost Investigation Task Force for the Policy and Planning Support Committee of the Council of Deputy Ministers Responsible of Transportation and Highway Safety. August 2008. See http://www.tc.gc.ca/eng/policy/report-aca-fullcostinvestigation-synthesis-index-1523.html

98 Kavage S, Frank L (2010). The Hidden Health Costs of Transportation Investment. Report for the American Public Health Association. See http://www.apha.org/NR/rdonlyres/E71B4070-9B9D-4EE1-8F43-349D21414962/0/FINALHiddenHealthCostsShortNewBackCover.pdf

99 TRB/IOM (2005).

100 Bagley MN, Mokhtarian PL. (2002). The impact of residential neighborhood type on travel behavior: A structural equation modeling approach. Annals of Regional Science, 36, 279–297.

Frank et al (2007b). Disentangling Urban Form Effects on Physical Activity, Driving, and Obesity from Individual Pre-Disposition for Neighborhood Type and Travel Choice: Establishing a Case for Causation. Social Science and Medicine 65 (9), 1898-1914.

Handy S, Cao X, Mokhtarian PL. (2006). Does self selection explain the relationship between built environment andwalking behavior? Empirical evidence from Northern California. Journal of the American Planning Association, 72(1), 55–74.

Khattak AJ, Rodriguez D. (2005). Travel behavior in neotraditional neighborhood developments: A case study in USA. Transportation Research Part A, 481–500.

(e.g. unmet or unsatisfied) demand for more walkable neighbourhoods.[101] Accommodating this demand could result in a behaviour shift for those that already prefer such lifestyles. Still, longitudinal research is needed to fully begin to untangle the many factors that shape our preferences, habits, location decisions, and travel / health behaviours. At this point, no longitudinal studies on this topic have been published, although several are underway.

PLANNING TO ACHIEVE HEALTH: RECOMMENDATIONS

1. Take action now, but do so with awareness.

Although many questions remain, when taken as a whole the evidence produced to date supports taking action now to create more health-supportive built environments. Given the severe nature and prevalence of obesity – especially for youth – and given that changing the built environment will take some time - it will likely be *more* harmful to postpone action until conclusive scientific evidence is available. . The Precautionary Principle, which recognizes that a level of scientific uncertainty is acceptable when seeking to reduce or prevent irreversible harm, may be an appropriate way to frame the issues outlined in this report. When potential stakes are high, waiting for scientific certainty is not an acceptable reason for failing to take timely action. However, care needs to be taken in the planning process to consider *all* the potential costs and benefits, in order to avoid or properly mitigate unintended consequences. This is especially important for issues of air pollution exposure and impacts to vulnerable populations. Dealing with these trade-offs will require an in-depth, multidisciplinary approach to implement, and then evaluate, any actions taken.

2. Key planning, development and investment principles

The evidence supports the following principles for land planning, land development and transportation investment:

- ⇨ Increase urban residential density while limiting development in 'fringe' or exurban areas.
- ⇨ Increase land use mix, particularly near employment centers and transit. Small neighbourhood-serving nodes of everyday destinations, such as small grocery stores and restaurants, can help to serve residential areas while preserving existing neighbourhood character.
- ⇨ Increase pedestrian connectivity. In areas where a disconnected road network already exists, pathways that provide shortcuts to pedestrians and bicycles may be easier to develop and maintain than full-scale streets.
- ⇨ Increase public transit, particularly in walkable population and employment centers and low-income areas.
- ⇨ Increase availability of recreational facilities and parks, including bike lanes, trails and pathways.

Kitamura R, Mokhtarian PL, Laidet L (1997). A microanalysis of land use and travel in five neighborhoods in the San Francisco Bay area. Transportation, 24, 125–158.

Schwanen T, Mokhtarian PL (2004). The extent and determinants of dissonance between actual and preferred residential neighborhood type. Environment and Planning B: Planning and Design, 31, 759–784.

Schwanen T, Mokhtarian PL. (2005a). What affects commute mode choice: Neighborhood physical structure or preferences toward neighborhoods? Journal of Transport Geography, 13, 83–99.

Schwanen T, Mokhtarian PL. (2005b). What if you live in the wrong neighborhood? The impact of residential neighborhood type and dissonance on distance traveled. Transportation Research Part D, 10, 127–151

101 Belden Russonello & Stewart (2004). "American Community Survey National Survey on Communities." For Smart Growth America and National Association of Realtors.

Levine J, Frank LD (2007). Transportation and land-use preferences and residents' neighborhood choices: The sufficiency of compact development in the Atlanta region. *Transportation.* Vol 34 No. 2, p. 255-274.

- ⇨ In neighbourhoods where crime is a concern, recognize that addressing those concerns may be a necessary precedent to getting people walking or into neighbourhood parks.
- ⇨ Enhance streetscape design to be safer and more pedestrian friendly, including strategies such as sidewalks, street trees, traffic calming and better street crossings. Because traffic may be a particular burden for youth and elderly populations, consider prioritizing improvements close to schools, recreational facilities and parks, and medical facilities.
- ⇨ Improve access to healthy foods where possible, including farmers' markets and community gardens.
- ⇨ Keep sensitive and vulnerable populations and associated land uses (such as schools and medical facilities) separate from sources of air and noise pollution like high traffic roadways and industrial development. Where conflicts occur, HVAC systems, vegetation and screening, and discouraging or slowing vehicles can help to decrease the associated negative impacts.

3. Increase the use of Health Impact Analysis (HIA) and health costs analysis.
HIA is growing in popularity as a way to understand the human health costs and benefits of specific development undertakings. However, its application in the Canadian context remains limited. The Federal Environmental Assessment Act and associated provincial legislation, which require rigorous assessment for actions with potentially detrimental environmental impacts, contain limited requirements for addressing human health impacts. Likewise, although methods and evidence exist to calculate at least some of the health costs and benefits of plans, developments and transportation investments, again, it is rarely done in practice. Neither federal or provincial legislation contains requirements for health based cost-benefit analysis.

Encouragingly, a number of efforts are being made at the provincial and municipal levels to more routinely include HIA as part of development review or environmental assessment.[102] Integrating such processes into the daily business of planning decisions will take time. A simple HIA can be conducted by developing an evidence-based checklist, as is being done by the BC Provincial Health Services Authority.[103] Such a checklist may be sufficient for smaller actions or in cases where a quick assessment is needed. For larger proposals, the checklist may be more useful as a first "screening" step, followed by more in-depth assessments where appropriate. HIAs can nest into an Environmental Assessment process, looking at the information that comes out of that process through a health lens – or building on that information when possible.

4. Develop Multi-Disciplinary, Multi-Sectoral Coalitions
Social, economic, environmental and health impacts of transportation investment and land development decisions need to be addressed in an integrated manner. Implementing the above recommendations will require a broad coalition of disciplines and sectors, including:

Public sector:
- Planning / development review
- Transportation / public works / engineering
- Public health
- Social services
- Public officials and other decision-makers
- Parks and recreation
- Schools

[102] The Canadian Partnership Against Cancer's effort, Coalitions Linking Action & Science for Prevention (CLASP), includes several efforts to support healthy community planning, including the development of an evaluative tool for municipalities. See: http://www.partnershipagainstcancer.ca/priorities/primary-prevention/strategic-initiatives/coalitions-linking-action-science-for-prevention-clasp/

[103] See more about BC's Healthy Built Environment activities, and many more resources at: http://www.phsa.ca/HealthProfessionals/Population-Public-Health/Healthy-Built-Environment/default.htm

Councils on Aging
Private sector:
Residents
Business owners
Developers
Research institutions
Advocacy organizations

The public health and medical community should reach out to planners and decision-makers and begin building a shared understanding of knowledge, information, and best practices between disciplines. Knowledge of each others' vocabulary, methods and approaches will be invaluable and a necessary step to being able to move forward in the creation of healthier communities.

Conclusion

The public health and medical community has an opportunity – even an obligation - to play a leadership role on the issue of healthy built environments. Public health officials bring a great deal of relevant information and data on the environmental determinants of health and are also well-connected to the needs of the communities in which they work. Many public health staff understand the daily realities of the people in their local health districts – particularly the most vulnerable populations. Opening dialogues with local and regional planners, engineers, and economists on these issues should be a critical role for public health.

The planning field originally evolved, in part, to enable healthy communities. Things like adequate air and light, building codes, wastewater treatment, and separation of factories from homes have been part of a planner's mandate for decades. However, the dominant pattern of low-density, auto-oriented, single-use development that has developed over the last 50-60 years is likely undermining those very health gains made by planners a century ago. Our capacity to refocus growth and development into healthier patterns rests with reconnecting the planning and health disciplines once again.