Canadian Association of Physicians for the Environment (CAPE) Position Statement on Active Transport

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Prepared by Dr Courtney Howard, MD, CCFP-EM, BSc(Kinesiology)
Emergency Physician, Stanton Territorial Hospital, Yellowknife, NT, Canada.
Board Member, Canadian Association of Physicians for the Environment.

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EXECUTIVE SUMMARY

The Cardio-Commute: Can it save the world?
Getting to where we want to go is an everyday task, and most of us use a variety of different techniques to help us get around. Some days we're drivers, sometimes pedestrians, sometimes cyclists, or some days all three. But how many factors do we actually consider at the beginning of each trip to help us choose how to get from Point A to Point B? Here are a few things you might not be taking into account…

Driving	**Cardio Commute: ie Active Transport** **ie:** Walking, Cycling, Rollerblading, Wheeling, and Skateboarding to where you want to go
Leads to social isolation[1] **and is associated with being overweight**. Each additional hour spent in a car per day is associated with a 6% increase in the likelihood of obesity. [1,2]	**Is associated with decreased cardiovascular disease and decreased mortality.** [1,5,6] Each kilometre walked per day decreases the risk of obesity by 4.8%.[2] -**Bike commuting** in Copenhagen was showed to reduce the risk of premature mortality by approximately one third.[1]
Obesity is bad for you and our society is getting more obese. (Someone probably told you that already). If not, a list of the badness associated with obesity includes increased risk of Type II diabetes, cardiovascular disease, some cancers and osteoarthritis, as well as social stigmatization, discrimination, and poor body image, which may lead to depression.[3]	**Physical activity is good for you. (But no one may have told you…):** That moderate activity (about 30 min/day 5 days per week in adults) has been shown to be associated with decreased rates of mortality, cardiovascular disease, diabetes, dementia, breast cancer and colon cancer. [1]
Leads to injury Traffic injuries are the second leading cause of death for people age 5-29 worldwide .[1]	**Leads to fewer injuries** There is evidence from Berlin, London, Amsterdam and Copenhagen of a "safety in numbers" effect: substantial increases in bike use have been accompanied by reductions in the number of serious injuries to cyclists.[7]
Leads to air pollution: Affects kids the most: has been shown to cause childhood asthma exacerbations.[8] -Has been correlated with increased	**Is affected by air pollution**: Cyclists and pedestrians breath less concentrated air pollution than do drivers because they're farther away

mortality, cardiovascular mortality and morbidity, the onset of childhood asthma, and exacerbation of respiratory symptoms in adults. [8] -Is a major contributor to greenhouse gases that then contribute to Climate change . [1] -Health effects of climate change may include: more pollen, more allergies, more mosquitoes more places, more heat-related mortality, flood, famine, population displacement and war. Just sayin'. [9,10,11]	from the cars, but they breathe faster and may inhale more.[1,6] -Despite the ill-effects of air pollution and injury, using UK numbers, the benefits of cycling are still 7 times larger than the risks.[6] - It has been estimated that if the US population between the ages of 10 and 64 reduced their car use by the same number of kilometres that they could cycle if they biked for 60 minutes per day, it could reduce US CO2 emissions by almost 11%.[12]
Expensive: Requires extensive public expenditures on infrastructure as well as private expenditures on vehicle costs and fossil fuels.[13] -Leads to increased healthcare costs due to associated health risks.	**Cheap**: -Requires much less road space and infrastructure than driving. [13] -Leads to decreased healthcare costs. The New Zealand Transport Agency estimated in 2008 a savings of $4.27 per km walked and $2.14 per km cycled (NZ $) taking into account morbidity, mortality, and health-sector costs. [14] -The WHO has made a handy-dandy online calculator (HEAT: Health Economic Assessment Tool for Walking and Cycling) so you too can estimate the per-km savings of walking and cycling for your various commutes and transportation infrastructure projects. [15]

So…driving is bad for humans, bad for the environment, and expensive. Walking and cycling are good for humans, much better for the environment, and cheap. Could we have a win-win situation on our hands?

How do we make it easier and more convenient for more of us to cardio commute more often? These evidence-based things have been shown to help:

Bike lanes, bike routes, well-lit streets, parks and low-cost recreational facilities. [1,7,16]
Traffic calming measures: speed limits <30kph, road humps, pedestrian crossings.[1]

Neighbourhoods with high "walkability" measurements, ie: neighbourhoods with nearby shops, public transit, sidewalks, bicycle facilities, low-cost recreational facilities and less single-family homes.[1,17]
Sidewalks.[1,12]
High street connectivity: ie the classic grid pattern where streets cross at right angles and form small blocks and numerous intersections. [1,17]
Increased residential density.[1,17]
Increased employment density.[1,17]
Better public transport [17]
Attractive street and neighbourhood design.[18,19]
Support from schools and work: walking school bus programs, available bike racks, change rooms and showers. [20]
Car congestion fees and expensive parking spots.[1]
Lots of people walking, biking, rollerblading and skateboarding. Humans like to go with the flow….the more we cardio-commute and make it cool, the safer it'll be for everyone, and the more people will participate! [18,21,22]

The challenge in moving towards more cardio-commutes has to do with silos and finances: doctors don't usually have input into how or where new roads are built, city planners don't treat asthma exacerbations, and municipal counsellors don't usually get credit for decreases in health budgets. So how can we bridge these interdisciplinary divides and begin to look at the physiology of the human-transportation-environment holistically?

We need to know what to ask for.

CAPE's Recommendations

	What to do	**Why**
All interested parties	**Liaise with other groups to lobby** all levels of government for increased funding and attention for public relations campaigns which encourage active transport and built environment measures designed to encourage a modal shift from driving to active transport.	Many voices make for quicker change.
Health Care Professionals	-**Talk to patients**: suggest increasing their level of activity to 30 min/day 5x/week for adults and 60min/day most days of the	**Many parents underestimate their kids' levels of obesity**. They're more likely to encourage activity if they're in the know.[23] Evidence does show conversations

	week for kids. -**Lead by example**: ride your own bike and advocate for strong connections to public transit and bike facilities for your local hospital. -**Engage** directly with urban planners and all levels of government to advocate publically for active-transport-friendly initiatives	about physical activity between health care workers and patients do lead to increased activity levels.[24]
<u>Advocacy groups</u>		
Health and Environment related	**Form alliances** with other impacted health groups and lobby as a team. These issues have direct impacts on people with asthma, diabetes, cardiovascular disease, breast cancer, colon cancer, osteoporosis and mental health problems.	Time and costs of public-relations materials are lower when shared and your voice will be heard more loudly.
Cyclists	**Talk** to Urban Planners and Municipal Councillors and ask for bike lanes, bike routes, well-lit streets, increased parking fees, and car congestion fees. **Look for partners in health fields** to help bolster your arguments.	These have been shown to increase cycling rates, and increase safety. [1,16]
Elders	**Connect** with urban planners, transport planners and governments to lobby for more elder-friendly sidewalks and public transport including: -benches to sit down on -affordable public transport ticket prices -regular and reliable bus service -bus stops placed more	Transport is significantly associated with quality of life. Many elderly people have been drivers all their life and become active transport users when mobility and vision concerns result in the loss of their drivers' licences. They then have to try to learn and negotiate a new system with those same limitations. This can be scary and is associated with falls. These

	frequently along routes -"Hail and ride" services + demand stops.[25]	barriers lead to avoidance and then to social isolation and poor medical care, both of which have negative health outcomes. [25]
Employers	**Provide bike racks** instead of subsidizing employee parking passes. **Provide changing facilities** for active commuters. **Allow** flexible start and finish times.	There is some evidence that people who get exercise are more productive at work and have higher levels of job satisfaction. [14] Your employees will be less smelly
Parents Groups	**Start or contribute to walking school bus programs** **Lobby** for traffic calming measures such as road humps and pedestrian crossings near schools **Volunteer** to patrol a crosswalk during the to-and-from-school commute **Walk or cycle with the kids to school.**	Traffic calming measures have been shown to increase walking and decrease pedestrian injury. Each driving trip you DON'T take means less air pollution, and less risk of injury to everyone else. Safety in numbers effect: Each self-propelled trip you DO take means another cyclist or pedestrian on the road: increased numbers have been shown to decrease per-person accident rates. Also, more "eyes on the street" help prevent neighbourhood crime and encourages other parents to let their kids walk or cycle to school.[18,21,22]
Urban Planners and Municipal Governments	**Divide the task of increasing active transport in your comunity into 3 different time-lines** -Short-term goals: easy and cheap changes like increased bike lanes, traffic calming measures, and car congestion fees -Medium-term goals: improved transit -Long-term goals: rezoning to encourage higher density and mixed-use developments. [17]	It takes a long time to rebuild a suburb: the reality is that much of the physical infrastructure that will be used for the next 50 years is already in place. Focus initially on simple measures that have been shown to work .[12] Consider short-term trial solutions with pre-and-post periods of study to help get controversial projects through and contribute to longitudinal study data.

	Work with other levels of government to develop and implement a calculation system that links health-care dollars saved through increased active transport to the infrastructure projects that enabled the healthy changes . Use tools such as the WHO's HEAT: Health Economic Assessment Tool for Walking and Cycling" (found at: http://www.euro.who.int/en/what-we-do/health-topics/environment-and-health/Transport-and-health/activities/promotion-of-safe-walking-and-cycling-in-urban-areas/quantifying-the-positive-health-effects-of-cycling-and-walking/health-economic-assessment-tool-heat-for-cycling-and-walking)	"HEAT" is an on-line tool that seeks to answer the question: "if x people cycle or walk y distance on most days, what is the economic value of mortality rate improvements?" You should get credit for health-care dollars saved because of your Active-Transport-friendly initiatives. Conversely, if you cover your eyes and ignore the external health costs and pollution associated with long, windy roads in suburbs where the nearest interesting walking destination is 10km away from the average house,..you should be held to account.
	Encourage the use of systems like the US Green Building council Leadership in Energy and Environmental Design (LEED) standards for neighbourhood development. **Give tax breaks and zoning support** to developments that score well.	Similar to its points-based system for certifying green buildings, LEED ND certifies neighbourhoods on a credit system based on their inclusion of features that promote greater walkability, mxed use, public transportation, reduction in vehicle miles travelled and greater energy efficiency. [26]
<u>Provincial and National Governments</u>	**Work with municipal levels of government** to preferentially fund Active-Transport-friendly initiatives.	

	Encourage distance-based vehicle insurance instead of flat-rate programs.[17]	Currently, the # of km driven barely influences car insurance prices, despite the fact that # of accidents increases with # of km. If driving more often is more $, people will drive less.[17]
	Encourage banks to give mortgages that give favourable rates to people who buy houses in walkable areas.[17]	People in walkable areas spend less on transport and have more $ to service a mortagage.[17]

So…can cardio-commuting save the world? Difficult to say—but if enough of us start to self-propel we'll certainly be many steps closer to the world we want.

Happy Wanders from the Canadian Association of Physicians for the Environment.

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B-Full Write-Up

What follows will deepen the discussion by going through the academic evidence of the risks and benefits of active transport, as well as the effects of the built environment on it, and attempt to identify critical places worth targeting by activists, planners and governments in their attempts to improve the situation.

Methods

Given the huge amount that has been written on this subject in recent years, it was decided to do a review of the review articles contained within the Pubmed database. Only English articles written in the last five years (as of end-August 2011) were considered. Terms searched were: "active travel", "active transport", "active commuting", "neighbourhood safety," "crime and environment," "public transportation," "air pollution AND exercise, health, traffic, and climate change", parking, commute, bicycling, "walking for transport", and "obesity AND environment." A total of 2,699 articles were found. Obviously inapplicable studies and duplicates were discarded, with any questionable cases being discussed between the two searchers. 87 studies were retrieved and read. A separate Google search was conducted to try to find more Canadian-specific economic and transport data, as well as to look for relevant position statements. No attempt was made to search out the source articles that contributed information to the review articles, though an attempt has been made to make attributions to those sources when applicable. Information that was present in more than one review article was generally attributed to the most recent article.

1-Overview of the Obesity Epidemic, its Health Effects, and Recent Trends in Active Commuting and Community Planning

Adults

The developed world has been overcome by what has been called an obesity epidemic. Obesity is associated with an increased risk of Type II diabetes, cardiovascular disease, some cancers and osteoarthritis, as well as social stigmatization, discrimination, and poor body image, which may lead to depression (Brisbon 2005). Indeed, the WHO estimated in 2009 that overweight and obesity are responsible for 2.8 million deaths annually (de Nazelle). Physical inactivity is separately responsible for an additional 3.2 million deaths (de Nazelle 2011) and is felt to contribute worldwide to 21.5% of ischemic heart disease, 11% of ischemic stroke, 14% of diabetes, 1.6% of colon cancer and 10% of breast cancer (de Nazelle 2011).

These concerning health statistics have prompted international concern and led to the development of activity guidelines. It is recommended that adults get at least 30 min of moderate-intensity physical activity on most days of the week, and that children and young people aim for 60 min per day. Unfortunately, this can be difficult for people to fit into days already crowded with work, childcare, after-school activities, commutes and various types of media consumption. Demonstrating this, stats show that 26% of US adults do not engage in any physical

activity (Casagrande 2009). Though health-care providers are encouraged to provide exercise counselling, and there is some evidence that this increases activity rates (Ogilvie 2007), any doctor who has ever attempted to convince someone to increase their level of exercise knows that one throws out many nets and catches precious few fish. It begins to seem that individual motivation and self-discipline are not up to the challenge, and that for real, population-level change to occur, a system must be created in which it is simply be easier to move than it is not to. In fact, it may be partly the switch from self-propelled transport to vehicular transport which is responsible for the obesity problem: as Woodcock 2007 points out "Over the past century, oil has increasingly displaced food as the energy source for human movement."

The answer may lie in switching back. This thought is echoed by a UK study which concluded that "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," (Giles-Corti 2003, quoted in Frank 2009). Rissel 2009 further states, "While the concept of active travel is quite simple, people will default to current practice (ie: use of the private motor vehicle) unless the alternative travel modes are uncomplicated, safe, easy, affordable and convenient."

It doesn't get any simpler than walking. Walking is already the most popular form of physical activity for North American adults (Rissel 2009). That said, for matters of practical transportation, we do much less of it than our friends in other countries. In recent studies, in the Netherlands, 19% of workers walked and 27% cycled to work, while in Sweden the corresponding figures were 39% and 10% (Shephard 2008). In Canada they are much lower, with only 6.6% of workers walking and 1.2% biking to work (Shephard 2008). In Victoria, British Columbia, the more temperate-than-average climate may explain slightly higher rates, with one survey finding 10.4% of workers commuting on foot and 4.8% on a bike (Shephard 2008).

Kids

As in adults, rates of childhood obesity have increased dramatically in recent years. In the early 1970's, approximately 15% of youth aged 2-19 years were considered overweight or at risk of becoming overweight. By the period of 2003-2006 this had increased to 32% (Dunton 2009). Being overweight is associated with an increased risk of new-onset asthma in boys and in children without allergy and an increased rate of Type II Diabetes (Brisbon 2005). Interestingly, caregivers frequently underestimate the risk for or presence of obesity in their child: in one study only 26% of the parents of overweight or at-risk children were actually worried about their child's weight (Floriani 2007). Given that parents are more ready to promote behaviour change when they believe their child is overweight, and once they have been made aware that being overweight is a health problem, it is crucial that primary pediatric providers bring the issue to the attention of the caregiver (Floriani 2007). In order to prevent body image issues, the intervention should be focused on promoting fun and good health rather than losing weight (Floriani 2001).

A good opportunity to increase levels of physical activity in a way that fits well into people's lives is to encourage children to walk to school. Unfortunately, in the US, according to the National Household Travel Survey, the rate of children aged 5-15 who walked or biked to school was 48% in 1969 and had fallen to less than 16% by 2001 (Davison 2007). Although some of this may be due to the fact that smaller schools have been consolidated into a lesser number of larger schools, and therefore school may now be farther away from home for the average child, data from the US HealthStyles Survey in 1999 indicated that even amongst children who live within 1 mile of school (thought by researchers to be a reasonable walking distance) only 31% of them actively commuted (Davison 2007). This trend holds in most developed countries: in England in 1971 and again in 1990, children and parents living in the same five neighbourhoods were surveyed. Results showed that though their physical environments had not been altered, the rate of 7 and 8 year olds going to school on their own had dropped from 80% in the 1970's down to less than 10% 2 decades later (Jacobson 2009) In Canada, over half of young people aged 5-17 rely solely on inactive modes of transportation to get to and from school (Faulkner 2009).

2-Health Effects of Different Transportation Modalities in Adults.

Moderate intensity physical activity has been associated with decreased rates of mortality, cardiovascular disease, diabetes, dementia, breast cancer and colon cancer (de Nazelle). Based on self-reported measures of emotions, there is also some indication that an activity carried out in a natural environment can have more positive emotional effects than similar activities in a synthetic environment (Bowler 2010). Although there is little evidence about the effect of active transport on mental health, exercise itself compares favorably to antidepressant medications as a first-line treatment for mild to moderate depression and there is some evidence also that it is also an effective and cost-efficient treatment alternative for a variety of anxiety disorders (Carek 2011).

The simple act of walking has been relatively well studied from a health-benefit standpoint. A meta-analysis done in 2011 by Hamer et al selected 18 prospective epidemiological studies of walking and cardiovascular disease and all-cause mortality. They incorporated data from 459 833 participants who were free from cardiovascular disease at baseline but in whom 19249 cases were found at follow-up. The pooled hazard ratio of cardiovascular disease in the highest walking category compared with the lowest was 0.69 (95% CI 0.61 to 0.77, $p<0.001$) and 0.68 (0.59 to 0.78, $p<0.001$) for all-cause mortality. Walking pace was a stronger independent predictor of overall risk than was walking volume (48% vs 26% risk reductions, respectively) and there was evidence of a dose-response relationship. Another 2009 meta-analysis showed a 19% reduction in coronary heart disease risk for a weekly increment of 8 MET-hr achieved through walking (Zeng 2009 in de Nazelle 2011).

Practically speaking, what is "moderate physical activity" in terms of walking? In adults, a weekly energy expenditure of at least 4 MJ is recommended to reduce all-cause and cardiovascular mortality (Shephard 2008). As found by

Hamer and Chida, the walking pace is more important than the distance travelled in terms of its effect on cardiovascular health. The walking pace of most commuters is around 5 kph (Shephard 2008). Depending on an individual's body mass, walking on a smooth level surface at this speed would lead to an energy expenditure of about 18 kJ/min. Therefore an energy expenditure of 4 MJ would be the equivalent, on average, of walking 1.9 km in 22 minutes twice per day, 5 days per week, or cycling at 16 kph for 11 minutes, twice per day, 5 days per week (Shephard 2008). Young, fit people may need to walk more quickly than this, or on an incline in order to enter their training zone and optimize their health benefits. Conveniently, for those of us in Canada, there can be a 2-3 fold increase in the energy cost of a given commute after a heavy snowfall (Shephard 2008).

Likely because of the greater ease of entering a training zone, cycling has more frequently been associated with reduced all-cause and cardiovascular mortality. At least 3 studies have directly assessed mortality related to cycling to work. A prospective study found that bike commuting in Copenhagen could reduce the risk of premature mortality by approximately one third (Anderson et al 2000 quoted in De Nazelle 2011). In the Shanghai Women's Health Study, leisure-time exercise and cycling for transport were both inversely and independently associated with all-cause mortality (25% to 35% reduction in risk for activities above 3.5 MET-hours/day compared to none) (Matthews et al 2007 quoted in de Nazelle 2011). Finally, a Finnish study that combined cycling and walking to work and compared this to nonactive commuting also showed significantly better outcomes for active commuters with RR in the range of 0.71-0.79 (Hu 2004 quoted in de Hartog 2010). The largest estimated gain in life years was for the elderly. Additionally, in 2008 Hamer and Chida did a meta-analysis of 8 studies which represented the data on active commuting of 173,146 participants and which demonstrated a relative risk of 0.89, 95% CI 0.81-0.98 p=0.016) for cardiovascular outcomes. The protective effects were most pronounced in women.

These health benefits are seen despite the not-insignificant risks of air pollution (discussed in a later section) and injury, which are associated with cycling or being a pedestrian.

Meanwhile, traffic injuries are the second leading cause of death for people age 5-29 worldwide (WHO 2004 in de Nazelle 2011). In Australia and the US, pedestrian motor vehicle collisions are a leading cause of pediatric mortality (Giles-Corti 2009) with the peak time for child pedestrian injuries between 2PM and 4PM during school term time (Giles-Corti 2009). Additionally, approximately 12 million people are seriously injured in traffic crashes yearly (Haines 2007). Injury rates vary tremendously from country to country. In places with high rates of cycling and infrastructure designed to facilitate active transport, injury rates are much lower: for instance fatality risks are nearly 6 times greater for cyclists per kilometre travelled in the US compared to in Holland (Pucher and Buehler 2008 in de Nazelle). Pedestrians and cyclists are overall more vulnerable to injury than car users: in the US pedestrians are 23 times, and cyclists 12 times more likely to die in a crash than car occupants per kilometre travelled (Pucher and Dijkstra 2003 in de Nazelle). If risks are calculated per hour travelled, the risks are more equal for cars and bicycles, however walkers remain at a 3x higher risk than car users per hour (Peden

et al 2004 in de Nazelle), partly because car users drive more "safe" highway kilometres while cyclists and walkers remain on dangerous urban roads.

It doesn't need to be so dangerous. There is evidence from Berlin, London, Amsterdam and Copenhagen of a "safety in numbers" effect: substantial increases in bike use, facilitated by infrastructure programs, have been accompanied by reductions in the number of serious injuries to cyclists (Pucher 2010). In contrast to the approach taken in those cities, in North America, most studies and initiatives addressing cycling safety have emphasized helmet design, regulation and implementation (Reynolds 2009). Unfortunately, helmets, though useful, only protect the head, and don't prevent incidents from occurring. (Reynolds 2009). As well, the requirement to wear a helmet may actually decrease cycling rates (Reynolds 2009, Pucher 2010). This strategy of putting the onus for safety on individual cyclists as opposed to society in general reflects the fact that in North America the needs of car drivers have long been put before those of other roadway users, and that car proponents had the major control over traffic laws and traffic engineering policies (Jacobson 2009). As evidenced by the much higher fatality rates for cyclists and pedestrians in North America—it is time to look elsewhere for a new approach.

The overall impact of cycling was estimated in a study done by de Hartog (2010) which sought to quantify the impact on all-cause mortality of 500,000 people making a transition from car to bike for short trips on a daily basis in the Netherlands. In that country, the increased physical activity involved in making that shift was estimated to lead to a gain 3-14 months of life whereas the mortality effect of the inhaled air pollution would only result in 0.8-40 days of life lost, and the increase in traffic accidents would lead to 5-9 days of life lost. Aside from the beneficial effect on participating individuals, society as a whole would benefit from the reduction in air pollution and traffic accidents consequent to taking that many cars off the road. The net benefit would still hold true in countries with higher bicycle injury rates such as in the UK, where the risk of dying per 100 million km for a cyclist is about 2.5 times higher, resulting in a projected loss of life expectancy of approximately 14 days per person. Overall, even with UK numbers, the benefits of cycling would still be 7 times larger than the risks.

What are the health effects of the alternative—driving? A study by Larry Frank in 2004 (quoted in Rahman 2011) estimated that each additional hour spent in a car per day is associated with a 6% increase in the likelihood of obesity, whereas any additional kilometre walked per day is associated with a 4.8% decrease. Driving has also been associated with negative impacts such as road rage and time spent away from family (Frumkin 2002 in de Nazelle 2011). The lack of opportunity for interaction with others during a vehicular commute also results in a loss of social capital (de Nazelle 2011), which has negative consequences for neighbourhood crime rates and personal mental health (Kawachi), and increases the risk of dying prematurely (de Nazelle 2011). Increased driving leads to increased traffic, which is associated with increased injury, air pollution, noise and the rising trend in allergic respiratory diseases (D'Amato 2010). Living near high-traffic roads is associated with impaired respiratory health including more asthma exacerbations and more frequent ER visits and hospital admissions (Holguin 2007,

D'Amato 2010) Additionally, exposure to road traffic noise has been associated with hypertension (Bluhm 2011), annoyance, sleep disturbance and myocardial infarction in long-term studies (de Nazelle 2011, Bluhm 2011). Traffic may also have effects on mental health and child development (Dora 2000, stated in Hosking, Cochrane 2010).

Finally, what about people who have trouble accessing transportation? An auto-oriented transportation network marginalizes those who cannot drive, including youth under 16, disabled persons, the elderly, low-income households and the homeless (Frank 2009). Many of the people in these groups rely on public transport , which is an important component of the web of active transport given that most people will access buses or rail-lines on foot. It is also an important part of their lives: transport has been identified as one of the most important social determinants of health (de Nazelle2011, Ramin 2009). Given the aging population in Canada and other Western countries, elements of the transportation system which affect the Elderly are of particular concern. In the US, 21% of those over 65 do not drive. This group of non-drivers takes 15% fewer trips to the doctor and 65% fewer trips to friends and family (de Nazelle 2011). Social isolation and lack of social networks have been demonstrated to increase the risk of dying prematurely from all causes in cohort studies in the US, Europe, and Japan (de Nazelle 2011), and links have been demonstrated between increased social activity and improved quality of life, better health, longer life and lower rates of institutionalization. Social roles, such as being a family member or friend, are often the most valued roles for older people (Broome 2008). A car-oriented transportation system does not serve these people very well (Broome 2008). Unfortunately, the same physical limitations that often result in their right to drive being removed, namely vision and mobility limitations, also make it difficult to catch buses (Broome 2008). On un-adapted buses there is a pronounced risk of falls. In a study of older people done in Germany, Finland and Italy, the third most common suggested strategy to improve mobility and social activity was the suggestion (given by 55% of respondents) to adapt public transit buses to meet the needs of older people" (Broome 2008).

3-Health Effects of Active Transport and Physical Activity in Children

Active school commuters have been found to be more physically active than passive commuters (Faulkner 2009, Lee 2008). That said, as with much of the evidence in this area, most studies have been cross-sectional: intervention studies need to be done to help determine causation (Lee 2008). Children who use active forms of transport to school accumulate approximately 20 additional minutes of moderate to vigorous physical activity (MVPA) per weekday and expend 33.2 to 44.2 kcal more per day than do youth who are driven to school (Davison 2007). There may be some gender differences, as boys who actively commuted to school were shown to accumulate 45 more minutes of MFPA per day whereas girls only accumulated 4 more minutes of MVPA per day (Davison 2007). This may speak to the informal interactions in the street and the schoolyard. The fact that levels of physical activity between active and non-active commuters were limited to weekdays speaks to the fact that differences in physical activity were likely not

simply due to the fact that more active children chose to walk or cycle (Davison 2007).

Data from the Youth Heart Study further showed that young people who cycled to school were nearly 5 times as likely to be in the top quartile for fitness than were kids who were driven (Davison 2007). Increased rates of cardiovascular fitness among youth who commute actively are important for their links with reduced coronary heart disease, stroke and cancer (Davison 2007). Also, it has been shown that fitness habits created in childhood tend to track through to adulthood (Ferreira 2006), where there is more robust evidence for the health effects of exercise. Research into the association between physical activity and mental health in young people is lacking longitudinal or randomized studies that would help establish causation, but there are consistent associations showing small to moderate positive effects with additional small but consistent associations between sedentary screen time and poorer mental health (Biddle).

Evidence for an impact of active transport on obesity or Body Mass Index in children is not compelling (Faulkner 2009).

4-Health Effects of Air Pollution and Climate change

Air Pollution

Urban air pollution is associated with poor health outcomes (D'Amato 2010, De Nazelle.), and is felt to account for approximately 3% of mortality from cardiopulmonary disease, and 1% of mortality from acute respiratory infections in children under 5 years worldwide (de Nazelle 2010). Specifically traffic related air pollution has been shown to contribute to decreased health through respiratory, cardiovascular, reproductive and neuro-developmental effects (de Nazelle 2011). A review by the Health Effects Institute (Tager 2010) found the evidence "suggestive but not sufficient" for a causative line with mortality, cardiovascular mortality and morbidity, onset of childhood asthma, and exacerbation of respiratory symptoms in adults." The only variable for which the evidence was deemed to be sufficient to imply causation was for the exacerbation of symptoms in children previously-diagnosed with asthma by Traffic-related air pollution (Tager 2010; HEI) .Additionally, it has been shown that pollen in heavily polluted zones is more dense in allergenic proteins(Bartra).

These effects are not in dispute: in fact associations between long-term exposure to particulate matter and mortality have played an essential role in the establishment of national air quality guidelines in the US and Canada (Krewski 2007). As the proportion of people who live in cities continues to rise, conditions will likely worsen and the amount of people affected will grow (de Nazelle).

Risks are actually larger for children than for adults. Kids are more vulnerable to environmental exposures than adults because:

- They breathe more, eat more and drink more water per kilogram of body weight
- their metabolism is immature and less able to process toxins
- they have more years for long latency periods to produce illness

- they're less aware of risk, and they have less control over their environment (Bolte).

The Children's Health Study, a large cohort study that enrolled children from 12 communities across California, showed that children from ages 10-18 who were exposed to higher air pollutant concentrations have reduced lung growth (in Holduin 2008). These effects were seen in children both with and without asthma. Asthma is the major chronic disease of childhood and the principal cause for school absenteeism and hospitalization in children (Kinney 2008). As detailed above, there is a strong body of evidence that traffic-related air pollutants aggravate asthmatic symptoms (Braback 2009).

Although specific risk ratios have not been well delineated, short-term exposure to high levels of air pollution during commutes has measureable effects. Most studies have found that increased levels of outdoor air pollution are associated with decreased lung function in asthmatics (Holguin 2008). One study showed that a 2-hour walk on a busy street in London has been associated with an asymptomatic but consistent reduction in forced expiratory volume in 1 second of up to 9.1% and in forced vital capacity of up to 5.4% in people with Asthma (McCreanor J, 2007 in D'Aato and de Nazelle). Short-term exposure to air pollution has also been linked to nonfatal MI, physiological changes in heart function, functional decrements in lung function and airway inflammation and DNA (de Nazelle 2011, Holguin 2008). These findings are consistent with the fact that the prevalence of atopic problems is greater in urban areas than in the rural setting (Kinney 2008).

Most studies show that overall air pollution exposures are higher for vehicle occupants than for cyclists or pedestrians, a fact that is attributable to the relatively steep gradient of pollutant concentration as one goes from the middle of the street to its edges (de Nazelle 2011.) That said, pedestrians and cyclists tend to have a higher respiratory rate than drivers due to the intensity of their physical exertions, which can lead to higher inhaled doses of small particles, particularly PM 2.5 and elemental carbon (de Hartog 2010, de Nazelle 2011). The exact dose of pollution inhaled by all parties using transport-ways varies greatly, and depends on route, speed, trip duration, car speed and type, ventilation status, street configurations and weather conditions (de Hartog 2010).

Future models give some sense of the potential health effects of working to get people out of their cars. Woodcock et al modelled the health effects of alternative transport scenarios for London and Delhi: the scenario with the largest health gains for London combined increased active travel with increased adoption of lower emission motor vehicles and produced an estimated 10-19% reduction in the number of years-of-life-lost from ischemic heart disease, as well as reductions in cerebrovascular disease, depression, dementia and diabetes . This outcome did require a 37% reduction in car use as well as significantly higher distances walked and cycled but is potentially achievable (Woodcock 2009 in Dennekemp 2010).

Real effects have also been seen during short-term initiatives to decrease air pollution. For instance, during the 1996 Summer Olympics in Atlanta the city actively encouraged the use of public transportation. This led to a 22% decline in traffic counts, a 28% decline in daily ozone concentrations, and most importantly, a 41% decline in asthma acute-care events (Brisbon 2005). One longitudinal study

also showed that improvements in air quality led to a slowed decline in lung function as measured by Forced Expiratory Volume in 1 sec (FEV1) over the course of an 11 year follow-up period (Gotschi 2008).

The share of transport activities in green house gas emissions is thought to be approximately 23% worldwide and continues to grow at a faster rate than any other factor (de Nazelle 2011). Unfortunately, this increase is playing out in developing countries as well as developed ones: a survey in China found that 43% of bicyclists had reduced bicycling (Jacobson 2009). In 1% of cases it was because they'd bought a car, while in the remaining respondents it was because they perceived the increasingly busy streets to be too dangerous to cycle (Jacobson 2009). Similar effects have been seen in various African cities: in Nairobi, the share of trips by bike fell from 20% in the 1970s to 0.5% in 2004 (Jacobson 2009, Woodcock).

A population-scale switch from motorized transport to active transport will have important direct environmental and health effects including the reduction of vehicle emissions, greenhouse gases, noise, and potentially urban heat island effects (de Nazelle 2011). It has been estimated that if the US population between the ages of 10 and 64 reduced their car use by the same number of kilometres that they could cycle if they biked for 60 minutes per day, it could reduce US CO2 emissions by almost 11% (Jacobson 2009).

Heat

Initially termed "Global Warming," a hotter world has been a main element of Climate Change worries since headlines first trumpeted scientists' concerns about increased greenhouse gas emissions. These concerns are no longer theoretical: since 1950, average land temperatures in Australia have risen by 0.9 degrees (Kjellstrom 2009). For Canadians, the effects on the far north are perhaps the most worrisome: Arctic air has been warming twice as fast as air in the rest of the world (Jones 2011), and there has been a downward trend in summer sea ice coverage in the Arctic Ocean since 1970, with 2007-2011 being the lowest yet (Jones 2011). Some predictions postulate that the Arctic Ocean may be free of floating summer ice sometime between 2030 and 2050 (Jones 2011). Further south, the number of days per year above 30 degrees almost doubled in the city of Toronto between the period of 1961-1990 and the period 1995-2005 (Ramin 2009).

There are serious health effects expected from this warming trend. Heat waves are associated with increases in mortality, particularly in vulnerable populations such as the young, the elderly, the disabled and the homeless (Ramin 2009). In Mediterranean cities, a 1 degree celcius increase above threshold was associated with a 3% increase in daily mortality (Ramin 2009). Similar effects have been shown in the US and in Korea (De Nazelle 2011). As urban centers become more paved and have less heat-absorbing green space, they become "heat islands," which can impede night-time cooling (De Nazelle 2011). Models of the impacts of heat-waves project a doubling to tripling of mortality in many urban centers in the US and Canada over the next several decades (Ramin 2009). There is also a

multiplier effect: emissions from power plants increase during heat waves due to peaks in air conditioner use, leading to still more air pollution, respiratory illness, and greenhouse gases.

Because sunlight is necessary to convert oxygen to ozone, an increasingly warm world is also expected to lead to increased levels of ground-level ozone, which is associated with premature mortality, shortness of breath, increased hospital admissions for pneumonia, COPD, asthma, allergic rhinitis (Kinney 2008). A 2-degree increase in temperature is expected to lead to an increase of 2-4% of ground-level concentrations of ozone.

On the upside, in Canada, cold-related mortality may decline by 45-60% by 2050 (Ramin 2009).

Changing Weather Patterns, Extreme Weather Events and Further Health Consequences of a Changing Climate

The world is already seeing an increase in extreme weather events. One study estimates that there was a 24% increase in the frequency of extreme precipitation events in the continental US between 1948 and 2008 (Ramin 2008). Even in the absence of massive population displacement, these events are profoundly stressful for people: 20-30% of residents who lived through Hurricane Andrew met criteria for post-traumatic stress disorder at 6 months and at 2 years after the event (Ramin 2008). Australia is likely to experience increases in droughts, which have been shown to be associated with an increased rate of suicide (Kjellstrom 2009). This is in the context of recent increases in the prevalence of mental health: in 2001, major depression ranked among the 10 leading contributors to the global burden of disease worldwide, and is projected to be among the top three contributors by 2020. In the US, the number of hospital outpatient visits for depressive disorders escalated by 48% between 1995 and 2005 (Kim). Many factors can account for this, but given that climate change is predicted to lead to such stressors as increased malaria, sea level rise with crop loss and population displacement, famine and potential maladaptive human responses such as war (Butler 2010), it is unlikely that a changing climate, or even the threat of it, will be associated with decreases in levels of mental illness.

Less-dramatically, but more immediately and irritatingly, variations in temperature patterns and increasing levels of CO2 are altering the pollination characteristics of plants, leading to advancement and prolongation of the pollination period and increased biomass and pollen output, with likely adverse consequences for allergy-sufferers everywhere (Bartra).

5-Correlates of Active Transport in Adults

Health Canada's definition of the 'built environment' is that which "includes our homes, schools, workplaces, parks/recreation areas, business areas and roads. It extends overhead in the form of electric transmission lines, underground in the form of waste disposal sites and subway trains, and across the country in the form of highways. The built environment encompasses all buildings, spaces and products that are created or modified by people. It impacts indoor and outdoor physical environments (eg: climactic conditions and indoor/outdoor air quality), as well as social environments (eg civic participation, community capacity and investment) and subsequently our health and quality of life" (Brisbon 2005). Although there is much evidence finding correlations between the built environment and health outcomes, there is little that establishes causation, largely because of the difficulty in conducting a randomized trial on a neighbourhood (Frank 2009). Most studies are of a cross-sectional design, though there are some well-done longitudinal studies that track outcomes before and after a change has been made. Many researchers have called for more such long-term studies (Frank 2009), because in the absence of them when links are found between neighbourhood walkability indexes and Body Mass Index (BMI), for instance, it is difficult to tease out how much of the effect is due to self-selection and how much is due to the environment ie: do active people who like walking simply choose to live in areas where walking is easy and pleasant, or do areas where walking is pleasant lead to increased levels of walking?

Limitations of the literature notwithstanding, people who live in neighbourhoods deemed more "walkable," (ie, with easy-to-access places that are worth going to, as measured by mixed uses in proximity, high residential density, well-connected streets, and pedestrian-oriented retail) walk and bike more often, have lower BMIs, drive less, and emit less air pollution than people living in less-walkable neighbourhoods (Frank 2004 in Rahman 2011, de Nazelle 2011). Conversely, neighbourhoods characterized by dispersed low-density single-use land patterns without desirable destinations within walking distance are inhabited by people who are more likely to be overweight or obese, suffer more from hypertension and other chronic diseases, and experience greater traffic fatalities, especially as pedestrians (de Nazelle, Frank 2009).

Built Environment Correlates of Active Transport and Physical Activity

Element	Active Transport (AT) or Physical Activity (PA)
Neighbourhoods with high "walkability" measurements, ie: bundled measures such as having nearby shops, public transit, sidewalks, bicycle facilities, low-cost recreational facilities and less single-family homes	-35-49 minutes more PA per week than those in less-walkable neighbourhoods (de Nazelle) -study of 11 countries: 20-50% more likely to meet PA guidelines (cross-sectional studies: unable to identify causation) (de Nazelle)

Sidewalks	Have the strongest association with physical activity out of a number of environmental variables (11-country study, reported in Frank 2009, de Nazelle) -when roadways are equipped with sidewalks nearly 4x as many people walk (Jacobson 2009)
High street connectivity: ie, the classic grid pattern where streets cross at right angles and form small blocks and numerous intersections.	Associated with higher transit use, higher walking rates and lower driving rates (de Nazelle). -This lay-out shortens walking distances and provides multiple paths to reach destinations (de Nazelle)
Increased population density	Higher walking, higher public transport use, lower driving (de Nazelle). -Doubling residential density might reduce motorized transport by 5-12% and potentially as much as 25% (US Study: de Nazelle). -Walking begins to increase at densities between 1000 and 3999 persons per square mile (Frank 2009).
Increased employment density	Higher walking, higher public transport use, lower driving (de Nazelle).
Traffic calming	Can reduce traffic injuries by 15-25% -improves both safety and perceptions of safety, which encourages more AT, gets more people on the streets, and in turn, leads to the 'safety in numbers' effect (de Nazelle). **note: if these measures lead to more stop-and-go traffic, it can unfortunately result in higher local air pollution concentrations (study done in Vancouver—de Nazelle).
Land-use mix	-Higher walking, higher public transport use, lower driving (de Nazelle). -negatively associated with per-capita amount of car travel, and positively associated with active transportation, physical activity and BMI (Frank 2009).
Proximity to supermarkets	-Supermarkets may be particularly attractive walking destinations. Proximity is associated with less rates of overweight, obesity and hypertension (Lovasi 2009).
Decreased driving	-Begins to drop at densities greater than 3000 persons per square mile (Frank 2009).
Attractive street and neighbourhood design	Increased walking (Frank 2009).
Organizational travel	A Cochrane Collaboration systematic review (Hosking

plans: ie bundled behaviour change programs at schools or workplaces including increased facilities, social marketing, cycle training and flexible start/finish times	et al 2010) looked at this: -2 controlled before-and-after studies found that school travel interventions increased walking. -One study directly measured the health effects of promoting walking in a workplace—it found improvements in some aspects of health, including mental health. -Overall there is insufficient evidence to know whether organizational travel plans are effective. More research is needed.
Car congestion fees	Cycling rates in London have doubled since the introduction of a steep toll on vehicles entering the downtown core. However, causation cannot be inferred because this occurred at the same time as significant investment in cycling infrastructure (de Nazelle).
Safety	Foster 2008: "Women were over 4.5 times more likely to walk if they perceived average levels of safety, compared with below average levels of safety in the neighbourhood."

Correlates of Bicycle Safety and Use

Promoter of bike use or safety	**Effect**		**Deterrant to bike use or safety**	**Effect**
On-road marked bike lanes (painted lines or a coloured surface to designate that it is reserved exclusively for cyclists)	Positive safety effect in 5 studies, consistently reducing injury rates, and collision frequency by about 50% compared to unmodified roadways (Reynolds 2009). -in a study of US studies, a 1% increase in the length of on-street bike lanes was associated with a 0.31% increase in bike commuters (de Nazelle). -Before and after		**Perceived Risk of injury**	Reynolds 2009: In a survey of adults in Vancouver the following concerns acted as deterrents to bike use: -risk of injury from car-bike collisions -risk from motorists who don't know how to drive near bicycles -motorists travelling faster than 50 km/hr -streets with a lot of car, bus and truck traffic.

	counts in Toronto, Vancouver, San Francisco and London showed increases in cyclist numbers after bike lanes were installed (Pucher 2010). ***More experienced cyclists prefer on-street lanes to bike paths (Pucher 2010)			
Shared bus/bike lanes	Popular with cyclists in the UK. Do not appear to slow bus traffic (Pucher 2010).		**Sidewalk riding**	Very hazardous for cyclists: 1.8 to 1.6 times the risk of cycling on-road (Reynolds 2009).
Bike routes (roads signed as being a "bike route")	Positive safety effect in 3 studies (Reynolds 2009).		**Roundabouts with multiple traffic lanes**	Hzardous to cyclists (Reynolds 2009).
Presence of street lighting on rural roads	Reduced rate of cycling injuries by half (Reynolds 2009).			
Bicycle promotion programs including construction of bike facilities and bike sharing systems	Bike share of trips more than doubled in Berlin, Paris, Barcelona and Bogota (Reynolds 2009).			
End-of-trip facilities and transit integration	There is consensus on the need to provide secure, sheltered parking for bicycles (Pucher 2010), though few studies on the impact of bike parking on biking rates. -Increased levels of cycling are seen with the provision of parking and showers			

	(Pucher 2010). -Better integration of transit with bicycling (via short-term city-based bike rentals at transit stations and increased parking) leads to more bike trips (Martens 2007 in Pucher 2010).			
Reduced speed limits for vehicles to 20-30kph	Reduced bicyclist accidents and increased bicycling (Pucher 2010).			

Safety:

For pedestrians and cyclists there is safety in numbers. Jacobson (quoted in de Nazelle) finds that a doubling of people walking would lead to a 32% decrease in total injuries and a 34% reduction in each walker's individual risk. Reduction of risks to cyclists has been shown to occur along with increased cycling rates in Berlin, London, Amsterdam and Copenhagen (Pucher 2010). In these situations not only is there the increased safety that comes with better infrastructure and engineering, but also motorists become more accustomed to looking for and sharing the road with self-propelled people and are more likely to be part-time cyclists and pedestrians themselves (Reynolds 2009). This makes them more attuned to their needs, and more able to anticipate their movements. Interestingly, there is evidence that perceived safety improvements in bicycle transportation have an aggregate elasticity value greater than one: ie—a 10% increase in perceived safety results in a greater than 10% increase in the share of people commuting by bicycle. (Reynolds 2009)

6-Correlates of Active Transport and Physical Activity in Children

Positively correlated with Physical Activity (PA) or Active Transport (AT)
Decreased distance between home and school (Galvez 2010, Frank 2009) -Children living within 800m of school were 5-10 times more likely to commute actively to school (Timeperio et al quoted in Giles-Corti 2009). -In the US, children who lived within 1 mile of school were more than 3 times as likely to AT to school (Davison 2008).
Increased population density (higher likelihood of walking to school) (Galvez 2010).
Direct route to school with minimal steep roads in a neighbourhood deemed "walkable" (increased AT to school) (Davison 2008).
Improved street connectivity (adolescents, both genders, inc AT) (Giles-Corti.,

Galvez 2010).
Sidewalks (higher levels of walking for children and adolescents) Giles-Corti 2009, Boarnet et al 2005).
Time spent outside (increased PA) (Floriani).
Well-lit streets with higher traffic volume (inc PA in adolescent girls) (Giles-Corti 2009).
Parents perception of the neighbourhood as "safe" (inc AT to school) (Davison 2008).
When a greater percentage of houses within 0.25 miles from the school had windows facing the street: a measure of "eyes on the street" (inc AT to school (Davison 2008).
In older primary school children, the presence of crossings and having no busy roads to cross (increased likelihood of children, particularly boys, walking to school (Giles-Corti 2009).
Boys >Girls One study showing boys almost twice as likely as girls to walk or bicycle to school. Pattern noted both in the US and internationally (Davison 2008).
Neighbourhoods rated as more attractive with more green space, less visible litter, less urban decay, and less concrete-covered playgrounds (increased PA in adolescent girls) (Davison 2008, Galvez 2010).
Living on a cul-de-sac>through road (increased PA in boys) (Galvez 2010).
Time spent outdoors (increased PA) (Carver 2008).
Presence of traffic calming measures (increased PA in boys) (Galvez 2010).
Proximity of parks and sports (increased PA in ages 4-17, both genders) (Galvez 2010, Giles-Corti 2009).
Presence of walking and cycling infrastructure (increased PA in non-organized activities in girls) (Galvez 2010).
Father's physical activity time, time spent outdoors, school PA-related policies, mother's education level, family income (inc PA) (Ferreira 2006).
Low crime incidence (as measured through objective police reports) in the neighbourhood (in adolescents) (Feirreira 2006).
Well-designed and well-implemented school-based programs (Feirreira 2006) Outdoor lessons>Indoor lessons for total energy expenditures.
Children of low Socioeconomic Status >high Socioeconomic status (Davison 2008).
Children of parents who actively commuted to school, who currently actively commute to work, who value the physical activity and the social interactions that take place among children during the commute, who perceive that other children in the area actively commute and when other family members agree with the decision to allow a child to walk or bicycle to school (increased AT) (Davison 2008).

<u>Negatively</u> correlated with Physical Activity (PA) or Active Transport (AT)	**Factors studied that have <u>NO association</u> with Physical Activity (PA) or Active Transport (AT)**
Automobile transport to school (inactivity in boys)	Access to public transport:

Galvez 2010.	not associated with AT in kids (Davison 2008)
Length of annual school sports meetings (inactivity in boys) Galvez 2010.	Most studies find no association between parents' perceptions of traffic safety and children's AT, (Davison 2008, Pont 2009) although the literature is somewhat mixed.
Parents' perceived neighbourhood safety and risk of assault or abduction of the child during travel. Although the actual risk may be low, the high perceived risk is a barrier to AT to some (Rowland 2003 in Hosking 2010 Cochrane, Floriani 2007). Subjective rating of crime is a stronger predictor of behaviour than actual crime rates (Carver 2008).	No clear difference between children from rural vs urban environments for PA levels save limited evidence for increased PA in rural kids under 13, mostly attributable to time spent outdoors in unstructured PA (Sandercock 2010).
Screen time (inactivity): recommendations are to limit total time spent in front of a TV or computer screen to less than 2 hours per day (Floriani 2007).	
Time spent playing video games (inactivity in boys) Galvez 2010.	
Increased distance to school: (Davison 2008).	
Transition between childhood and adolescence (age 13-15): steep decrease in PA levels (Ferreira 2006).	
Vegetation and the presents of hazards (ie: litter, trash, noise) were correlated with obesity in kids (Dunton 2009).	
Increased household income and increasing number of household cars (decreased children's AT) (Pont et al 2009)	

Safety concerns

Speed humps have been significantly associated with a reduced risk of child pedestrian injury. A Californian study (Tester et al 2004 quoted in Carver 2008) found that the odds of a child being injured or killed when struck by a motor vehicle were reduced by 53-60% if the child lived in a street on which a speed hump was located. More comprehensively, the Netherlands adopted the concept of "street for living" to promote the coexistence of pedestrians, cyclists and motor cars, creating a streetscape where vehicles are permitted to enter, as opposed to a street where pedestrians were tolerated. To do this they reengineered the streetscape to include

speed humps, vegetation and narrow sections of road, and removed kerbs to create spaces that were deemed acceptable for children's play. Vehicles are allowed though at restricted speeds without access to on-street parking. The success of this approach is reflected in low child pedestrian injury rates in the Netherlands.(Carver 2008). In terms of preventing exposure to air pollution, anti-idling restrictions around schools can help limit the exposure kids get to exhaust from cars and buses. It is also a good idea to place schools and parks far away from high-pollution sources such as airports and highways, and if that is not possible, to put buffers such as walls or hedges in place.

Relationship of Built Environment Characteristics to Obesity:

Vegetation and the presents of hazards (ie: litter, trash, noise) were correlated with obesity in kids (Dunton 2009). Intersection density was negatively related to obesity for girls (Dunton 2009 and Galvez 2010) and parent-reported road safety was negatively related to obesity in older children (10-12 years of age). Other features of paths such as crossing lights and public transport were not associated with BMI in children (Dunton 2009).

Parental Perception vs Objective Measurement of the Built Environment

Interestingly, overall, parents' perception of the environment is a stronger predictor of children's walking and cycling to school than are urban form variables (Davison). There is a significant difference in the factors influencing young children, whose transportation mode choice is generally much-influenced by their parents, and those of adolescents and young adults who make more of their own decisions.

Walking school bus programs are one way that various communities have sought to address parental concerns about the safety of children's active commuting. Essentially, a walking school bus is a voluntary program one or more adults arrange to meet children at a "bus stop" for the trip to-and-from school. There has been little formal evaluation of these programs (Davison 2008). One long-term study in New Zealand initiated a program in 2000 and followed-up on it in 2003: by then there had been a 54% decline in the number of routes and a decline in the average number of children from 9 per route to 7.7. Nevertheless, many children were still walking to school 3 years after the initiation of the study. Concerns included a lack of parental volunteers, road safety and communication issues (ie: who decides if the school bus should run in inclement weather and a lack of communication between parents and school) (Davison 2008). A possible solutions is to encourage the involvement of non-parental volunteers, such as retired neighbourhood elders, to help with the gaps in volunteer manpower.

Overall, there is significant irony involved in transportation behaviour to and from school. Parents cite safety concerns as their reason for driving their children to school, but in getting in the car and becoming yet another vehicle on the road, they in fact decrease the safety of their neighbourhoods through their own contributions to traffic, noise, injury rates, and air pollution. Additionally, by their lack of presence as pedestrians on the sidewalk, they reduce the social cohesion of their surroundings, resulting in less "eyes on the street" and less support for other

children to participate in walking or cycling. The increased traffic and "stranger-danger" related fears can create a local downward spiral (Carver 2008).

7-The economics of getting out of our cars

The Stern Review, which was released to international attention prior to the Copenhagen climate change summit, estimated that the cost of near-term action to mitigate climate change is likely to be substantially less than would be the subsequent cost of inaction (in Haines 2007). Climate change could result in the loss of about 5% of Gross World Product by 2050, perhaps even up to 20% if the worst-case projections came to pass (Haines 2007). Although a modal shift from vehicles to self-propelled transport would reduce emissions and thus greenhouse gases, hopefully helping to lessen the decrease in Gross World Product, happily, there are other economic benefits of Active Transport which are more short-term and easier to calculate. Active transport is therefore a "no regrets" option that will be beneficial even if some of the current climate change risk estimates turn out to be inaccurate (Haines 2007).

Attempts to monetize the health-cost savings of active transport

A 2004 analysis by Campbell et al estimated that in Canada, the 7.8% of Canadian workers who engaged in active commuting were saving the national economy $2 billion dollars per year (quoted in Shephard 2008). Conversely, there are increased care costs associated with the health ill-effects of vehicle use that were detailed earlier, as well as the economic costs to society of increased school and work absenteeism associated with higher levels of air pollution (Holguin 2007). As detailed earlier, the Health Effects Institute felt that there was sufficient evidence to support a causative link between air pollution and asthma exacerbations in children. Given that asthma is one of the leading causes of school absenteeism, even something as simple as a reduction in air pollution that decreases asthma exacerbation rates would lead to significant savings via a reduction in lost productivity, emergency department crowding and hospitalization (Brisbon 2005). If such a thing can be done in the short-term, as during the Atlanta Olympics, surely a more long-term improvement of the situation is not impossible.

The challenge is to calculate the cost savings associated with active transport in order to facilitate interdisciplinary cooperation and budgeting. This was actually done by Stokes, MacDonald and Ridgeway 2008 (quoted in Litman) for a new light rail transit system in Charlotte, NC. They estimated numbers of future riders and took the effects of daily walking to and from the transit stations as well as local obesity rates into account to project cumulative public health cost savings of $12.6 million over nine years resulting from the rail project. The WHO and Land Transport of New Zealand have both attempted to provide tools to systematically calculate the economic value of each kilometre walked or cycled in order to both evaluate the health effects of current infrastructure, and to help in the planning of new infrastructure. The WHO tool "HEAT: Health Economic Assessment Tool for Walking and Cycling" is an on-line tool that seeks to answer the question: "if x people cycle or walk y distance on most days, what is the economic value of

mortality rate improvements?" Land Transport New Zealand also used a best-available-evidence approach to calculate the per-kilometer benefits of active transport modes, taking into account morbidity, mortality, and health-sector costs and coming up with (in NZ dollars) $4.27 per km walked and $2.14 per km cycled. (Genter 2008).

There are other non-health-related potential economic benefits to investing in active transport-friendly neighbourhoods. In terms of housing developments, it appears that there is an unmet need for more walkable environments. According to Frank 2009, a 10 point increase in walkability increases property values by 5-8% depending on property type (Frank 2009). Also there could also be spin-off effects for local businesses. Although retail areas often subsidize parking spaces to encourage consumer access, a study of consumer expenditures by a UK marketing firm found that consumers who walk actually spend more than those who drive, and that transit and car travellers spend about the same amount (Littman 2011). For the consumer, shifting from driving to walking or biking involves savings to the consumer on fuel, oil, vehicle operating costs, insurance costs, parking costs, the frequency of vehicle repairs and replacement, and increases vehicle resale value (Litman 2011). For society, aside from the health benefits, a shift towards active transport saves on road maintenance, parking spot maintenance, other car infrastructure, and lost productivity due to congestion, One analysis, done by a transportation policy analyst in Victoria BC, puts the savings at approximately 25 cents per vehicle-mile reduced, and 50 cents per vehicle-mile reduced under urban-peak conditions. Another analysis estimates that the benefits of increased cycling are worth approximately 4-5 times the costs of investing in new cycling infrastructure (Reynolds 2009).

As well as being economically advantageous, using public funds to facilitate a shift to active transport is economically just. As Enrique Penalosa, former mayor of Bogota, Colombia points out, "A safe cycle path is a symbol of democracy; it shows that a person on a $40 bicycle is as important as a person in a $40,000 car" (personal communication to Rissel 2009).

8-Evidence-Based Strategies for Action.

All Groups can advocate for the following evidence-based enhancers of Active Transport:

Bike lanes, bike routes, well-lit streets, parks and low-cost recreational facilities (de Nazelle, Pucher, Reynolds).
Traffic calming measures: speed limits <30kph, road humps, pedestrian crossings (de Nazelle).
Neighbourhoods with high "walkability" measurements, ie: neighbourhoods with nearby shops, public transit, sidewalks, bicycle facilities, low-cost recreational facilities and less single-family homes (de Nazelle, Frank 2009).
Sidewalks (de Nazelle, Jacobson).

High street connectivity: ie the classic grid pattern where streets cross at right angles and form small blocks and numerous intersections (de Nazelle, Frank).
Increased residential density (de Nazelle, Frank).
Increased employment density (de Nazelle, Frank).
Better public transport (Frank).
Attractive street and neighbourhood design (Davison, Galvez).
Support from schools and work: walking school bus programs, available bike racks, change rooms and showers (Hosking).
Car congestion fees and expensive parking spots (de Nazelle).
Lots of people walking, biking, rollerblading and skateboarding. Humans like to go with the flow….the more we cardio-commute and make it cool, the safer it'll be for everyone, and the more people will participate! (Davison, Ferreira, Gilles-Corti).

Additionally, the following groups can take these steps:

Health Care Professionals

a-Talk to their patients about the importance of physical activity, and point out active transport as a sensible way to achieve the activity targets.
b-Take on the role of health role models: cycle and bike to work.
c-Work to make hospitals and health clinics models of good health and environmental stewardship: ensure that they are well-connected into the public transit systems and that there are bike racks available as well as shower/change facilities for active commuters.
d-Engage directly with urban planners and all levels of government to advocate publically for active-transport-friendly initiatives such as those listed below, particularly issues with the potential to be very effective but politically-sensitive and difficult to "sell" to the public, such as car congestion charges.

Advocacy groups (Heart Association, Lung Association, Cancer Associations, Environmental Associations)

a-Spread awareness in the community to increase the level of knowledge of the general population about the benefits of active transport.
b-Engage directly with urban planners and all levels of government to advocate for active-transport-friendly initiatives such as those in the above table.

Specific cases:

Elder groups:

Active transport for older people frequently requires interaction with the public transport system. Retired drivers are frequently not familiar with the bus systems they then need to rely on, and have physical/visual impairments that make it difficult to use, leading to fear of taking the bus and lack of use. In a study of older people done in Germany, Finland and Italy, the

third most common suggested improvement to mobility and social activity (given by 55% of respondents) was adaptation of public transit buses to meet the needs of older people" (Broome 2008). Meanwhile, there is likely substantial room to move in terms of improving cycling infrastructure in ways that will make it more accessible to older people in North America: in Holland and in Germany over 50% of trips by those aged over 75 years are by foot or bike (Woodcock 2007). Older people have the potential to make some of the greatest health-related gains through the increased activity associated with walking and cycling, so this should be a policy priority. Such groups would do well to lobby governments and transit commissions for:

-affordable public transport ticket prices
-regular and reliable bus service
-clear and accessible bus schedules with options for infrequent users of computers and people with low-vision
-bus stops placed more frequently along routes
-"Hail and ride" services
-demand stops
-real-time information at bus stops
-pedestrian crossings near bus stops
-appropriately-placed handrails in buses
-culture of younger people leaving front seats for older people
-drop-step to assist getting on and off buses
-shelters with benches at bus stops
-increased presence of friendly personnel on buses who can help with ticketing and point out stops
-slower acceleration phases
-wheelchair-accessible buses
-improved cycling infrastructure.

<u>Cycling groups:</u>
Strangely, for the amount of cycling that is done and the amount of attention that cycling infrastructure has received, very few elements of such systems have been adequately studied. That said, there is evidence of benefit for the following, as shown above:

On-road marked bike lanes (painted lines or a coloured surface to designate that it is reserved exclusively for cyclists)	Positive safety effect in 5 studies, consistently reducing injury rates, and collision frequency by about 50% compared to unmodified roadways (Reynolds 2009) -in a study of US studies, a 1% increase in the length of on-street bike lanes was associated with a 0.31% increase in bike commuters (de Nazelle)
Bike routes (roads signed as being a "bike	Positive safety effect in 3 studies (Reynolds 2009)

route")	
Presence of street lighting on rural roads	Reduced rate of cycling injuries by half (Reynolds 2009)
Bicycle promotion programs including construction of bike facilities and bike sharing systems	Bike share of trips more than doubled in Berlin, Paris, Barcelona and Bogota (Woodcock)

Companies

Some studies have shown a positive association between job performance and moderate-and vigorous-intensity physical activity (Pronk et al 2004 in Genter 2008: NZ Transport) as well as improved mental health scores (Mutrie et al 2002 in Genter 2008: NZ Transport) and job satisfaction (Genter 2008).
There is therefore an incentive for them to encourage Active Transport amongst their employees by:

a-Redirecting savings realized through a reduction in employer-subsidized car parking to the construction of cycle storage and changing facilities for active commuters .

b-Implementing vehicular trip reduction programs by offering incentives for employees ranging from free transit passes to extra vacation time for people who leave their cars at home, and parking cash-out programs where employees who do not use their parking spots can receive the cash equivalent in their paycheck (Frank 2009).

Urban Planners and Municipal Councils

These groups are really the linchpins of the community-level built environment and transportation systems. Their knowledge of active transport and implementation of the measures below is crucial. Their plan of action should include:

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Short-term goals: easy and cheaper changes like increased bike lanes, walking school-buses, encouraging employer-implemented "parking cash-out" initiatives, traffic calming measures, increased parking fees, transit service increases, and car congestion fees (Frank 2009, Jacobson 2009).
Medium-term goals: improved transit, zoning changes to support active-transport, "spot" redevelopment of targeted locations, investment in parks and bicycle/pedestrian infrastructure, high-capacity transit investment (Frank 2009).
Long-term goals: high-capacity transit construction, school siting and redevelopment, improvements to street connectivity and the construction of new developments that incorporate AT-friendly concepts (Jacobson 2009).

There are many factors and groups with a stake in how cities develop, and it can be difficult to get all actors on-board with novel solutions. Some techniques to help bridge these difficulties include:

-"trial" solutions such as the bike lane on the Burrard St Bridge in Vancouver with before and after studies to determine their effects, and whether they should be made into permanent solutions.

-Encouragement of the use of systems such as the US Green Building council Leadership in Energy and Environmental Design (LEED) standards for neighbourhood development. Similar to its points-based system for certifying green buildings, LEED ND certifies neighbourhoods on a credit system based on their inclusion of features that promote greater walkability, mxed use, public transportation, reduction in vehicle miles travelled and greater energy efficiency (Durand et al 2011). The use of a certification system such as this provides an effective way for developers to communicate the virtues of a development to potential purchasers, and can also be incorporated into a system of property tax credits (Durand et al 2011).

-Tools such as HEAT to help quantify the health savings of different cycling and walking-encouragement endeavours. Work with the health sectors and provincial governments to help come up with an equitable way of sharing funds between municipal and provincial levels of government in order to fund and enable healthy developments rather than ignore the externalized costs of unhealthy developments.

Provincial and Federal Governments

In Canada, as reported by Frank 2009, the built environment recommendations developed as part of the National Physical Activity Plan recommend a performance-based transportation funding process where regions that make progress towards more active communities, as measured by increases in AT and decreases in driving are rewarded. Other initiatives could include:

-Encouraging Pay-as-you-drive distance-based vehicle insurance. Currently, insurance premiums only take mileage into account to a minimal extent, even though accident rates are closely tied to mileage (Frank 2009).

-Encouraging Location-Efficient Mortgages to increase the buying power for people who purchase homes in areas of high walkability. These people will both incur less health costs to the system and will spend less on transportation and therefore have more resources with which to service a higher mortgage debt (Frank 2009).

Conclusion

A modal shift from vehicular to self-propelled or Active Transport has the potential to address many current societal concerns: obesity, disease, air pollution, and climate change. To achieve a significant population-level shift, it will be necessary to work to modify the built environment in order to facilitate active transport and make vehicular transport more inconvenient. Doing this will be challenging, as it requires an increased level of integration between the health and transportation sectors, as well as urban planners and all levels of government.

Although it seems a novel idea to be urging the public health and urban planning spheres to work together to improve population health, historically, both in the UK and the USA, modern town planning actually grew from concerns regarding the crowded and unhealthy slums of industrializing cities in the 19th century (Lake 2006). A rapprochement between the two disciplines is therefore much less a newfangled, difficult concept and much more a natural return to a sensibly holistic way of operating. Let us call on our past as we run, cycle, wheel, skateboard, roller-blade, and walk into our future.

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