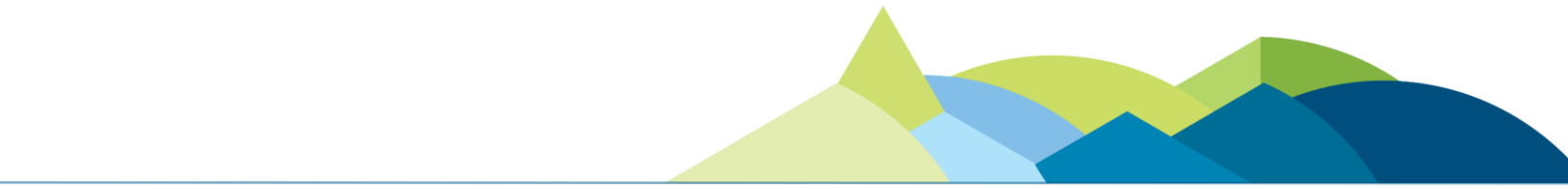
Working with local governments to support health equity through the built environment: A scoping review



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Executive Summary

The way communities are planned and built, and the services and resources provided within them, directly influence people's physical, mental, and social health. A commitment to health equity means planning communities to support the health of all community members including low income families, children, older adults, newcomers, Indigenous groups, and people living with physical or mental health challenges.

This report examines peer-reviewed empirical research on health equity and the built environment published since 2010. The aim of the report is to identify opportunities for public health staff and local governments to apply a health equity lens in support of healthy communities. The scope of the review corresponds with the five physical features of the built environment as outlined in the BC *Healthy Built Environment Linkages Toolkit* (Figure 1).

The evidence demonstrates that neighbourhood deprivation is a significant predictor of fair/poor health in all geographic regions in Canada, and is significantly associated with increased chronic health conditions, depression, anxiety and body mass index, as well as decreased general health and physical activity. In particular, there is growing consensus that differences in health outcomes may be influenced by variations in neighbourhood density, availability of public spaces and facilities, and the integration of different functions within the same neighbourhood (i.e., complete communities).

Emerging evidence in Canada shows residents of deprived neighbourhoods are often anchored in a setting of social disadvantage with little neighbourhood change over time. Research also documents a social gradient of health related to air pollution exposure, heat-related illness, and green space access. Socio-economic status, especially low income, is strongly and significantly associated with household crowding, increased exposure to environmental risks at home and poor residential quality. Low income children are particularly vulnerable and are more likely to suffer from multiple and cumulative exposures to biological and chemical hazards, insufficient sanitation and derelict public spaces. They are also more likely to be exposed to unsafe environments, including traffic, because they are typically more dependent on active transportation.

The evidence shows that the built environment can positively contribute to health, independent of a person’s socioeconomic position. Neighbourhoods with greater resources, informal social control and cohesion are significantly associated with less depression, anxiety, lower body mass index and better general health. Integrated action to provide community-based resources is essential to advancing health equity. For example, evidence shows that affordable housing may have the greatest influence on food security for low income families. Other key factors include access to affordable healthy food, affordable child care, safe and connected transportation routes, nearby and linked green spaces, safe and welcoming community spaces, and adequate sanitation services.

More inclusive community-based research is needed to further identify the specific needs of priority groups. While the scientific evidence examined in this review identifies key priority areas for improving health equity in the built environment, it says less about what should be done. There is a need for inter-sectoral approaches to knowledge translation to link scientific evidence with relevant policy and planning contexts used by local governments, as well as a need for natural experiments and evaluations of interventions to support healthy communities for all.

Key terms and definitions

Active transportation – Active transportation refers to any form of human-powered transportation such as walking, cycling, using a wheelchair, in-line skating or skateboarding. People often combine the use of active transportation with public transit as a complementary means of getting around.[1]

Built Environment – The built environment refers to the human-made or modified physical surroundings in which people live, work, and play. These places and spaces include our homes, communities, schools, workplaces, parks/recreational areas, business areas, and transportation systems, and vary in size from large-scale urban areas to smaller rural developments.[1]

Connectivity – Refers to the directness of links and the density of connections in a transport network. A highly permeable network has many short links and intersections, and minimal dead-ends. As connectivity increases, travel distances decrease and route options increase, allowing more direct travel between destinations, and creating a more accessible and resilient transportation system.[1]

Cumulative Impact Assessment – the process of analyzing the potential social and environmental impacts and risks of proposed developments over time, and proposing concrete measures to avoid, reduce, or mitigate such cumulative impacts.[2]

Density – The number of land uses or land users on a specified unit of ground. The most commonly used density indicators are dwelling units/hectare (residential) and the ratio of floor space or building area to the site area (commercial).[1]

Deprivation – A state of observable and demonstrable disadvantage relative to the local community or the wider society or nation to which an individual, family or group belongs. This disadvantage may occur at various levels, for example, with regard to food, housing, education, work or social ties.[3]

Food system – The whole array of activities, ranging from input distribution through on-farm production to marketing and processing, involved in producing and distributing food to both urban and rural consumers.[1]

Health equity – When all people (individuals, groups and communities) have a fair chance to reach their full health potential and are not disadvantaged by social, economic and environmental conditions.[4]

Health inequalities – Measureable differences in health between individuals, groups, or communities.[5]

Intervention – Policy and program interventions that operate within or outside the health sector and have the potential to impact health at the population level (as per the Canadian Institutes of Health Research (CIHR).[6]

Neighbourhood Deprivation – A measure based on the neighbourhood deprivation index, using a weighted factorial approach comprised of the following six census measures expressed as proportions: population aged 20+ without high school graduation; population aged 15+ who are unemployed; population aged 15+ receiving government transfer payments; population living below the low income cut off (adjusted for community size, family size and inflation); lone parent families; and homes needing major repairs.[7]

Social determinants of health – The interrelated social, political and economic factors that create the conditions in which people live, learn, work, and play.[4]

Introduction

The built environment is the human-made or modified physical surroundings where people live, work, and play. These places and spaces include our homes, communities, schools, workplaces, parks, recreational spaces, business areas and transportation systems, and vary in size from large-scale urban areas to smaller rural developments.[1] How communities are planned and built, and the services and resources provided within them directly influence people's physical, mental, and social health, and are reflected through levels of social cohesion, mental and physical well-being, chronic disease, obesity, and injury.[1]

Several essential resources have been developed by regional and provincial health authorities to support healthy built environments in British Columbia (B.C.), including:

- Provincial Health Services Authority (PHSA). (2014). *Healthy Built Environment Linkages – A Toolkit for Design, Planning, Health*. A project of the BC Healthy Built Environment Alliance. Available at: www.phsa.ca/NR/rdonlyres/4F760D04-827A-409D-90DA-2C3598024E8E/69564/LinkagesToolkitFINALApril8_2014_FULL.pdf
- BC Health Authority Healthy Built Environment Council. (2015). *Public Health Guide to Planning with Local Governments*.

In general, we know that compact, connected and walkable communities, with a mix of amenities, services, housing types, and people can support health. A commitment to health equity means considering the unique needs of more vulnerable community members, such as children, older adults, people living with physical mobility or chronic health challenges, as well as, low income, housing insecure or other marginalized community members. Health equity means all people (individuals, groups and communities) have a fair chance to reach their full health potential and are not disadvantaged by social, economic, and environmental conditions.[4]

A health inequity is a difference in health associated with social disadvantages that are modifiable and unfair.[4] Inequities can be found in the distribution of health supportive amenities (such as healthy housing or green spaces), the distribution of environmental burdens (such as air pollution), and in processes used to make decisions when planning healthy communities. Addressing health inequity and promoting health equality are major public health priorities in B.C.

To protect and promote health equity in B.C., health authorities' health protection divisions now include healthy built environment teams or staff members to maximize opportunities for health supporting environments for all people. Through their work in food premises, drinking water systems, sewage treatment operations, housing, personal services settings, and other built environments, B.C. environmental health

officers (EHOs)* directly encounter social determinants that impact the health of individuals and communities. They observe inequities linked to the social determinants of health, particularly related to socioeconomic status, culture, language and literacy, psychosocial and mental health issues, and geography.[8] Findings from consultations emphasize the essential role of EHOs in identifying unfairness and systemic barriers to health equity and for building trusting, supportive relationships in the communities where they work.[9]

Built environment interventions to support health are systemic in nature. For example, disproportionate levels of air pollution in a neighbourhood may be influenced by the availability of public transportation, historical and current zoning of roadways for industrial trucks, the design of street canyons, the concentration and regulation of local industry, investment in urban forestry programs, the walkability of the neighbourhood, and more.[10] Local governments have an important role in addressing a broad range of policies and services that focus on the social, economic, environmental, and physical health of communities. This includes healthy community design, parks and recreations facilities, healthy living programs, health related policies, and partnerships with non-profit and community organizations.[11]

Given the systemic nature of health promotion in community settings, there is a need to clarify how environmental public health professionals can work with local governments to promote health equity through the built environment. Specifically there is a need to: 1) examine recent evidence of how built environments can affect health equity; and, 2) identify opportunities for public health professionals to apply an equity lens when working with local governments to promote healthy public policy and planning processes.

* In BC, EHOs are certified public health inspectors – CPHI(c), and are sometimes referred to as Public Health Inspectors (PHIs) in other jurisdictions.

Purpose of review

This scoping review identifies, synthesizes, and summarizes the findings of relevant peer reviewed empirical research published since 2010, to help answer the question:

> **What is the evidence that the built environment can improve health equity or exacerbate health inequities in British Columbia?**

The purpose of the review is to identify: 1) where health inequities related to the built environment have been documented in the research; 2) what health impacts have been associated with these inequities; 3) how built environment interventions have been shown to exacerbate or minimize inequities; and 4) gaps in the research.

The study of the built environment and health encompasses a vast range of topics and a diversity of research disciplines. To manage the scope of this review, we limited our examination to:

1) Systematic or scoping reviews on health equity and the built environment

2) Recent and relevant Canadian-based research from a range of disciplines, including small community-based case studies

This approach aligns with recommendations of the World Health Organization to integrate broader research on health inequalities in the built environment with more local and community-based participatory research strategies.[12] Research on health inequities and social disparities are contextually, historically, and geographically specific.[13] As such, this review examines systematic and scoping reviews to gain an overview of the breadth of findings on topics of the built environment and health equity. These findings are complemented by Canadian-based studies to provide relevant local context where it exists. The goal of the review is to identify ways that public health staff can provide an equity lens in support of healthy built environments.

Background: health equity and the built environment

Despite universal access to health care in Canada, serious health inequalities persist. Health inequalities, often referred to as disparities, are measureable differences in health between individuals, groups, or communities.[4] For example, Indigenous people in Canada have a life expectancy 12 years lower than the national average and experience higher rates of preventable chronic diseases compared with non-Indigenous Canadians.[14,15] Determinants of health, such as income, housing, gender, Aboriginal status, and immigrant status, greatly impact the health of Canadians.[16]

The settings where people live, work, and play can greatly influence their health. Growing evidence in Canada documents a social gradient of health related to the unequal distribution of environmental supports (e.g., healthy green space and healthy food) and environmental burdens (e.g., air pollution and poor housing).[17] This can result in compounded health burdens, meaning that poor health disproportionately borne by those who are socioeconomically disadvantaged is compounded by greater environmental burdens and a lack of supports in the communities where they live. Vulnerable populations can be further marginalized if they are excluded from key decision-making processes that affect their health, thereby deepening health inequity.[18] The systemic nature of health inequities requires multiple policy approaches to address their causal pathways, including, policies aimed at reducing differences in environmental conditions and exposures (e.g., zoning and land-use planning), policies to address differences in susceptibility to health risks (e.g., income and employment equality), and policies aimed at reducing differences in health supports (e.g., access to essential medicines and healthy food).[12]

Health equity has been a priority for the public health sector in Canada since the release of the World Health Organization's Ottawa Charter for Health Promotion in 1986. In 2008, Canada's Chief Public Health Officer, Dr. David Butler Jones, prioritized reducing health inequities in Canada.[19] Provincial medical health officers have also highlighted health inequities as a priority issue.[20,21]

The built environment is a crucial setting for health equity because it influences the social determinants of health: interrelated social, political, and economic factors that create the conditions in which people live, learn, work, and play.[4] Prioritizing health equity through the built environment means ensuring that disadvantaged individuals and groups are supported in achieving healthy homes and communities that respond to their unique needs and addresses their barriers to health.

Public health efforts to promote health equity through the built environment require collaboration with other sectors, particularly community planning. Community planning can be good or bad for health equity. For example, zoning codes can affect neighbourhood-level exposure to pollution and intense traffic. Land use decisions can influence public transit, affordable housing, neighbourhood walkability, social activities and access to amenities and services. These elements shape patterns of daily community activity and connection and can significantly influence health and health inequities.[22] Given the systemic influence of the

built environment in supporting health, there is a need for more inclusive collaboration among community planners, public health professionals, and community members to better understand where and how health equity can be achieved.

In B.C., public health renewal efforts include a greater focus on health disadvantages experienced by some people as a result of their social and economic position. B.C. has one of the highest poverty rates in Canada and the highest child poverty rate, with Aboriginal peoples, low income families, people with mental illness, new immigrants, and those impacted by homelessness among those most affected by health inequities.[23] *A Framework for Core Functions in Public Health* was created to guide public health priorities and promote both a population-health lens and an equity lens. According to a recent B.C. study by Pauly et al.,[23] public health knowledge users report that health equity is not often a priority in health systems and that application of an equity lens is often challenging with little practical guidance available.

The goal of this evidence review is to examine the recent evidence of where health inequities in the built environment have been documented and opportunities to address them, in order to help identify ways for public health staff and local governments to apply a health equity lens and support healthier built environments.

Review approach and method

A scoping review method was employed to retrieve and examine peer-reviewed literature on the built environment and health equity.[24,25] The following six review stages were completed to identify and consolidate the broad evidence base:

1) Scoping and refinement of research question (January 2016)
3) Systematic database searching (final database search completed Feb 6, 2016)
4) Article appraisal and quality assessment (February 2016)
5) Data extraction (February 2016)
6) Data analysis and synthesis (February 2016)
7) Integration and results reporting (March 2016)

The scope of the review and research questions were developed in consultation with the B.C. Centre for Disease Control staff. Search terms were developed to correspond with the five built environment categories as outlined in the B.C. *Healthy Built Environment Linkages Toolkit* (Figure 1). The toolkit provides evidence-based and expert-informed messages around health and the built environment.[1]

Figure 1. Five physical features of the built environment: neighbourhood design, transportation networks, natural environments, housing, and food systems.

The electronic database search was limited to studies published between 2010 and 2016 and 827 unique articles were identified (*see Appendix A for search protocol and selection criteria*). Two reviewers independently appraised the articles by title and abstract, and rejected articles that failed to meet the inclusion criteria. Disputed articles were discussed to clarify reasons for exclusion. The full text of 59 accepted articles were retrieved and appraised for meeting the quality criteria. The reference lists of 47 accepted articles were hand searched and an additional six relevant studies were identified. A total of 53 studies were accepted into the review (Figure 2).

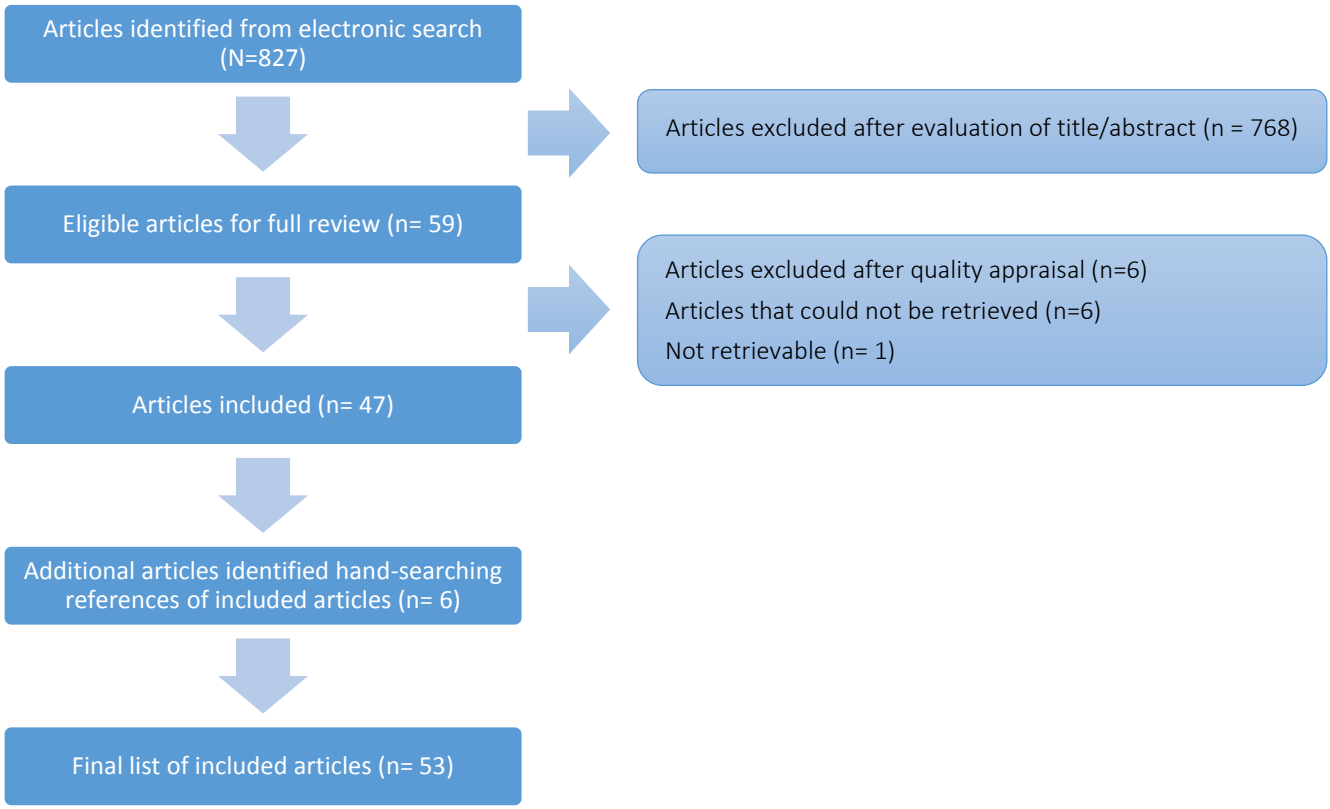

Figure 2. Article selection process and results

Two reviewers independently applied a standard data extraction form to 20 percent of the articles to check inter-rater reliability. Data extraction was then completed for all remaining studies. Variables such as date, location, study method, built environment feature and population were recorded using the statistical software program (SPSS) and a narrative account of each article's findings, limitations and implications were documented and summarized. Due to extreme heterogeneity of the methods, interventions, samples, context, and outcomes, the data were synthesized narratively. The contribution of each study to its relevant built environment category was examined and a synthesis of findings was completed and summarized in a narrative report.

Findings

OVERVIEW OF STUDIES

A total of 16 reviews and 37 Canadian studies on the relationship between the built environment and health equity were examined. Among the built environment categories, studies on natural environments and food systems were the most predominant, followed by healthy neighbourhood design (Table 1). No systematic or scoping reviews on healthy transportation and health equity were identified.

Few longitudinal or experimental studies were identified. The majority of Canadian studies were cross sectional, small qualitative case studies or ecological studies. This means that that while many significant and consistent associations between the built environment and health equity have been established, there is a lack of information on the underlying mechanisms or causes of these relationships. Only three longitudinal studies were identified: a cohort study on active transportation among low income children in Quebec[26]; a cohort study on the demographic distribution of intestinal infections from residential water systems in B.C.[27]; and a study on the effects of neighbourhood social and material deprivation change on psychological distress in urban Canadian adults.[28]

Table 1. Study type by built environment category and setting

Study type (count)	Built environment category (count)	Setting (count)
Reviews (16)	healthy neighbourhood design (2)	urban (3)
systematic (11)	healthy natural environments (4)	rural (1)
scoping (4)	healthy food systems (5)	urban and rural (12)
metanarrative (1)	healthy housing (5)	
Canadian Studies (n=37)	healthy neighbourhood design (n=9)	urban (33)
cross sectional (15)	healthy transportation (=4)	peri-urban (1)
qualitative case study (10)	healthy natural environments (n=11)	rural (2)
ecological (9)	healthy food systems (n=10)	urban and rural (1)
longitudinal (3)	healthy housing (n=3)	

Studies of health equity and the built environment are predominantly urban in focus. Among the Canadian studies, most are from urban or peri-urban settings in Manitoba (n=3), British Columbia (n=6), Ontario (n=11), Quebec (n=15) and Nova Scotia (n=1). One study looked at urban settings at a national scale. Only three Canadian studies were based in or near rural settings (one from Alexander First Nation, one is from

Lincolnville, Nova Scotia, and one from several rural settings in Nova Scotia). A lack of research from rural areas was a predominate theme among the systematic and scoping reviews.

The majority of studies (73%) examined health equity and the built environment through general measures of social disadvantage such as low income (n=23), low socioeconomic status (SES) (n=11), or relative neighbourhood deprivation (n=5). While some studies further stratified socioeconomically disadvantaged groups by variables such as health status (discussed in the in-depth findings), few studies specifically focused on the health of vulnerable subpopulations (Indigenous health (n= 5), immigrant health (n=1), child health (n=1)) (Figure 3). Notably the search did not return any Canadian studies that specifically focused on older adults, people living with physical disabilities or other mobility barriers due to chronic health conditions or homeless/housing insecure people.

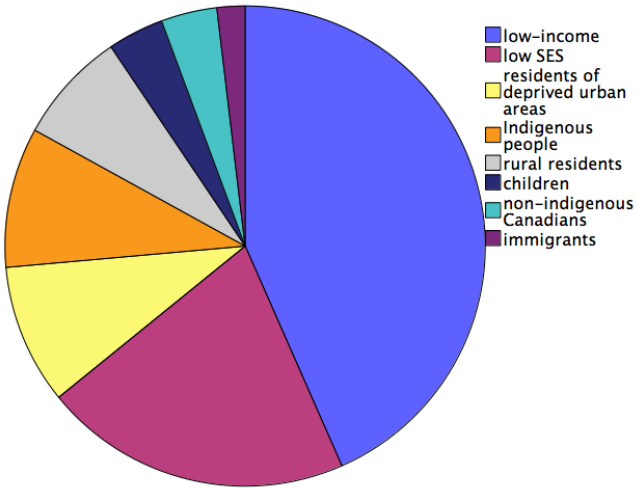

Figure 3. Distribution of sub-populations studied in relation to health equity and the built environment. Studies of low income children are included under "low income". Studies of Indigenous children are included under Indigenous people. Non-indigenous Canadians refer to studies of non-indigenous adults stratified by multiple variables such as age and gender.

In general, the studies can be categorized into two groups: 1) studies that identify health inequalities associated with a built environment feature and 2) studies that document health inequities related to the unequal distribution of a harm, benefit or process related to the built environment.

The majority of studies on health inequalities use various indicators of self-reported health to measure health status. Some researchers argue that self-assessments are too subjective. However self-reported health status is one of the most common indicators used to assess the health of populations and is known to be a reliable indicator of an individual's physical and mental health status and predictive of adverse health events

and mortality.[7] Recent critiques of built environment research argue that subjective perspectives and human agency are fundamental to equity-focused research and inventions of the built environment.[29]

Table 2 summarizes evidence of health inequalities documented in this review. Evidence of both health inequalities and health inequities are explored in-depth under the relevant built environment category of this report.

"Attention to how people understand their environment and navigate competing demands can improve the scientific value of ongoing efforts to promote active living and health, while also better fulfilling our ethical obligations to the individuals and communities whose health we strive to protect."

Table 2. Evidence of health inequalities related to the built environment.

Built environment characteristic	Observed health Inequalities	Study
Neighbourhood deprivation	Consistent and significant association with poorer health. The greater the disadvantage the worse the level of health or health behaviour for all measures of self-reported depression, anxiety, body mass index, general health, chronic health conditions and physical activity.	Gibson[30]; O'Campo[31]
	Increased neighbourhood material deprivation decreases psychosocial health (prospective study).	Blair[28]
	Significant predictor of fair/poor health in all Canadian geographic regions, but living on the Atlantic and Pacific coasts exacerbated the detrimental effects.	White[7]
Air pollution	Stronger pollution-mortality associations for people of lower SES, even adjusting for behavioural and occupational risk factors.	Gelormino[32]
Heat exposure	Greater vulnerability to heat related health risks associated with low SES, social isolation, lack of green space, access to air conditioning, and clinical frailty in the elderly.	Gelormino[32]; Bélanger[33]
	Increased cardiovascular risks and distress from pre-existing respiratory conditions.	Gelormino[32]
	Greater heat-related mortality among individuals of lower socioeconomic status.	Gelormino[32]
	High prevalence of heat-related health impacts in disadvantaged neighbourhoods (46%). Within disadvantaged communities, female gender and long-term medical leave are two impact risk indicators in people <65 years of age. Low income and lack of air conditioning at home are risk indicators at all ages. Having ≥2 chronic diseases and perceiving daily stress are risk factors independent of age.	Bélanger[33]

Built environment characteristic	Observed health Inequalities	Study
Green space	Stronger associations of health benefits from green space observed among lower SES groups than higher SES groups. Low SES groups reported largest benefit from green space exposure in terms of chronic obstructive pulmonary disease.	Gelormino[32]; James[34]
	Increased green space associated with increased play and physical activity in children.	Christian[35]
	Green space associated with cognitive and motor development in children.	Christian[35]
	Lack of green space associated with reduced opportunities for physical activity among lower SES groups, particularly low SES seniors due to lack of space.	Gelormino[32]
	In disadvantaged neighbourhoods, lack of green space significantly associated with probability of almost never walking, cycling and gardening.	Gelormino[32]
	Stronger positive association between greenness and healthy birth outcomes among mothers of lower SES.	James[34]
	Higher greenness found to decrease the effect of income deprivation on all-cause and cardiovascular mortality.	James[34]
	Strongest association between greenness and reduced mortality observed in the most deprived areas.	James[34]
	Protective against stress and may provide emotional, physical and social support for new immigrants with low incomes.	Hordyk[36]
Water pollution	Increased risk of intestinal infections from water for females, children, older adults or those residing in low income areas (prospective study).	Teschke[27]; Gelormino[32]
Neighbourhood food environment	Weak or equivocal evidence that greater availability of healthy foods was related to better dietary intake.	Black[37]; Kirkpatrick[38]
	Distance to the closest supermarket was significantly associated to the odds of being overweight or obese in children.	Larsen[39]
	Weak or equivocal evidence that multilevel strategies (individual-level behaviour change and environmental-level change to increase healthy foods and discouraging consumption of sugar-sweetened beverages) impacted weight status in rural settings.	Calancie[40]

Built environment characteristic	Observed health Inequalities	Study
Child relevant neighbourhoods (e.g., recreation center, library, school child care centre)	Significantly and consistently associated with domains of early child development.	Christian[35]
Non-urban setting	Greater likelihood of heart disease, cancer, diabetes and stroke among residents of rural setting compared to urban settings.	Terashima[41]
Housing	Strong evidence that interventions aimed at improving area characteristics, particularly moving to areas of lower poverty can lead to reductions in depression and increases in the proportion reporting good or excellent health.	Gibson[30]
	Very strong evidence that warmth and energy efficiency interventions targeted at lower SES individuals confer positive health benefits (improved general health, respiratory health, and mental health and may also promote improved social relationships and reduce absenteeism from school or work due to illness).	Gibson[30]; Thomson[42]
	Significant positive association between food insecurity and proportion of income allocated to housing.	Kirkpatrick[43]
	Heat related illness in deprived neighbourhoods was significantly associated with self-reported 1) dissatisfaction with the temperature inside the dwelling in summer; 2) problems of air pollution outside of dwelling.	Bélanger[44]

HEALTHY NEIGHBOURHOOD DESIGN

Healthy neighbourhood design focuses on land-use decisions that affect the ability of people to connect to each other and with essential day-to-day services in their community. Health benefits such as increased physical activity, improved and safer mobility, increased employment productivity and social inclusion have been associated with complete, connected and compact neighbourhoods. Strategies to support connectedness include: enhancing neighbourhood walkability, creating mixed land use, and building complete, compact and connected neighbourhoods.[1]

Healthy neighbourhoods and health equity: review of the evidence

There is some consensus that both individual-level and population-level health inequalities may be influenced by variations in: 1) neighbourhood density; 2) availability of public spaces and facilities; and, 3) integration of different functions within the same neighbourhood (often referred to as "complete" communities). A review by Gelormino et al.[32] applied an explanatory framework method[†] to review 14 years of urban and medical research to explore the main mechanisms of neighbourhood design that may influence health inequalities (Figure 4). The review documents evidence of significant individual-level health inequalities related to air pollution, heat exposure, water, noise exposure, physical activity opportunities, green space exposure and food access (*see Table 3 for detailed health impacts*).

Using the framework, evidence of health inequalities was linked with three key built environment features: 1) density (concentration of buildings and population in an area); 2) availability of public spaces and facilities; and 3) integration of different functions within the same neighbourhood. Their analysis proposes that these three factors may influence individual health through their impact on natural environments and social contexts, as well as individual behaviours. These effects may be unequally distributed, leading to disproportionate health burdens among socioeconomically disadvantaged individuals. The review cautions that while, in general, the expected links proposed by the framework are well documented in the literature, there is a lack of direct evidence for how interventions (related to neighbourhood density, public spaces and services) impact health inequalities due to confounding factors, diversity in study design, and difficulty generalizing evidence that is rooted in local contexts.[32]

[†] Application of Whitehead and Dahlgren (1991)'s framework by multi-disciplinary team of experts in urban planning, public health, social and political sciences, based on both literature research and interdisciplinary consensus.

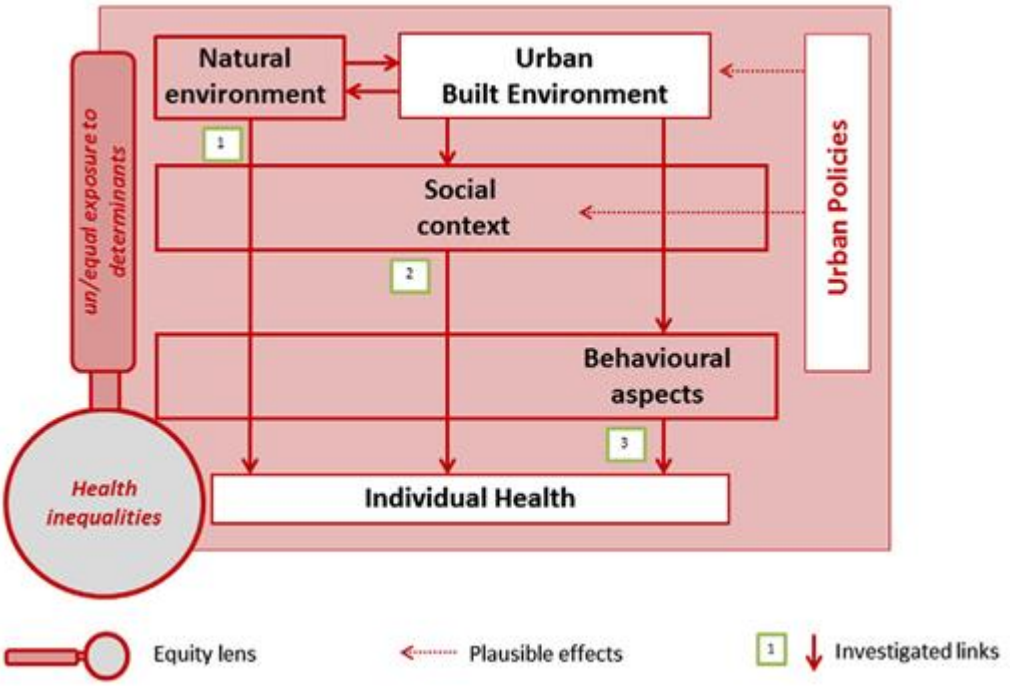

Figure 4. Explanatory framework of mechanisms through which the built environment might influence health inequities and subsequent health inequalities. Using the framework, evidence of health inequalities was linked with three key built environment features: 1) density (concentration of buildings and population in an area); 2) availability of public spaces and facilities, and 3) integration of different functions within the same neighbourhood. (Gelormino E, Melis G, Marietta C, Costa G. (2015). From built environment to health inequalities: An explanatory framework based on evidence. *Prev Med Reports* 2: 737-745.doi:10.1016/j.pmedr.2015.08.019 Creative Commons Attribution-NonCommercial-No Derivatives License (CC BY NC ND).)

A scoping review on the built environment and child health by Christian et al.[35] adds support to Gelormino's framework. They find that both the availability of public spaces and facilities, and the integration of different functions within the same neighbourhood may be particularly important for children's health. However, the effect of the first pathway (neighbourhood density) is less clear. The review examined 32 studies on population–level associations between the neighbourhood built environment and child health and found consistent evidence of a significant positive association between access to various types of neighborhood green space and increased child play/physical activity, as well as child cognitive and motor development. Four studies, identified in the review, reported a significant association between domains of early child development and the presence of child relevant neighborhood destinations (e.g., recreation centre, library, school and child care centre). One of the few studies in the review to objectively measure the neighborhood built environment, reported a significant positive association between less connected streets and less outdoor play in boys. Among the five identified studies on housing density, two studies reported that greater housing density may constrain opportunities for play because the lack of indoor and outdoor space

limits children's ability to play. Three other studies found no association between residential density and children's outdoor play and physical activity.[35]

Among Canadian research, there is growing evidence of negative health impacts associated with relative neighbourhood material and social deprivation. Material deprivation involves a relative lack of goods and conveniences, such as adequate housing or parkland. Social deprivation refers to a lack of social supports at home, at work or in the community.[3] Individual-level data from a sample of 133,694 participants of the Canadian Community Health Survey was combined with area-level data from the 2001 Canada Census to explore the relationship between neighbourhood deprivation[‡] and regional inequalities in self-reported health. The study reported that neighbourhood deprivation was a significant predictor of fair/poor health in all geographic regions. The strength of association varied across Canada, ranging from a 12–13% increased risk for each unit increase in deprivation in Quebec, the Prairies, and Alberta, and to a high of 28% in B.C. The authors report that neighbourhood deprivation appears to have a strong detrimental influence on the perceived health of residents in the Atlantic region and in B.C., and suggest that living in neighbourhoods marked by high levels of deprivation may be more influential on the pathways to disease for populations residing in the coastal regions of Canada. The neighbourhood-level variance remained significant for Ontario and B.C., despite the inclusion of several individual-level risk factors, such as household income, chronic disease and perceived stress, suggesting that there is still a variation at the neighbourhood level in these regions that is not fully explained by the risk factors included in their models.[7]

"Neighbourhood deprivation was a significant predictor of fair/poor health in all geographic regions."

A more recent cross-sectional study by O'Campo et al.[31] examined neighbourhood effects on health and well-being among 2,412 randomly selected Toronto adults between the ages of 24 and 65. This study is unique because it uses strong design features for sampling neighbourhoods and individuals. The study collected 1) census measures (per cent of households below low income cutoff, unemployment rate of males over the age of 15; percentage of lone parents in the neighbourhood; per cent of high school dropouts; and average household income), 2) Community based resources in each neighbourhood, 3) aggregated self-reported assessments of neighbourhood problems, social control, social cohesion, and 4) self-reported health measures for depression, anxiety, body mass index, general health, chronic health conditions and physical activity. The study controlled for education (in years), age (in years), gender, and ethno-cultural status (Canadian versus foreign born).

The results showed that neighbourhood disadvantage is consistently and significantly associated with worse health outcomes for all health measures. Neighbourhoods with greater resources, informal social control, and cohesion are significantly associated with less depression, anxiety, lower body mass index and better general health. The authors note that their findings support substantial evidence that neighbourhood disadvantage is a fundamental determinant of health, but also that neighbourhood socioeconomic position alone is not a proxy for health determining features of their neighbourhood. This means that the resources

[‡] a measure based on the Neighbourhood Deprivation Index, see Definitions of Terms in Appendix C

in the built environment can positively contribute to health independent of a person's socioeconomic position.[31]

The first known prospective cohort study of changes in neighbourhood material and social deprivation on distress was undertaken by Blair et al.[28] and supports the findings of cross sectional research that the negative health impacts of living in a deprived neighbourhood appear to be exacerbated as deprivation increases. The study paired data from 2,745 urban participants of Canada's National Population Health Survey who completed the Kessler 6-Item psychological distress-screening tool at baseline and follow-up with neighbourhood social and material deprivation data from the census-based Pampalon Deprivation Index.[3]

Data were paired using participants' postal code. Multiple linear regression models were stratified by baseline deprivation levels and controlled for key confounders. The study found that a worsening of material settings was significantly associated with a worsening of distress scores at follow-up. A lack of responses to distress questions were found most among elderly and lower income participants, suggesting that findings may underestimate health risks for vulnerable subpopulations. The authors note that the lack of change in highly materially deprived neighbourhoods over time is consistent with other studies, suggesting that structural inequities keep some neighbourhoods "locked in a context of disadvantage" (p937).[28] These persistent inequities can negatively impact an individual's long-term health trajectory over the life-course, from childhood through adulthood.

The findings from these larger studies appear to be supported by community based case-studies on the well-being of residents living in deprived urban neighbourhoods. Synthesized data from community based health equity assessments in Vancouver, Winnipeg, and Toronto identified multiple inequities in deprived neighbourhoods in comparison to the settings of more affluent neighbourhoods. These include: inadequate sanitation services relative to neighbourhood density and pedestrian use; limited supply and restrictive use of the neighbourhood commons; insufficient and poor quality public and green spaces; and a lack of investment in response to the unique needs and priorities of the community. Residents of deprived neighborhoods reported general negative health impacts related to neighbourhood stigma, segregation, and patterns of neighbourhood deprivation.[45]

A related community based study in Winnipeg indicates how inequities identified in the built environment by Aboriginal youth (related to derelict, unsafe, restrictive, limiting and unwelcoming spaces) convey negative health impacts related to social isolation, segregation and limited mobility.[46] Similarly, an ethnographic study of low income mothers from Spryfield, Nova Scotia indicate that the intersection of physical and social deprivation keeps mothers in a cycle of

Structural inequities keep some neighbourhoods "locked in a context of disadvantage."

disadvantage. In particular the absence of local, affordable, and regulated child care prevents mothers from accessing paid employment to improve their access to healthy housing, food, and opportunities for social inclusion.[47]

Similar to recommendations by Blair et al.[28], all community case studies identified the need to address larger structural socioeconomic barriers in order to address relatively static patterns of neighbourhood deprivation.

Only one Canadian case study, from Hamilton, Ontario, was identified that examined the role of a municipal planning process to reduce health inequities. The study reported on the essential role of community developers in navigating power differences in order to advance the interests of low income residents, and that low income residents were able to strongly influence the city by successfully developing neighbourhood plans. The study also reports that community developers are often constrained by other municipal planning priorities and that a more arms-length role facilitates their ability to prioritize health equity needs of low income residents.[48]

It is crucial to note that findings of neighbourhood health equity are greatly biased toward urban settings and that there is very little data on rural areas. A large cross-sectional study by Terashima et al.[41], of 11,233 adults in Nova Scotia, examined inequalities in chronic disease prevalence across urban and non-urban communities. They found that respondents living in towns were 21% more likely to report a chronic disease (heart disease, cancer, diabetes, and stroke) than respondents living in urban communities even after accounting for individual-level and community-level characteristics. The study reports that people who live in non-urban settings, particularly towns, experience extra challenges in maintaining health beyond social and economic conditions of the community and individual demographic, behavioral and socioeconomic attributes. This study highlights the great need to address the marginalization of small towns and rural settings in built environment research.

Healthy neighbourhood design and health equity: recommendations for action

The current evidence base documents significant relationships between inequities in the built environment and health inequality, but cannot explain the extent to which these inequities contribute to health inequalities or the key mechanisms involved. As such, identifying specific interventions for addressing health inequity is limited. However, key priorities have been identified from the literature to support health equity in neighbourhood design.

1) **Prioritize the health settings of deprived neighbourhoods (particularly compact neighbourhoods); increase availability of public spaces and facilities; and the integration of a full range of services and functions (i.e., mixed use) within the same neighbourhood.** Deprived neighbourhoods are those that are experiencing a confluence of multiple social and material deprivations. Despite the limited number of health outcomes studied to date, there is strong and

consistent evidence that residents living in deprived neighbourhoods experience poorer health than people living in less deprived areas. These health risks may be underestimated since there is a lack of data on the effects of neighbourhood deprivation on vulnerable sub-populations, such as people living with a physical or mental disability, older adults living with a chronic disease, or low income children. While more research on the impact of specific built environment interventions is needed, there is consistent evidence that stressors at the neighbourhood level, such as social disorder, concentrated poverty, crime and neighbourhood disrepair, contribute to poor mental health. Conversely high levels of neighbourhood services and amenities, green space and walkability, or strong social ties and support can elevate mental health or even act to counter the negative impact of stressors.[31] There is some evidence that deprived or disadvantaged neighbourhoods are affected by stigma that perpetuates neglect, restricted access and use of public spaces, and a sense of isolation from other neighbourhoods. In these cases, 'equal' investments may be inadequate, since deprived neighbourhoods may need more tailored and intensive investments through an integrated range of service and amenities to ensure equal opportunities for health afforded by the built environment.[32]

2) **Ensure density goals do not compromise sufficient and well-connected natural spaces and play areas for children and youth.** Strong and consistent evidence shows that access to various forms of green space is significantly associated with increased physical activity, play, and cognitive development in children. While the impact of housing density on children's play is unclear, some evidence suggests that increased density may constrain opportunities for play because the lack of indoor and outdoor space limits children's ability to play. Therefore, neighbourhood density targets should be paired with provisions for sufficient, safe, connected, accessible, and nearby natural green spaces and play areas.

3) **Support the collaboration of planning and public health sectors through approaches such as multiple impacts mapping for deprived neighbourhoods.** There is a need for stronger links between local governments and public health to tackle residential conditions of deprived neighbourhoods. Approaches may include the use of multiple impacts mapping that assess both multiple neighbourhood burdens (e.g., related to traffic and local unwanted land uses) and neighbourhood deprivations (e.g., related to poor transit and lack of affordable housing). The goal is to avoid or respond to concentrations of environmental burdens and deprivations that can further marginalize disadvantaged neighbourhoods. This could be accompanied by integrated regional planning to consider the impacts of new facilities and infrastructural developments on inequities.

4) **Support multiple avenues for vulnerable or priority populations to participate in planning and decision-making processes, particularly the identification of structural barriers to the social determinants of health.** The specific forms of neighbourhood deprivation and underlying mechanisms that lead to poor health are unclear. There is some evidence that materially disadvantaged neighbourhoods limit or restrict protective social support networks, expose residents

to chronic stress, decrease safety and security, decrease residential access to adequate service provision and housing, decrease access to education and employment opportunities, and reduce access to health-promoting and coping resources.[28,32,35,45] Despite the emergence of common themes, case studies show that the forms and effects of deprivation are often context specific and distinct neighbourhood circumstances need to be considered. Efforts toward neighbourhood renewal may result in unintended health inequities if the local context and needs of vulnerable populations are not considered in planning processes. For example, neighbourhood-level investments in green space and other local amenities may instigate neighbourhood gentrification. Renewal strategies without integrated commitments to affordable housing, transportation, and food, can lead to further marginalization of low income residents who can no longer afford to live in the very neighbourhoods designed to support them.[49] Evidence-based policies to address health inequalities related to the built environment requires a focus on local contexts that explore both physical and social settings of neighbourhoods.[32] The case study by Cahuas et al.[48] sets out some preliminary analysis into how municipal and regional planning models can promote equitable priority setting and decision-making processes through the support of community developers. The case also shows potential for residents of disadvantaged neighbourhoods to influence the city by successfully developing neighbourhood plans. The study reports that their findings are consistent with similar literature that demonstrates how marginalized community groups can use participatory approaches to influence health supportive policy.[48]

5) **Employ health equity impact assessments in neighbourhood planning.** Due to a lack of evidence of best practices to support health equity in neighbourhood design, equity-focused impact assessments are important for ensuring that proposed neighbourhood zoning or land-use does not further contribute to the health inequities that have been identified in the literature. Potential health inequities include but are not limited to 1) disparities in the distribution of environmental amenities or burdens, such as air pollution, green spaces and trees, the urban heat island, noise, opportunities for physical activity, and access to healthy food, and 2) disparities in access to the social determinants of health, such as education, transportation, employment, child care and housing. Due to the lack of research and data on health impacts to sub-populations, it is important to engage specific target populations in the health equity assessment process in order to uncover potential health inequities in neighbourhood renewal strategies or other planning processes.

6) **Support neighbourhood reclamation of derelict or under-used public spaces.** Emerging evidence from Canadian case studies report restricted use, neglect, and poor maintenance of public spaces in some deprived neighbourhoods in Canada. While the causes for neglect are unclear, there is a need for strategies that support community reclamation of public spaces in order to maximize opportunities for health benefits. Strategies include proper lighting, sanitation, and repair commensurate with intensity of use, on-site community based programming, and community-driven activities and celebrations.

Table 3. Studies on neighbourhood design and health equity

Reviews	Method and context	Findings
Gelormino[32]	Scoping review and explanatory framework design of 23 studies of individual-level inequalities related to the built environment	▪ Proposes three mechanisms through which the built environment might influence health and its social distribution according to the literature: 1) neighbourhood density, 2) provision of public spaces and 3) services provided. ▪ Reported evidence of significant individual-level health inequalities related to the built environment: 1) *Air pollution* (stronger pollution-mortality associations for people of low SES, even adjusting for behavioural and occupational risk factors, 2) *Heat exposure* (greater vulnerability related to lower SES, social isolation, lack of green spaces, access to air conditioning, and clinical frailty in the elderly increasing cardiovascular risks and distress from pre-existing respiratory conditions and socioeconomic inequalities in mortality), 3) *Water pollution* (single study found that females, children, older adults or those residing in low income areas are associated with higher risk, 4) *Noise exposure* (equivocal evidence of greater risk among lower SES groups, 5) *Physical activity opportunities* (reduced opportunities among lower SES groups, particularly low SES seniors, and increased probability of almost never walking, cycling and gardening in disadvantaged neighbourhoods, partly explained by a poorer urban design) 6) *Green space exposure* (health benefits appear stronger among urban and lower SES), and 7) *Food access* (greater access to unhealthy food sources among lower SES groups) ▪ Built environment influences health inequalities in two main ways: 1) people of lower social position who live in more deprived areas are more exposed to the health damaging mechanisms and 2) health status of socially disadvantaged people may reduce the resilience to health damaging factor.

Reviews	Method and context	Findings
Christian[35]	Scoping review of 32 quantitative studies to understand population –level association between neighborhood built environment (safety, facilities, services, housing density, quality of streets and outdoor home area) and early (0–7 years) child health development	▪ Strong empirical evidence of positive association between children's outdoor play and physical activity and the presence of safe and green neighborhood places to be active. ▪ Some evidence that child relevant neighborhood destinations and services are positively associated with physical health and well-being and social competence, and negatively associated with children's vulnerability to developmental delay. ▪ Absence of population-level studies examining the impact of: 1) urban sprawl; 2) high density living, outdoor space and traffic exposure; 3) the outdoor home environment; and 4) nature and parks on early child health and development.
Blair[28]	Longitudinal (prospective cohort) study of the changes in neighbourhood deprivation on distress outcomes among 2745 urban adults of Canada's National Population Health Survey	▪ For persons living in neighbourhoods with low levels of material deprivation at baseline, a worsening of material deprivation was significantly associated with increasing distress scores at follow-up, when controlling for individual socio-economic and demographic characteristics, even after controlling for baseline distress scores and baseline neighbourhood social deprivation levels.
Cahuas[48]	Qualitative case study assessment of municipal planning process to reduce health inequities in Hamilton, Ontario (A total of 150 interviews and participant observation data)	▪ Community developers play an important role in navigating power differences and promoting equitable processes in order to advance the interests of low income residents. ▪ Community developers may be constrained or compromised by larger structural barriers related to competing municipal planning priorities. ▪ Residents were found to strongly influence the city by successfully developing neighbourhood plans – consistent with similar literature demonstrating how marginalized community groups can use participatory approaches to influence policy
Chircop[47]	Qualitative, ethnographic case study of the influence of the neighbourhood on everyday health decisions of low income mothers in Spryfield, Nova Scotia (data from 11 participants)	▪ Poor quality housing, poor access to healthy food for low income mothers is exacerbated by neighbourhood segregation and a lack of social infrastructure, namely neighbourhood-level regulated child care.
Masuda[45]	Community based participatory environmental health equity assessment in Vancouver, Winnipeg and Toronto (data drawn by 49 community	▪ Data synthesis from community researchers in three Canadian cities identified common themes of environmental health inequities in deprived urban neighbourhoods related to: 1) sanitation services, 2)

Reviews	Method and context	Findings
	researchers)	housing, 3) access and quality of parks and gardens, 4) art displays, and 5) community services. ▪ Reported health inequities were related to restrictive, segregating and discriminatory treatment of disadvantaged neighbourhoods.
Skinner[46]	Community-based participatory mapping study of place, health and rights among 8 Aboriginal youth in Winnipeg, Manitoba	▪ Aboriginal youth describe how physical and social threats experienced in their everyday urban life (through descriptions of derelict, unsafe, restrictive and limiting environments) convey negative health impacts related to social isolation, segregation and limited mobility.
Terashima[41]	Cross-sectional study of 11,233 adults to examine inequalities in chronic disease prevalence across urban and non-urban communities in Nova Scotia, 2007–2011	▪ Multi-level logistic regression showed that living in rural communities and towns was significantly associated with at least one of the four diseases (diabetes, cancer, stroke and heart diseases) in unadjusted models. Once other community characteristics were included, they remained statistically significant for heart disease and cancer, while they attenuated for diabetes and stroke. Living in towns remained a significant risk factor for heart disease (OR 1.47 95% CI 1.07 to 2.02); cancer (OR 1.42 95% CI 1.02 to 1.99); and four diseases together (OR 1.22 95% CI 1.00 to 1.5).
O'Campo[31]	Cross sectional study of neighbourhood effects on health and well-being among 2412 Toronto residents	▪ Neighbourhood disadvantage was consistently and significantly associated with poorer health – as disadvantage increased, health or health behaviour worsened for all measures of self-reported depression, anxiety, body mass index, general health, chronic health conditions and physical activity.

Reviews	Method and context	Findings
White[7]	Cross sectional study of neighbourhood deprivation and regional inequalities in self-reported health among 133,694 individual from the Canadian Community Health Survey	▪ Neighbourhood deprivation was a significant predictor of fair/poor health in all geographic regions (OR=1.11; 95% CI: 1.08, 1.14), The strength of association ranged from a 12–13% increased risk for each unit increase in deprivation in Quebec, the Prairies and Alberta to a high of 28% in British Columbia. Neighbourhood deprivation showed a strong detrimental influence on residents living on the Atlantic and Pacific coasts (Atlantic region and British Columbia; OR 1⁄4 1.21; CI: 1.10, 1.33; OR 1⁄4 1.28; CI: 1.18, 1.39, respectively). Neighbourhood-level variance remained significant for Ontario and British Columbia despite inclusion of several individual-level risk factors, suggesting regional variation at the neighbourhood-level that is not explained by the risk factors included in study models.

HEALTHY TRANSPORTATION NETWORKS

Healthy transportation networks prioritize safe and accessible transportation systems for all ages and abilities and incorporate a diversity of transportation modes (e.g., cycling, walking and transit). Health benefits such as reduced pedestrian and cyclist injury, increased physical activity, decreased obesity, and increased social connectivity are associated with safe, attractive and accessible transportation systems that prioritize active transportation.[1]

Strategies to support healthy transportation networks include enabling mobility for all ages and abilities, making active transport easy and safe, supporting the use of public transit, and enhancing the attractiveness of road, rail and water networks.[1]

Healthy transportation networks and health equity: review of the evidence

Database searching did not return any systematic or scoping reviews on inequities related to transportation systems. This section summarizes the findings of four Canadian studies published since 2010.

A longitudinal study by Pabayo et al.[26] explored trends in active transportation (AT) among children who come from low socioeconomic backgrounds. The study featured 710 children participating in the Quebec Longitudinal Study of Child Development from 2003 through to 2006. The findings indicate that children at age 6 years who reside in deprived neighbourhoods were more likely to use AT to get to and from school. Insufficient household income and having an older sibling were also predictors of increased AT. The study followed children as they progressed from kindergarten through to grade two and found that the likelihood of using AT remained unchanged as children aged. Although AT is largely perceived as beneficial for increasing physical activity, the study highlights that children from low socioeconomic backgrounds rely on AT because of the absence of other transport options, primarily a result of limited family income. The study results further indicate that low income children who rely on AT are more likely to be exposed to unsafe environments, such as dangerous traffic and unsafe neighbourhoods.

Pabayo et al.[26] report that their findings are consistent with previous studies that identified associations between increased likelihood of injury due to exposures from unsafe neighbourhood environments among children from disadvantaged backgrounds. This study is one of the few longitudinal studies and follows participants from early school years onwards. While the study does fail to consider individual-level variables to account for

Low income children who rely on active transportation are more likely to be exposed to unsafe environments, such as dangerous traffic and unsafe neighbourhoods.

parental car ownership, which are largely identified to be strong determinants of AT to and from school, it does feature objective measures of neighbourhood safety and the density of vehicle collisions, as well as other predictors of AT to and from school.

There is evidence that some sub-populations report greater barriers to walking than others but research is limited. Clark et al.[50] examined barriers to walking in Hamilton, Ontario through self-reported data from 179 randomly selected adults. Population sub-groups, such as females, older adults, people of lower socioeconomic status, and people with a higher body mass index were identified as likely to experience greater barriers to walking. These barriers are primarily related to safety, poor health status and physical disabilities. However the findings from this study were drawn from a small sample and do not directly examine how the barriers impact actual walking.

A cross-sectional study of associations between trends in transit access and socioeconomic status by Fuller et al.[51] reported findings that differ from results commonly reported from North American cities. The Montreal, Quebec area study found that in areas where residents have low levels of income and education, they also have significantly greater access to transit systems, such as the subway and bicycle share program. The authors propose that these unique findings may be due to local policies that limit concentrations of low income housing and prioritize equitable access to the subway and bicycle share program. The study featured a number of limitations. Measures of public transportation access did not account for the bus and commuter train network. Access was also only defined in spatial terms and did not consider the influence of other factors, such as affordability. The results of this study highlight a need for further investigation into transportation systems and land use policies to reduce social and spatial inequities in access to key services.

Healthy transportation networks and health equity: recommendations for action

1) **Prioritize supportive and safe active transportation (AT) in deprived neighbourhoods, particularly for low income children.** There is evidence that AT is more prevalent in deprived neighbourhoods, particularly among children. Children are a particularly vulnerable population as their health and well-being are largely subject to the circumstances of their environment. Pabayo et al.[26] demonstrate the persistence of poor safety and other social inequalities among children who use AT to travel to and from school as they age. Interventions to improve the safety and enjoyment of active transportation for children in deprived neighbourhoods may include: the organization of walking groups; safe street crossings, traffic calming techniques and enforcement measures, such as speed limit reductions; development of linear parks, multi-use trails, greenways and sidewalks.

2) **Ensure equitable distribution and affordable access to public transportation.** Fuller et al.[51] demonstrate that health equity can be improved through transit and land use policies that increase access to services. In Montreal, policies that discourage the concentration of low income housing and ensure the equitable distribution of public transit services across populations may be effective

interventions for reducing social and spatial inequities. Equitable access includes physical access, affordability, and efficiency. Further research is needed on how improved access to transportation systems (including cost, physical access and travel time) results in improved health outcomes as well as how it influences health behaviours such as physical activity.

3) **Prioritize needs of vulnerable sub-populations.** Barriers to access can have varying degrees of impact on vulnerable sub-groups. For example, Clark et al.[50] demonstrate that issues of neighbourhood safety may be more of a barrier for women and older adults than other groups. The barriers faced by vulnerable or disadvantaged community members (e.g., low income families, women, children/youth, those with physical disabilities or ill health etc.) should be prioritized by research, public health interventions, and urban planning and policy processes. Improving neighbourhood safety, street connectivity and barrier-free streets, sidewalks and public facilities should be prioritized, as well as increasing affordable transportation options to improve access for vulnerable or disadvantaged groups.

Table 4. Studies on healthy transportation networks and health equity

Canadian studies	Method and context	Findings
Clark[50]	Mixed methods survey of barriers to walking among adults in Hamilton, Ontario). Self-reported survey data from 179 randomly selected adults between the ages of 18 and 92 in Hamilton, Ontario	▪ More barriers to walking were reported by females (poor lighting, lack of safety, sun exposure, traffic), older adults (poor lighting at night, traffic, dangerous crossings, no one to walk with), lower SES groups (not in good health, have a physical disability, and no safe place to walk because of crime), and people with a higher body mass index (uncomfortable, poor health, sun exposure, poor health, sun exposure, traffic).
Fuller[51]	Cross-sectional study of associations between socio-demographic variables and access to the road network, public transportation system, and a public bicycle share program among 6,495 adult respondents from 33 areas of Montreal, Quebec	▪ Individuals with lower incomes lived significantly closer to public transportation and the bicycle share program. At the area level, the interaction between low education and low income neighborhoods showed that these areas were significantly closer to public transportation and the bicycle share program controlling for individual and urbanicity variables. Access was only defined in terms of distance. Financial costs were not considered in the definition of access.

Pabayo[26]	Longitudinal Study of 710 children participating in the Quebec Longitudinal Study of Child Development from 2003 through 2006, examining the combined influence of poverty and "dangerousness" of the neighborhood on active transportation (AT)	▪ At age 6 years, insufficient household income, having an older sibling, and living in a neighborhood that is "not excellent" for raising children, or characterized with high decay were predictive of greater likelihood of using AT and remained unchanged as children progressed from kindergarten through grade 2. ▪ Low income children who rely on active transportation are more likely to be exposed to unsafe environments, such as dangerous traffic and unsafe neighbourhoods.
Reyes[52]	Cross-sectional study of child walking accessibility to urban parks in Montreal, Quebec	▪ Variations in the walking mobility of children in Montreal to parks may be influenced by locality, gender, income, and family structure. Study mainly focuses on the potential of tool development to measure potential inequalities.

HEALTHY NATURAL ENVIRONMENTS

Natural environments are fundamental to health. Time in natural settings is associated with reductions in stress, chronic disease, depression, anxiety, as well as improved mental health, concentration and cognitive functioning. Green spaces help to cool surrounding air and surface temperatures and reduce smog and particulate matter. Greener neighbourhoods can help mitigate heat island effects, provide relief from extreme temperatures and have been associated with a decrease in heat related morbidity and mortality. Healthy built environments depend on natural spaces that are supported, protected and made accessible to all.[1]

Strategies to maximize the benefits of nature in the built environment include: preserving and connecting open space and environmentally sensitive areas; maximizing opportunities to access and engage with the natural environment; expanding natural elements across the landscape; and, reducing environmental pollution.[1]

Healthy natural environments and health equity: review of the evidence

The built environment can influence both the distribution of environmental benefits, such as green space, as well as the distribution of environmental burdens such as air pollution. Although knowledge of the extent of environmental disparities is fragmented and inconsistent, there is growing and consistent evidence that the health of socioeconomically disadvantaged groups is more affected by local environments than more advantaged groups. This means that there are many opportunities to support the health of low income or disadvantaged groups through local settings.

There is evidence that socioeconomically disadvantaged people and groups: tend to live in more deprived areas with greater environmental burdens; have poorer access to health supportive environmental amenities; and often show less resilience to environmental hazards. A recent scoping review by Gelormino et al.[32] documented significant associations between lower socioeconomic status and increased exposure to air pollution and heat as well decreased exposure to green space *(see Table 5 for list of studies)*.

Disadvantaged children may be particularly vulnerable. In 2010, a systematic review was conducted for the World Health Organization (WHO) expert meeting on "Environment and health risks: the influence and effects of social inequalities." The review examined 21 European studies of children published since the year 2000 and found that, although research is fragmented, there is a consistent pattern that children living in deprived social circumstances: 1) suffer from multiple and cumulative exposures both within the home (e.g., exposure to biological and chemical hazards, poor heat and air quality, insufficient sanitation), as well as within the neighbourhood built environment (e.g., increased probability of living near polluted areas, lack

of safe urban amenities and play areas, and derelict public spaces); 2) are more susceptible to the negative health impacts of environmental hazards; and, 3) often lack supports, such as access to health care.[12]

The topics of air pollution and green spaces have been the predominant focus of environmental equity research. A scoping review of 152 studies on air pollution and health inequity reported equivocal evidence on exposure disparities – while some studies report greater air pollution exposure associated with low socioeconomic status other studies have found greater exposures associated with higher SES, and others found no association between air pollution and socioeconomic status.[53] In Canada, emerging evidence from ecological studies in Montreal, suggests that a social gradient of air pollution exposure may exist.[54] Positive associations were found between social disadvantage and exposure to traffic-related air pollution. Meanwhile disadvantaged communities generated the lowest quantities of pollution.

Another ecological study from Montreal examined air quality near 319 Montreal elementary schools and found that students from socioeconomically disadvantaged backgrounds tend to attend elementary schools located in more polluted environments.[54] The author reported that nitrogen dioxide (NO_2) concentrations near elementary schools were positively and significantly associated with levels of deprivation at these schools. The study used traffic indicators to estimate NO_2 exposure, so the level of direct exposure to children is unknown.

Positive and significant correlations were also found between seven indicators of air pollution exposure and the percentages of the low income and visible minority residents at the city block-level in Montreal, suggesting modest disparities for these two groups. Visible minorities were found to have only slightly higher exposures than non-visible minorities. The authors report that their findings are consistent with those of two other Canadian studies conducted in Hamilton and Toronto.[54] It is suggested that the lower degree of ethnic residential segregation in large Canadian cities, compared with American cities, may explain the more modest inequities found in Canada. Overall, there is a lack of research into various zoning, land use and other policies that lead to disparities in some areas and not others, making it difficult to determine equity-focused policy mechanisms.

There are many opportunities to support the health of low income or disadvantaged groups through local settings.

Similar to air pollution, there is evidence that green space distribution may also follow a socioeconomic gradient. A recent systematic review of 66 epidemiological studies, on the influence of green space on health, reported that there is some evidence that lower SES groups have unequal access to green space, but not in all cases.[34] Among Canadian studies, there is emerging evidence of unequal exposure to green spaces. In Montreal, Pham et al.[55] found that socio-demographics are significantly associated with the distribution of street trees, especially the presence of recent immigrants (negative effect). Another Montreal-based study by the same author reported a significant positive association between vegetation cover and area income.[56] Notably, this study found that disparities were more pronounced for public lands, suggesting that there are

opportunities for local governments to address disparities through green space planning. Similar studies in other regions may help local governments determine priority areas for green space initiatives.

In Vancouver, Montreal, and Toronto, ecological studies found that income variables were significantly and positively correlated with vegetation fraction, suggesting that the higher an individual's income, the greater the chance that they live in an area with greater amounts of vegetation. The results show strong and consistent correlations between median family income and vegetation fraction in all three cities.[5]

Overall, in Canada there are still many gaps in the research on what populations may be more vulnerable to environmental health inequities. A recent scoping review of 78 Canadian studies published between 1993 and 2013 determined that the role of gender and ethnicity in influencing environmental exposure levels among non-Indigenous Canadians has not been adequately addressed to date.[57] This represents an important barrier to identifying and developing place-based priorities and policies to address health inequities. In addition, very few studies examine the planning policies or processes that underlie potential inequities. Only one Canadian case study examined procedural inequities in public participation to unwanted environmental burdens (in this case, a waste facility). The study reported processes of exclusion, mainly through inequitable public consultation procedures that deny residents the opportunity to challenge local planning and land use decisions.[18]

There is consistent evidence of stronger associations between green space and health among socioeconomically disadvantaged individuals

While research on the extent of environmental inequities is fragmented, there is consistent evidence that people of lower socioeconomic status (SES) experience greater health impacts related to their residential and neighbourhood environments than those of higher SES. A review by Gelormino et al.[32] reported significant individual-level health inequalities related to: air pollution exposure (stronger pollution–mortality associations for people of low SES, even after adjusting for behavioural and occupational risk factors). Another review of 152 European studies of inequalities in air pollution exposure and health found a general pattern that although deprived populations are not always more exposed to greater levels of air pollution, they experience greater harmful effects of air pollution, because of vulnerability factors, such as low incomes and poor housing quality.[53]

In terms of heat exposure, the review by Gelormino et al.[32] reported evidence of significant individual-level health and mortality inequalities for people of lower SES, related to social isolation, lack of green spaces, access to air conditioning, and clinical frailty in older adults. Similarly, in Canada, a cross-sectional study among a stratified representative sample of 3,485 residents of disadvantaged neighbourhoods of nine cities in Quebec, reported a high prevalence of heat-related health impacts in disadvantaged neighbourhoods (46%). Within these communities, female gender and long-term medical leave are two risk indicators in people <65 years of age. Low income and air conditioning at home are risk indicators at all ages. Perceived daily stress and the diagnoses of two or more chronic diseases are risk factors independent of age.[33]

For green space exposure, a systematic review of 66 epidemiological studies reports consistent evidence of stronger associations between green space exposure and health among low SES individuals.[34] Multiple studies of birth outcomes found stronger positive associations between green space exposure and healthy birth outcomes among mothers of lower SES. Increased green space exposure also appears to decrease the effect of income deprivation on all-cause and cardiovascular mortality and participants with the lowest levels of education had the largest benefit from green space exposure in terms of chronic obstructive pulmonary disease. The association between green space and reduced mortality is also strongest in the most deprived areas.[58]

Despite consistent findings from systematic reviews on the health benefits of green space among lower SES groups, there are very few community-based case studies to provide a deeper contextual understanding of this relationship. Only one case study of the health benefits of green space among a Canadian subpopulation was identified. Using a hermeneutical phenomenology approach to examining every day practices of seven immigrant families in urban green spaces in Montreal, Quebec, the study reported a consistent theme that access to natural spaces was protective against stress (from factors such as poor housing), providing emotional, physical and social supports.[36]

Healthy natural environments and health equity: recommendations for action

1) **Integrate strategies to address poor air quality, extreme heat vulnerability, and a lack of green space that tend to co-exist in deprived neighbourhoods.** Taken together, evidence in Canada shows a pattern of compounded inequity where socioeconomically disadvantaged communities tend to experience higher levels of traffic-related air pollution, greater heat-related health risks and a lack of green infrastructure.[5,44,59,60] This means that communities with greater heat and air pollution related health risks may also lack the protective benefits of green space such as air pollution mitigation, the cooling of air and ground temperatures and the provision of shade and sheltered areas. There is a need to integrate immediate term cooling and traffic calming strategies with longer term plans for expanding green spaces, reducing air pollution and improving housing quality.

2) **Expand and intensify diverse forms of accessible and connected green spaces in underserved and disadvantaged areas to support physical and mental health. There** is consistent evidence that the strongest associations between greenness and health are found among socioeconomically disadvantaged groups. In addition, emerging evidence shows income-based disparities in public green space provision in Canada. Taken together, the evidence points to an opportunity for local governments to address disparities and improve the health of deprived urban communities through green space strategies. More investigation is needed to help determine the mechanisms through which greenness can mitigate health inequalities. For example, it is possible that green enriched settings provide health benefits via the cooler, more filtered air provided, by reducing stress, by increasing social and physical activity or through a complex system of mechanisms. While the specific

mechanisms are still unclear, the evidence suggests that ensuring disadvantaged neighbourhoods are rich in greenness may help to reduce health inequalities. A variety of connected green spaces, even in densely built areas can cool ground and air temperatures, mitigate the urban heat island and filter the air.[61] Given these benefits, providing abundant green space in disadvantaged neighbourhoods may improve health and help to address growing evidence of disproportionate exposure to heat and air pollution by lower SES groups (in addition to other pollution mitigation strategies).

3) **Prioritize child-friendly natural environments by minimizing residential exposures to chemical, biological and physical hazards and maximizing opportunities for daily exposure to nearby natural settings and play areas.** Children do not have much control over their environment and are more vulnerable to environmentally mediated risks that can impact their life-long health. Children living in disadvantaged communities are often greatest at risk due to trends of increased environmental burdens (such as air pollution or poor housing) and a lack of supports (safe play space and access to nature) where they live. There is a lack of research on environmental health inequities among children.[12] Emerging evidence, such as the consistent relationship between maternal exposure to green space and healthy birth outcomes[34] emphasizes the need to incorporate a child-focused equity lens to improve environmental quality. Key strategies include: 1) upstream measures through zoning and planning that minimize child exposures to traffic and industrial pollution, maximize daily access to green space and ensures affordable, healthy housing; 2) training for child health and education professionals to recognize and respond to environmental inequities that impact children; and, 3) policies aimed at reducing children's susceptibility to specific environmental pollutants and risk factors through healthy food programs and physical activity programs in child care centres and schools.[12]

4) **Engage vulnerable and priority populations to help identify inequities or barriers to enjoying healthy natural environments.** The majority of health equity research related to the natural environment looks at differential impacts by income or socioeconomic status and there is very little research on the vulnerabilities, needs or priorities of populations based on age, gender, culture, disability or chronic disease.[57] In the absence of adequate evidence, there is a need to engage in processes that ensure that the perspectives and needs of vulnerable sub-groups are included in intervention planning. Community-based studies demonstrate the capacity of vulnerable sub-populations to identify inequitable practices as well as possible intervention strategies. Case studies demonstrate how community-based engagement, through various forms of health equity assessments and equity-focused impact assessments can help identify needs of specific groups[47], inequities of planning processes[18], sources of environmental inequities[45], and possible actions for local governments.[48]

5) **Examine local policies of settings where greater equity in green space access and air quality has been reported.** Policies aimed at reducing the structural causes of environmental inequities are

essential to the long term goal of healthy built environments for all communities. For example, potential biases in the housing market may explain why some subgroups suffer from both low socio-economic status and high exposure to air pollution.[53] It is also suggested that disparities in air pollution distribution are greater in the United States than in Canada due to less ethno-cultural segregation of housing in Canadian cities. Investigation into successful policies that prevent the neighbourhood clustering of environmental inequities is lacking.

Table 5. Studies on the natural environment and health equity

Reviews	Method and context	Findings
Gelormino[32]	Scoping review of 23 studies and explanatory framework design for individual-level inequalities related to the built environment (2000–2014)	▪ Reported evidence of significant individual-level health inequalities related to: 1) a*ir pollution* (stronger pollution–mortality associations for people of low SES, even adjusting for behavioural and occupational risk factors), 2) h*eat exposure* (greater vulnerability related to lower SES, social isolation, lack of green spaces, access to air conditioning, and clinical frailty in the elderly, increasing cardiovascular risks and distress from pre-existing respiratory conditions and socioeconomic inequalities in mortality), and 3) *green space exposure* (health benefits appear stronger among urban and lower SES groups).
Bolte[12]	Systematic review of 21 European studies published since 2000 on the relationship between socio-economic factors, children's environmental exposures, and/or environmental health	▪ Findings show common pattern that children living in adverse social circumstances: 1) suffer from multiple and cumulative exposures, 2) are more susceptible to a variety of environmental toxicants, and 3) often lack environmental resources/goods and other resources such as access to quality health care to counterbalance environmental harms. ▪ Evidence on the relationship of socio-economic position and exposure to chemicals is scarce in Europe. One exception is lead: overall, recent reviews of data in Europe showed that children from families living in adverse housing conditions or with lower socio-economic position have higher blood lead levels.

Reviews	Method and context	Findings
Chakravartty[57]	Scoping review of 78 studies published between 1993 and 2013 to determine extent, range, and types of studies of differential environmental chemical exposures among non-Indigenous Canadians as a function of gender and ethnicity	▪ The role of gender and ethnicity in influencing environmental exposure levels among non-Indigenous Canadians has not been adequately addressed to date.
Deguen[53]	Scoping review of 152 studies published before April 2009 of inequalities in air pollution exposure and associated health impacts in Europe	▪ Equivocal evidence on exposure disparities; while some studies found that low income people are more exposed to air pollution the reverse was observed in other papers. ▪ Twenty-three of 152 European studies investigated the effect modification of socioeconomic factors on the association between air pollution and health. In general, the current evidence shows that deprived populations, although not always more exposed, experience greater harmful air pollution effects (e.g., mortality, cardiovascular mortality, chronic disease, myocardial infarction events and asthma attacks). These effects are related to compounded vulnerability factors such as low income and health status related to low incomes, poor housing quality, and residential segregation in areas with greater exposures and fewer health supports.
James[34]	Systematic review of 66 epidemiologic studies on the health benefits of green space	▪ There is some evidence that lower SES groups have unequal access to green space. There is consistent evidence of stronger associations between greenness and health among individuals of lower SES. Lower SES groups may benefit more from greenness exposure that higher SES groups.
Pham[55]	Ecological study to understand how the built environment, socio-demographic factors and administrative boroughs influence tree and lawn cover in public and residential land. Montreal, Quebec	▪ Socio-demographics are significantly associated with distribution of street trees, especially the presence of recent immigrants (negative effect) and of university degree holders (positive effect).

Reviews	Method and context	Findings
Pham[56]	Ecological study to understand socio-demographic distribution of green space in Montreal, Quebec. Various vegetation indicators were extracted from high resolution satellite images, including the proportion of city blocks, streets, alleys, and backyards covered by total vegetation and trees/shrubs. Socio-demographic variables were obtained from 2006 Canada Census and rescaled to the city block-level, by using a population based weighing method	▪ Low income is significantly associated with lower exposure to vegetation in all models. Disparities are more substantial in public street vegetation than in private backyard vegetation. A significant negative relationship was also reported between visible minorities and trees/shrubs and public lands.
Bélanger[44]	Cross-sectional study of characteristics of a stratified representative sample of 3485 people who report their physical and/or mental health as adversely affected by summertime heat and humidity, within the most disadvantaged neighbourhoods of the nine largest cities of Québec (Canada)	▪ High prevalence of reported heat-related health impacts in disadvantaged neighbourhoods, with notable differences according to age, stress levels and long term medical leave, previously unmentioned in the literature. The total numbers of pre-existing medical conditions appear to be a preponderant risk factor. Within disadvantaged communities, female gender and long term medical leave are two impact risk indicators in people <65 years of age. Low income and air conditioning at home are risk indicators at all ages. Results for having ≥2 diagnoses of chronic diseases, particularly for people self-describing as in poor health (odds ratio, OR<65 = 5.6; OR≥65 = 4.2), and perceiving daily stress, are independent of age.
Carrier[62]	Ecological study of distribution of ambient air pollution among 319 Montreal elementary schools	▪ Nitrogen dioxide concentrations from near elementary schools are positively and significantly associated with levels of deprivation at these schools.

Reviews	Method and context	Findings
Carrier[54]	Ecological study to understand air pollution levels among specific social groups (low income population, visible minorities, children under 15 years old, and people aged 65 and older) at the city block scale in Montreal	▪ Positive and significant correlations were found between the seven indicators of pollution exposure and the percentages of the low income population and members of visible minorities. Moderate, positive associations between the proportion of low income individuals and: 1) the lengths of collector roads, arteries and express roads (r = 0.330, 95% CI: 0.312–0.347); 2) the total lengths of highways and secondary roads (r = 0.321, 95% CI: 0.304–0.339); and 3) the NO_2 level (r = 0.436, 95% CI: 0.422–0.453).
Deacon[18]	Qualitative case study analysis to understand the process(es) that may perpetuate environmental injustices, using in-depth interviews with 22 residents of Lincolnville, Nova Scotia regarding local environmental conflict over a municipal solid waste site	▪ Processes linked primarily to public participation are found to create and sustain environmental injustices by denying residents the opportunity to object to unwanted developments Inequities are found to stem from a lack of distributive and procedural justice as well as evidence of environmental racism.
Hordyk[36]	Hermeneutical phenomenology examining every day practices of seven immigrant families in urban green spaces in Montreal Quebec	▪ Families expressed common themes that activities in the natural environment serve as a protective factor in their health and well-being, and provide emotional and physical nourishment and greater social cohesion in the face of adversities such as inadequate housing and stress.
Sider[59]	Ecological study to determine land use and socio-economics as determinants of traffic emissions and individual exposure to air pollution in Montreal, Quebec	▪ Findings indicate inequities in the generation of and exposure to traffic-related air pollution. Exposure to emissions is positively associated with dense and walkable neighborhoods and negatively associated with car ownership and larger vehicles.
Sider[60]	Ecological study to evaluate socio-demographic distribution of traffic-related air pollution generation and exposure in Montreal, Quebec.	▪ Social disadvantage was found to have a significant positive relationship with exposure to air pollution ($p < 0.001$) meaning that the most socially disadvantaged communities tend to experience the highest levels of traffic-related air pollution.

Reviews	Method and context	Findings
Teschke[27]	Longitudinal study investigating the association between residential drinking water quality and the incidence of intestinal infectious disease in the Township of Langley in the Metro Vancouver area township (encompassing rural and urban areas)	▪ Variability in crude incidence rates of intestinal infectious diseases was greatest for age. The rates were consistently high among those under 5, whereas those in the oldest ages had more variable rates due to small numbers, especially among those over 90 years old for physician visits and over 70 years for hospitalizations. Those living in neighbourhoods with the two lowest household income quintiles had higher rates**.** Socio-demographic variables showed higher physician and hospitalization rates in females; the very young and very old; and in those in low income areas.
Tooke[5]	Ecological study of the distribution of vegetation according to socioeconomic status in Vancouver, Montreal and Toronto. Vegetation is estimated from satellite imagery. The relationship of vegetation estimates between cities and within each city is then quantified	▪ In all three study areas, income variables were significantly positively correlated with vegetation fraction, suggesting that the higher an individual's income, the greater the chance that they live in an area with greater amounts of vegetation. Variables representing education also demonstrate significant relationships with vegetation, but more variability can be observed between cities. Key results show strong and consistent correlations between median family income and vegetation fraction for Montreal (r=0.473), Toronto (r=0.467), and Vancouver (r=0.456).

HEALTHY FOOD SYSTEMS

A healthy food system is one that ensures healthy food is available and accessible to everyone. Healthy food system strategies include: enhancing agricultural capacity through the support of farmers and farms at all scales; increasing access to healthy foods in all neighbourhoods including schools and retail outlets; and, supporting community-scale food infrastructure and food services, such as community kitchens and gardens. Health benefits associated with these strategies include improved diet, reduced obesity, increased food skills, increased social supports, and strengthened community networks.[1]

Food systems and health equity: review of the evidence

In this review, the literature on food systems and health equity comprises two main categories: 1) studies of disparities in neighbourhood food environments and health, and 2) influences on food insecurity among low income community members. Studies on health equity related to farming, food production or cost of food were not identified and may be a limitation of the search strategy employed.

Neighbourhood food environments

Canadian research on socioeconomic differences in neighbourhood food access is sparse and equivocal, with little evidence of health impacts. A systematic review by Black et al.[37] offers the first synthesis of ten previous reviews to determine the evidence for socioeconomic disparities in the neighbourhood food environment. They report strong consensus among nine reviews that low income or minority neighbourhoods in the United States have disproportionally poorer access to healthy foods and greater access to unhealthy food outlets than residents of more affluent neighbourhoods. However, the evidence from Canada, Australia, and the UK is unclear. Canadian research reports a minimal difference in supermarket access in Edmonton, Alberta and abundant access to supermarkets in low income neighbourhoods of B.C. and Quebec.[37] There is some evidence of lower income neighbourhoods predominated by convenience stores in Ontario and that in Alberta, poorer neighbourhoods, as well as those with higher percentages of Aboriginal residents, have greater access to fast food outlets than more affluent neighbourhoods.[37]

Another systematic review of neighborhood disparities in healthy food access also reported equivocal findings from Canadian studies. Studies from Nova Scotia and Alberta found a significant association between socioeconomic deprivation and higher prevalence and accessibility of fast food restaurants, but a study of 862 census tracts in Montreal found no association between density of all types of fast food outlets and neighborhood income level.[63] These studies emphasize the need for geographic comparisons and the examination of local contexts when developing local food policies because food access and mediating factors vary by region.

The health impact of neighbourhood food environments is unclear. The systematic review by Black et al.[37], of nine previous reviews, reports weak evidence that greater availability of healthy foods was related to better dietary outcomes. In Canada, a cross-sectional study by Larsen et al.[39] examined the association between neighbourhood food environments and objective measures of childhood overweight and obesity among 1,035 grade 5 and 6 students in Toronto, Ontario. They reported that the distance to the closest supermarket was significantly associated to the odds of being overweight or obese in children. For children, living in a neighbourhood with a higher density of fast food restaurants or less healthy food outlets was not associated with the likelihood of being overweight or obese.

While the majority of studies on food environments are set in urban environments, one systematic review examined the impact of food interventions in a rural setting. Unique challenges in rural settings include, long distances that increase food costs and limit availability of fresh foods, poor responsiveness to cultural food preferences, and difficulties establishing local partnerships to develop community food strategies. The challenges were particularly prevalent among Indigenous communities in Northern Canada.

Among the rural studies, weight status was the only health outcome reported (examined in six studies). All six studies examined multilevel strategies that targeted individual-level behaviour change, policy, and environmental-level change that increased availability of healthy foods and discouraged consumption of sugar-sweetened beverages. Only one of the six studies reported reduced weight status of participants, two studies found that weight status increased, and the other studies found that weight status did not significantly change.[40]

A limitation of current studies is that most are ecological or cross-sectional in design, which means it is unclear whether the disproportionate distribution of food sources contributes to health inequalities. Overall, there is little evidence that differing food environments result in differential food choices or have any relationship with obesity.[37] Environmental and genetic causes of obesity may be confounders. In addition, other factors that may affect food consumption and health are income, access to transportation, food prices, psychosocial and physical health, home food preparation environments, and cultural preferences.[37] Further research on the influence of neighbourhood food environment, particularly prospective studies at finer scales, is needed to address the limitations of current studies and identify effective policy actions.[37,40]

Food Security

The literature on food security and health equity is vast. To understand ways in which health equity can be strengthened or compromised by food systems, Weiler et al.[64] completed a systematic meta narrative mapping review of 1,196 papers. They reported eight distinct pathways through which inequities in the food system can impact health (Figure 5). The authors report that equity in food systems can be advanced through multiple settings and contexts, such as promoting healthy school food systems, gender equity, nutrition, and addressing structural racism, in combination with longer term socio-political restructuring processes.

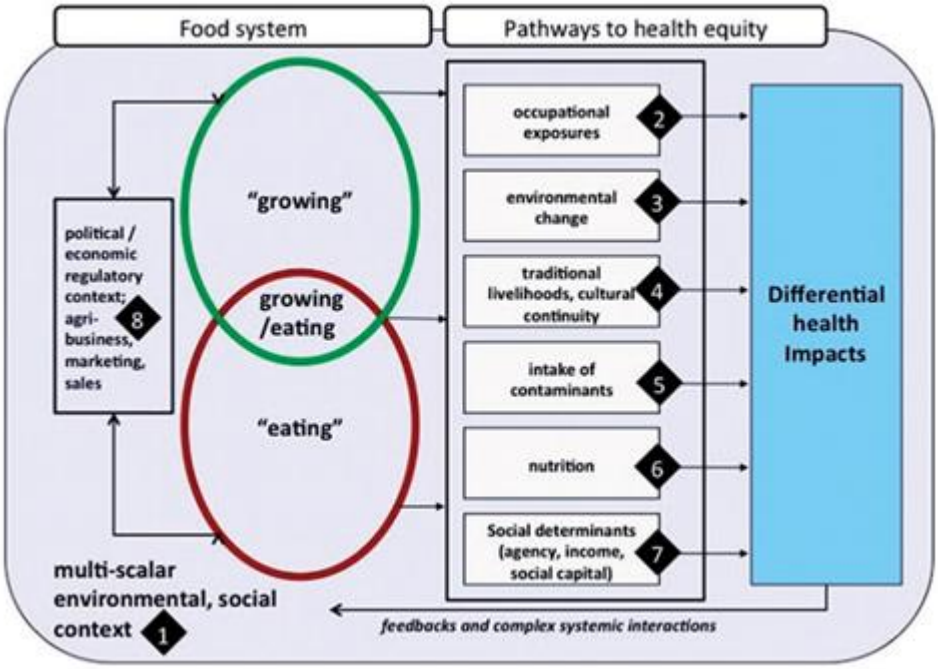

Figure 5. Pathways for health equity through the food system. "1—Micro- and macro-level social and ecological factors (e.g., global environmental change, cultural change). 2—Vulnerability to occupational hazards (e.g., pesticide exposure, musculoskeletal injuries due to factors such as weak employment standards protections). 3—Effects of ecological change on health equity (e.g., impact of fisheries depletion on coastal communities). 4—Threats to and revival of traditional food producer livelihoods and cultural foodways (e.g., with implications for a range of health determinants). 5—Ingestion of chemical or biological contaminants (e.g., either directly through human consumption or indirectly through effects on livestock). 6—Household food access and nutritional interventions (e.g., among impoverished communities). 7—Interactions with income and other social determinants of health (e.g., uneven effects of agricultural production and retailing). 8—Macro-level processes (e.g., trade liberalization, state welfare policies, foreign aid that affect agricultural production and food access)." (From Weiler, A.M., Hergesheimer,C., Brisbois, B., Wittman, H., Yassi, A., & Spiegel, J.M. (2015). Food sovereignty, food security and health equity: a meta-narrative mapping exercise. *Health Policy and Planning*, 30(8): 1078–1092. http://doi.org/10.1093/heapol/czu109.)

Among the multiple pathways for advancing health equity in food systems, household income, relative to housing costs, may have the greatest influence on food security for low income families. In a systematic review of 78 studies on environmental influences on food security, household income was the most frequently identified factor associated with food insecurity.[65] The review found that in low income households, adequacy of spending on food declines as relative spending on housing increases. The review reported some evidence that unsuitable housing standards such as a lack of storage facilities, cooking facilities, and home gardens are also related to food insecurity.

Emerging evidence in Canada supports previous evidence that income is a main determinant of food security. A cross-sectional study of 484 low income families living in rental housing in one of twelve high-poverty neighbourhoods in Toronto, Ontario was conducted to examine the association between household food security and neighbourhood features.[38] Food insecurity was pervasive, affecting two-thirds of families with about a quarter categorized as severely food insecure. Food insecurity was significantly associated with

low income. No association was found between family proximity to a supermarket (within 2 km) and whether they were food insecure. There was also no relationship between whether families incurred costs for transportation for grocery shopping and whether they were food insecure. Lastly, there was no significant association between social capital and household food security status. In sum, food security did not appear to be mitigated by proximity to food retail or community food programs and high rates of food insecurity were observed in neighbourhoods with good geographic food access.

In terms of the built environment, affordable housing may be central to addressing income related food insecurity. A cross-sectional study examined the influence of housing circumstances on household food security among 473 families in market rental (n=222) and subsidized (n=251) housing in 12 high-poverty Toronto, Ontario neighborhoods. Food insecurity was evident among two thirds (65.5%) of families. Among families in market rental housing, there was a significant association between food insecurity and the proportion of income allocated to shelter, indicating an increased probability of food insecurity as the proportion of income allocated to housing rises.[43] Among market rental families, the proportion of income allocated to housing was also significantly inversely associated with food expenditures and crowding was significantly inversely associated with housing costs. This study suggests that subsidizing housing costs may improve food security but prospective studies on housing interventions are lacking.

Food programs, such as community kitchens, community gardens, and food banks have also been examined as neighbourhood-level strategies to address food insecurity. Iacovou et al.[66] conducted a systematic review of 10 studies on the health benefits of community kitchens. Notably, the majority of studies were qualitative case studies from Canada. The synthesis of case studies, ranging from 6 to 82 participants, identified 4 main health benefits to low income and food insecure communities: 1) increased reported intake of nutritious food and food security; 2) increased self-reliance, dignity and engagement with community services; 3) improved social skills and, 4) increased skills, confidence and enjoyment in cooking.

Among these case studies was a participatory action research project that used semi-structured interviews and observational methods to assess the impact of a unique urban Aboriginal community kitchen garden project among 10 women in Vancouver B.C.. The participants reported that they were able to increase health promoting capacities related to cooking and growing food, as well as create health supporting social networks, particularly among longer term participants. While the sample size of this study is very small, it offers insight for reducing Aboriginal health inequities through an Aboriginal-led decolonizing health promotion approach.[67]

Despite the broader health benefits of community kitchens identified by case studies, cross-sectional research suggests that they have a limited capacity to resolve food insecurity because they do not substantially alter the economic status of households.[38,43,68] In addition, there is evidence that participation of low income families in community gardens, kitchens and the food box programs is very low. Of 317 low income families living in deprived neighbourhoods, only 12 families had participated in a community garden, 16 in a community kitchen, and four in a food box program. Reasons for non-participation were grouped

under two themes: 1) programs were not accessible due to location or a lack of knowledge of how to participate; or, 2) programs were unfit for families because they were not suited to busy schedules, interests, or needs (*community garden – not accessible 66.3%, lack of fit, 38.7%; community kitchen – not accessible – 65.6%, lack of fit 41. %; food box – not accessible 92.9%; lack of fit 9.5%).* These findings suggest that more research is needed to understand how local food programs can best meet the needs of low income and other vulnerable groups.

There is some evidence that there may be important differences between food bank users and participants of other community-based food programs. A cross-sectional study by Roncarolo et al.[69] examined differences among 824 people in Montreal, Quebec who use traditional food programs (such as food banks) and non-traditional food programs (such as community gardens and kitchens). They found that individuals participating in traditional interventions came from more food insecure households compared to those participating in alternative interventions. Individuals participating in traditional interventions reported significantly worse physical and mental health, compared to those participating in alternative interventions. Participation in alternative interventions was significantly associated with higher levels of civic participation, higher salaries, better education, and better self-reported health when compared to participants using traditional interventions. These findings provide some support to Loopstra et al.[68] findings that community kitchens and community gardens may not fit well to the needs of more food insecure households.

Affordable housing may be central to addressing income related food insecurity

While some evidence suggests food bank users may be more vulnerable to food insecurity than people participating in other programs, there is little evidence that food bank programs improve the food security of participants. A cross-sectional study of food bank use and household food insecurity among 371 low income Toronto families, found that only 23 percent of food insecure families reported using a food bank.[43] Over half of families experiencing severe food insecurity "chose not to use" food banks because: a) they felt the food was unsuitable food (22%); b) they did not identify themselves as a food bank candidate (12%); c) the felt degraded (11%); and d) they felt they "can manage on our own" (38%). The other 47% of food insecure families reported barriers to using food banks that included a lack of access and a lack of information. Among families that did use food banks, there was no evidence that the programs alleviated food insecurity. The findings suggest that food banks represent a "last resort"[43] (p506) for food but do not address chronic food insecurity. Despite the small sample size, the study authors note that their findings align with five previous Canadian studies.

The majority of food security research examines measures of income or SES, and few studies look at the needs of specific sub-populations. For example, food security and related issues of obesity among Indigenous children is a recognized public health priority, yet research of Indigenous children's perspectives and experience related to food is very limited.[70] This review identified one Canadian study of First Nations children's lived experience with food and food security issues in their rural reserve community. The study

reported that despite children's liking for fruits and vegetables and the importance of traditional foods, packaged, quick preparation foods played a dominant role in their everyday food experiences.[71] In general, there is a need for research that incorporates Indigenous knowledge and ways of knowing to address food insecurity.

This review of the evidence indicates a lack of research into strategies or interventions for addressing food insecurity among low income Canadians and other vulnerable populations. A lack of prospective studies or experimental data limits the interpretation and translation of case study results into food system policy. While income interventions through housing cost reductions appear to be an important strategy, other important pathways identified by Weiler et al.[64] are still underexplored in Canada, particularly in regards to Indigenous populations.

Healthy food systems and health equity: recommendations for action

1) **Maximize affordable housing opportunities for low income people and families.** Despite the need for more comprehensive research on multiple pathways for addressing food insecurity, evidence from reviews and Canadian studies indicate that household income, relative to housing costs is a central determinant of food security.[38,43,65,69,72] Public health advocacy to maximize affordable housing in community planning appears to be central to supporting food security for lower income residents. Other important avenues for freeing up food dollars for low income families include local, accessible, and affordable child care and local flexible employment opportunities.[47,72]

2) **Ensure access to affordable healthy foods in ALL neighbourhoods**. Canadian evidence of disparities in neighbourhood food access is sparse and equivocal. It is important to rely on local information and understand local needs to ensure all neighbourhoods have access to a variety of healthy, affordable, and culturally relevant foods. Support for smaller food retailers, farmers markets and small-scale commercial food producers may improve access to healthy, culturally relevant foods in neighbourhoods where larger retailers may be deficient or inappropriate.

3) **Involve community members, including vulnerable and priority populations, in the design of community food programs.** Low income people and families without adequate food are largely reliant on community-level charitable food assistance and community food programs**.** While there is growing interest in community gardens, community kitchens, and other food programs in Canada, the evidence suggests caution in assuming that these programs provide an adequate, accessible, or efficient way for families to meet their food needs.[68] Limited but consistent evidence shows low participation in these programs despite high levels of food insecurity. The involvement of vulnerable sub-groups among food insecure residents may help to develop more relevant programs that also address the stigma and barriers to access identified in the research.

4) **Support and evaluate a range community food programs.** Knowledge of the health benefits of community food programs to low income residents and other vulnerable groups is very limited. While evidence suggests that no single program can adequately address more structural causes of food insecurity, case studies document a range of health supporting benefits including social cohesion and opportunities to address specific ethno-cultural imbalances of more traditionally marginalized groups, such as new immigrants and Indigenous populations.[64-67] Analysis from a case study of equity in community garden policy in the city of Hamilton, Ontario provides an example of procedural frameworks that can maximize equity. The study reported that key aspects of equity included: fair distribution of gardens, stability and security of land tenure, and support for the affordability of gardening; provision of gardening support and education to enhance equity of access; and the need for increased autonomy and self-management.[73] Further research in the form of natural experiments may help to understand both the processes that confer health benefits and the differences in health outcomes among participants and non-participants in community food programs. This information may also improve understanding of the range of health benefits these programs provide, and how to maximize their relevance to specific sub-populations in disadvantaged neighbourhoods.

5) **Continue to evaluate and monitor the impact of neighbourhood food environments on health.** The current state of research on the health impacts of food environments in deprived or disadvantaged neighbourhoods in Canada is too inconsistent to inform specific policy interventions. Cohort studies that control for confounders are needed to better understand the impact of neighbourhood food environments on the health and weight status of low income communities and other vulnerable populations.

6) **Prioritize strategies to meet unique needs of rural and Indigenous communities.** Strategies include reducing travel distances to food sources, supporting cultural food preferences, and strengthening partnerships between food producers and distributers.

Table 6. Studies on healthy food systems and health equity

Reviews	Method and context	Findings
Gelormino[32]	Scoping review and explanatory framework design for individual-level inequalities related to the built environment (2000–2014)	▪ Reported evidence of significant individual-level inequalities related to food access (greater access to unhealthy food sources among lower SES groups).

Reviews	Method and context	Findings
Black[37]	Systematic review and first synthesis of 10 previous reviews to determine the evidence for socioeconomic disparities in the neighbourhood food environment and assess the evidence for effect on dietary intake	▪ There is consensus across nine reviews that residents of low income or ethnic minority neighbourhoods in the US have disproportionally poorer access to healthy foods and greater access to food outlets selling less healthy foods than residents of more affluent neighbourhoods. ▪ The evidence for differences in access to healthy food by level of area deprivation from other developed nations including Canada, Australia and the UK was equivocal. However, there was more consistent evidence for disparities in access to fast food outlets in these countries, with greater access in more deprived neighbourhoods. ▪ Evidence that greater availability of healthy foods was related to better dietary outcomes is weak and/or equivocal.
Weiler[64]	Systematic meta narrative mapping of 1196 papers related to food sovereignty, food security and health equity	▪ Research was mapped along a conceptual framework and eight pathways to health (in) equity through the food system were identified: 1—Multi-Scalar Environmental, Social Context; 2—Occupational Exposures; 3—Environmental Change; 4—Traditional Livelihoods, Cultural Continuity; 5—Intake of Contaminants; 6—Nutrition; 7—Social Determinants of Health and 8—Political, Economic and Regulatory context.
Calancie[40]	Systematic review of 29 studies (including four Canadian studies) to assess the effectiveness of policy and environmental obesity prevention strategies in rural settings	▪ Interventions commonly focused on increasing access to more nutritious foods and beverages or decreasing access to less nutritious options. Rural adaptations included accommodating distance to food sources, tailoring to local food cultures, and building community partnerships. ▪ Weight status was the only health outcome reported (examined in six studies). All six studies examined multilevel strategies that targeted individual-level behaviour change plus policy and environmental-level change that increased availability of healthy foods, and discouraging consumption of sugar-sweetened beverages. Only one of the six studies reported reducing weight status of participant's, two studies found that weight status increased, and the others studies found that weight status did not significantly change.
Hilmers[63]	Systematic review of 24 studies of neighborhood disparities in access to healthy foods and their effects on environmental justice	▪ 14 of the 24 studies reported a relationship between neighborhood deprivation and fast food outlet density. Among these Canadian studies from Nova Scotia and Alberta found a significant association between socioeconomic deprivation and higher prevalence and accessibility of fast food restaurants. A study of 862 census tracts in Montreal found no association between density of all types of fast food outlets and neighborhood income level.

Reviews	Method and context	Findings
Iacovou[66]	Systematic review of 10 studies (eight qualitative studies, one mixed method study and one cross-sectional study) on the social health and nutrition impacts of community kitchens	▪ Among the 10 studies, 8 are Canadian and examine groups with either low incomes or experiencing food insecurity. Synthesis of studies investigating the effectiveness of community kitchens as a health promotion strategy led to the identification of four health impacts: 1) increase in reported intake of nutritious food and food security; 2) increased self-reliance, dignity and engagement with community services; 3) improved social skills and, 4) increased skills, confidence and enjoyment in cooking.
Gorton[65]	Systematic review of 78 studies on environmental influences on food security in high income countries	▪ Household income was the most frequently identified factor associated with food insecurity. Housing costs are reported as the main expenses that take priority over food—in low income households, adequacy of spending on food declines as relative spending on housing increases. People who rent a home were at least two and a half times more likely to be food insecure than those buying or owning in two Australian studies. Literature contains some evidence that unsuitable housing standards, especially in relation to storage facilities and kitchen and cooking facilities are related to food insecurity. A study conducted in the US found that while having a vegetable garden contributed to the presence of more food in the house, it was not associated with food security (OR 0.92, 95% CI 0.48 –1.77).
Black[74]	Ecological study to assess associations between socio-demographic and urban planning variables with the availability of large supermarkets and stores selling fresh food within one-kilometre buffers from residential addresses across 630 census tracts in British Columbia	▪ Multivariate regression results indicated that neighbourhoods with higher median household incomes had significantly decreased access to food stores.

Reviews	Method and context	Findings
Genuis[71]	Photo-mediated community based participatory research to understand perspectives on food among 26 young children attending a rural reserve school in Canada	▪ Five primary findings were reported: 1) children had a dualistic understanding of healthy vs. unhealthy foods; 2) packaged, quick preparation foods played a dominant role in children's everyday food experiences; 3) families were critical to children's food-related experiences; 4) although traditional foods are viewed as central to Aboriginal health, few were depicted in the photographs; and 5) despite the smaller numbers of fruits and vegetables in photos, children reported that they like to eat these foods when they are available at home.
Holben[75]	Cross sectional study of 528 food bank users among four food banks in British Colombia to understand the self-reported food security status and produce intake associated with food bank users	▪ Among the sample of food bank users, fruit and vegetable intake were below Health Canada recommendations.
Jermé[73]	Case study analysis of equity in drafting a community garden policy in the city of Hamilton, Ontario	▪ Key elements of equitable policy includes: equitable distribution of gardens, stability and security of land tenure, support for the affordability of gardening; provision of gardening support and education to enhance equity of access, and the need for some degree of garden autonomy and self-management.
Kirkpatrick[38]	Cross sectional study examining the association between household food security and neighbourhood features of 484 low income families with children lived in rental housing in one of twelve high poverty neighbourhoods in Toronto, Ontario	▪ There were no associations between whether families lived within 2 km of the nearest discount super market and whether they were food insecure in either the unadjusted or adjusted model, although the effects of income, reliance on welfare and immigrant status on household food security status persisted. ▪ There was no relationship between whether families incurred costs for transportation for grocery shopping and whether they were food insecure or severely food insecure. ▪ There was no significant association between social capital and household food security status.

Reviews	Method and context	Findings
Larsen[39]	Cross sectional study of 1035 grade 5 and 6 students in Toronto, Ontario, examining the association between neighbourhood food environments and objective measure of childhood overweight and obesity	▪ Distance to the closest supermarket was significantly associated to the odds of being overweight or obese in children, while the density was not significant. ▪ For children, living in a neighbourhood with a higher density of fast food restaurants or less healthy food outlets was not associated with the likelihood of being overweight or obese. ▪ The distance to the nearest fast food restaurant or less healthy food outlet was also not a significant independent variable.
Loopstra[72]	Cross sectional study of food banks and household food insecurity among 371 low income Toronto families	▪ 23 percent of food insecure families reported using a food bank. ▪ Among those families experiencing severe food insecurity and did not use a food bank: o 53% "chose not to use" food banks (22% unsuitable food, 12% did not identify themselves as a food bank candidate, 11% felt degraded, and 38% felt they can manage on their own) o 47% identified barriers to using food banks (19% reported access and 18% reported information barriers)
Loopstra[68]	Cross sectional study of perspectives on community gardens, community kitchens and the Good Food Box program among 371 low income families in Toronto	▪ Of 371 families, 12 families had participated in a community garden, 16 in a community kitchen, and 4 in the Good Food Box program. Reasons for non-participation grouped under two themes: 1) programs were not accessible due to location or a lack of knowledge of how to participate; and 2) programs lacked fit for families, as they were not suited to busy schedules, interests, or needs.
Mundel[67]	Participatory action research case study using semi-structured interviews and observational methods to assess the impact of the Urban Aboriginal Community Kitchen Garden Project among 10 women in Vancouver. B.C.	▪ Participants reported increased health promoting capacities related to cooking and growing food, as well as health supporting social networks, particularly among longer term participants. Increased food related capacities and social support are seen as pathways for the Garden Project to positively impact health through a health promotion framework.

Reviews	Method and context	Findings
Roncarolo[69]	Cross sectional study of traditional and alternative community food security interventions among 824 people in Montreal, Quebec	▪ Individuals participating in traditional interventions (food banks) came from more food insecure households compared to those participating in alternative interventions (community kitchens and gardens). This holds true for both moderate (adj OR 0.15; 95 % CI 0.07–0.32) and severe food insecurity (adj OR 0.10; 95 % CI 0.05–0.21). ▪ Individuals participating in traditional interventions reported significantly worse physical and mental health, compared to those participating in alternative interventions. Participating in alternative interventions was significantly associated with higher levels of civic participation, higher salaries, better education and better self-reported health when compared to participants using traditional interventions.

HEALTHY HOUSING

Healthy housing is affordable, accessible for all and free of hazards. Differences in housing, such as quality, accessibility, and affordability can positively or negatively affect our health. Healthy housing is fundamental to good nutrition healthy relationships, good mental and physical health, and improved quality of life. Strategies to promote healthy housing include: support for affordable housing through provision of diverse housing forms and tenure types; ensuring good housing quality that includes proper housing structure, heating, insulation, and ventilation; prioritizing the housing needs of the homeless, older adults, low income groups, and people living with disabilities; and, siting and zoning to minimize exposures to environmental hazards.[1]

Housing and Health Equity: review of the evidence

There is evidence that lower socioeconomic status is associated with poorer quality housing characteristics both within and around the home. A European scoping review by Braubach et al.[76] assessed the evidence of social inequities in risk associated with housing and residential location. They reported that lower SES, especially low income, is strongly and significantly associated with crowding, increased exposure to environmental risks in the private home (e.g., exposure to dampness, mould, chemical contamination, noise, temperature problems and poor sanitation) and poor residential quality (e.g., traffic, traffic-related pollution and close proximity to industrial pollution).

Database searching did not return a systematic review of health equity and housing in Canada and in general, there is a lack of Canadian research into how housing influences health inequalities. There is some evidence that the proportion of income allocated to housing is significantly and inversely associated with food expenditures.[38] This means that for many low income families, compromises in housing quality are associated with food insecurity. The same study reported that living in subsidized housing does not appear to insulate families from poor housing conditions (particularly crowding) and positive associations were observed between living in a dwelling in need of major repair and food insecurity, suggesting that low income families make serious compromises in both food and housing needs. Limitations of this study include a small sample size (n=473), derived from only one Canadian city, and the reliance on self-reported data to assess housing quality. The authors suggest their findings may underestimate levels of crowding, or disrepair since respondents may be reluctant to report the actual number of people living in their home for fear of penalties from housing authorities.[38]

Poor housing has also been associated with heat-related health risks. A cross-sectional study of housing inequality and heat in Canada reported a high prevalence of heat-related health risk in disadvantaged neighbourhoods.[44] The study examined the dwelling characteristics associated with health effects from heat among 3,485 people in the most disadvantaged neighbourhoods of the nine largest cities in Québec,

Canada. Almost half of respondents (46%) reported that their health was adversely affected by summer heat due to uncomfortable temperatures inside their home and the perception of traffic-related air pollution. This is the first known survey to assess the burden of perceived heat-related health effects in deprived urban neighbourhoods in a developed country. The reliance on subjective self-reporting of heat related illness and the lack of similar studies limits the interpretation of findings.

Research is needed on specific actions to address housing inequities experienced by vulnerable or priority populations in Canada. One systematic review of the social determinants of health among Indigenous Canadians was identified. The review documents a higher proportion of Indigenous people in Alberta living in inappropriate housing conditions than non-Indigenous peoples (e.g., crowding, homes in need of significantly greater repairs, lacking smoke detectors and extinguishers, and lacking appropriate supports for people with physical disabilities). While inappropriate housing conditions have been associated with unintentional injuries, respiratory and infectious diseases, psychosocial challenges, and domestic violence, the review reported that overall, there is a need to identify key factors contributing to current housing status for Indigenous people in Canada, in order to address them and improve health equity.[77]

Studies on the effect on housing interventions on health are also limited. A small exploratory case study by Alaazi et al.[78] used in-depth qualitative interviews to explore Indigenous perspectives of place and health among 14 Indigenous participants in a landmark Housing First intervention in Winnipeg. Participants expressed some improved health and relative satisfaction with the intervention, mainly related to an increased sense of security, stability, sense of control and privacy. However, participants felt that broader structural factors, particularly the shortage of affordable housing and the lack of Indigeneity in the urban landscape adversely affected their health and sense of place.

Housing that is affordable to heat is linked to improved general health, respiratory health, and mental health and may also promote social relationships and reduce absenteeism from school or work due to illness.

Outside of Canada, a 2011 systematic review was conducted on five previous systematic reviews to assess the impact of housing interventions on health inequalities. The review explores housing and neighbourhood conditions along three pathways recognized for having an important influence on the social determinants of health: 1) internal housing conditions, 2) area characteristics, and 3) housing tenure.[30,79]

For area characteristics, the review reported strong evidence (randomized controlled trials and controlled and uncontrolled prospective studies from the United States and the United Kingdom) that interventions aimed at improving area characteristics, namely through housing vouchers, that allowed people to move from high to low poverty neighbourhoods, can improve mental health, reduce obesity, reduce health inequality, and improve determinants of health, such as self-reported experience of social disorder. However, the specific mechanisms that link these interventions to improved health outcomes are not well understood and it was observed that interventions to improve deprived areas may be more cost-effective, inclusive, and

have similar health impacts. Reductions in health inequality as a result of area-level improvements are difficult to track due to a lack of suitable comparison groups and difficulty in monitoring the complex components of interventions to identify mechanisms in health changes.[30] Data from nested qualitative studies suggest improved mental health and reductions in obesity may result from greater outdoor mobility because of safer neighbourhood environments. Overall, the review findings should be interpreted cautiously because the neighbourhood contexts in the United States are very different from Canada, particularly in regards to neighbourhood segregation, crime and violence.

Figure 6. Healthy housing pathways that impact the social determinants of health: a) internal housing conditions, b) area characteristics, and c) housing tenure. Acevedo-Garcia et al.[79]

For internal housing interventions, the review by Gibson et al.[30] reported strong evidence that improvements in warmth and energy efficiency result in positive health impacts to low income groups, particularly older adults or those living with an existing health condition (two European non-randomized prospective controlled trials and two New Zealand randomized control trials reported significant improvements in several general health measures). Evidence on the impact of other housing renovations remains inconclusive—among 72 studies that examined multiple pathway interventions, 49 reported a significant improvement in health outcomes. However, the specific nature of the interventions or health outcomes is not reported. While specific interventions are unclear there is some consensus the multiple-level interventions that target individuals, households, housing and neighbourhoods are most likely to be successful in delivering health gains.

It is important to note that no studies in any review examined interventions aimed at more structural causes of housing inequities, nor did any report on the third pathway (housing tenure), representing a significant gap in the evidence base for building healthy housing policy.[30]

A more recent systematic review adds further support to Gibson et al.'s[30] findings. Thomson et al.[42] review 39 studies and report strong evidence that interventions to improve thermal comfort are significantly associated with improved health, particularly in cases targeted at those with inadequate warmth or who have a chronic respiratory disease. The review found that the best available evidence suggests housing that is affordable to heat is linked to improved general health, respiratory health, and mental health, and may also promote improved social relationships and reduce absenteeism from school or work due to illness.[32]

Housing and health equity: recommendations for action

1) **Prioritize affordable and supportive housing in conjunction with adequate neighbourhood supports and amenities.** Affordable housing provides stability to low income families and allows them spend more money on food and other necessities, such as transportation. There is strong evidence from the UK and the US that housing subsidies for low income families to in live in less deprived neighbourhoods can improve mental health, reduce obesity, reduce health inequality, and improve determinants of health, such as social inclusion and support networks. There is some evidence that interventions that address neighbourhood deprivation may be more cost-effective and inclusive and have similar impacts as moving individuals to lower poverty areas. Therefore, to maximize health benefits there is a need for concomitant investments in affordable housing, adequate and accessible neighbourhood services, welcoming and safe amenities, and relevant social supports.

2) **Ensure affordable housing is also quality housing by investing in maintenance and retrofits that prioritize air and water quality, safety, climate control and accessibility.** There is growing evidence of disproportionate exposure to physical, chemical, and biological hazards through poor quality housing among low income and other vulnerable populations, including Indigenous people. There is also emerging evidence that housing conditions of lower SES groups make them more susceptible to heat related health risks. Disparities in the housing market mean that less expensive housing is often poor quality or even dangerous housing. This represents a serious health inequity, as health inequalities already associated with lower socioeconomic status are compounded by greater exposure to higher risk settings for families who may be more susceptible and least equipped to address them. There is strong evidence that health supporting retrofits, particularly housing that is affordable to heat, can improve general health, respiratory health, and mental health, and may also promote improved social relationships and reduce absenteeism from school or work due to illness.

3) **Involve low income and other priority groups in housing planning and decision-making, particularly older adults, Indigenous populations, people living with disabilities, and people who have experienced homelessness.** While the housing needs of vulnerable and under housed populations must be a priority, there is very little research on the unique priorities or barriers experienced by many vulnerable sub-groups and even less evidence on the health impacts of housing intervention aimed at supporting them. While rehabilitation of existing housing stocks and neighbourhood renewal are two main targets for action, inventions that are not responsive to the unique needs and barriers of vulnerable groups may deepen health inequities. In the absence of sufficient evidence, it is essential to develop avenues for vulnerable groups to contribute to housing planning and decision-making to ensure housing is not only safe and affordable but also conducive to other social determinants of health such as access to food, employment, and social supports.

4) **Ensure neighbourhood renewal strategies are planned in tandem with affordable housing and access to services to ensure low income renters are protected from displacement effects of gentrification.** Renewal strategies without parallel commitments to affordable housing, transportation and food can lead to further deprivation of low income residents if they can no longer afford to stay in the neighbourhoods they call home. Mechanisms include bylaw protection for renters when neighbourhoods are undergoing renewal or redevelopment.

Table 7. Studies on healthy housing and health equity

Reviews	Method and context	Findings
Braubach[76]	Scoping review to assess the evidence of social inequities in risk associated with housing and residential location in Europe (number of studies not reported)	▪ Lower social status, especially low incomes are strongly and significantly associated with increased exposure to environmental risks in the private home or related to residential location.

Reviews	Method and context	Findings
Gibson[30]	Systematic review of 5 previous systematic reviews to provide an overview of housing interventions on health inequalities	▪ Multiple-level housing and neighbourhood interventions were most likely to be successful in reducing health inequalities. ▪ Strong evidence that interventions aimed at improving area characteristics, particularly moving to areas of lower poverty can lead to reductions in the percentage of participants reporting depression and increases in the proportion reporting good or excellent health. ▪ Very strong evidence that warmth and energy efficiency interventions targeted at vulnerable individuals confer positive health benefits including. ▪ Lack of research on interventions aimed at altering housing tenure or structural causes of housing inequity; an important area for further research and evidence syntheses.
Kolahdooz[77]	Systematic review of 25 studies to understand the social determinants of health among Indigenous Canadians	▪ There is limited knowledge of factors contributing to current housing status and its impacts on health outcomes for Indigenous people in Canada.
Thomson[42]	Systematic review of 39 studies on the impact of housing improvements for health and associated socio-economic outcomes	▪ Strong evidence that warmth and energy efficiency interventions is significantly associated with improvements to general health, respiratory health, and mental health. ▪ Studies of interventions targeting those with inadequate warmth and existing chronic respiratory disease were most likely to report health improvement. ▪ Significant associations between warmth improvements and increased usable space, increased privacy, improved social relationships, and reduced absences from work or school due to illness. ▪ Health impacts following housing-led neighbourhood renewal are inconclusive.

Reviews	Method and context	Findings
Kirkpatrick[43]	Cross sectional study of 473 families in market rental (n=222) and subsidized (n=251) housing among 12 high poverty urban Toronto neighborhoods to examine the influence of housing circumstances on household food security.	▪ Food insecurity was evident among two thirds (65.5%) of families and among families in market rental housing, there was a significant association between food insecurity and the proportion of income allocated to shelter, indicating an increased probability of food insecurity as the proportion of income allocated to housing rises. ▪ Among market families, the proportion of income allocated to housing was also significantly inversely associated with food expenditures. ▪ Among market families, crowding was inversely associated with housing costs.
Alaazi[78]	Exploratory case study using in-depth qualitative interviews to explore Indigenous perspectives of culture, place, and health among 14 Indigenous participants in a Canadian Housing First intervention in Winnipeg	▪ Participants expressed some improved health and relative satisfaction with the Housing First intervention, mainly related to an increased sense of security, stability, sense of control, privacy, and self-worth. ▪ Broader structural factors, particularly the shortage of affordable housing and the legacies of assimilation and eradication of Indigeneity from the urban settings, adversely affect Indigenous peoples' sense of place and home.
Bélanger[44]	Cross sectional study of dwelling characteristics associated with the self-reported adverse health effects of heat among 3485 people in the most disadvantaged neighbourhoods of the nine largest cities in Québec, Canada	▪ 46% of respondents reported their health as adversely affected by very hot and humid summer conditions, mostly through physical health effects (CI:44.2–47.8). ▪ The prevalence of effects that led to a health professional being consulted was 11.9% (CI:10.7–13.0). ▪ Consulting a health professional for heat related illness was significantly associated with six variables: 1) dissatisfaction with the temperature inside the dwelling in summer; 2) a problem of air pollution in the neighbourhood according to the respondents, plus 4 confounding factors (prior diagnoses of chronic diseases, long term absence from work due to disability or sickness, state of health perceived as fair or poor and stress perceived daily or almost daily).

Gaps in research

It is not possible to provide an exhaustive list of research gaps across the many research disciplines represented in this review and many gaps were identified under the relevant built environment category of this report. This section highlights overarching gaps that require attention in order to support health equity in the built environment.

1) **Need for knowledge translation to support the evaluation of interventions.** While the scientific evidence examined in this review identifies key priority areas for improving health equity in the built environment, few studies identify or assess specific interventions or policy mechanisms to address them. The evidence points to who may be more at risk and what those risks may be, but it says less about what should be done. There is a need for inter-sectoral approaches to knowledge translation to relate the scientific evidence to relevant policy and planning contexts used by local governments, as well as a need for natural experiments and evaluations of interventions in order to support collaborative action on health inequities.

2) **Lack of research of vulnerable sub-populations.** Most studies examine health inequity through measures of socioeconomic deprivation and there is a lack of research into the unique needs of vulnerable sub-populations including older adults, low income children, Indigenous populations, newcomers to Canada, people living with physical disabilities or chronic illness and homeless populations. In Canada, the number of seniors is expected to double by 2033 from about 5 million to 10 million (medium growth scenario) with at least 75% burdened by a chronic health condition.[80] Currently Indigenous people in Canada have a life expectancy 12 years lower than the national average, experience higher rates of preventable chronic diseases than non-Indigenous Canadians and experience trans-generational trauma from past assimilation policies.[77] More inclusive, local and participatory approaches are needed to understand the lived experience of health inequalities and to identify pathways for action. This includes methods that incorporate Indigenous ways of knowing and concepts of health.

3) **Lack of analysis into the specific compounded neighbourhood characteristics that lead to health inequalities.** Many studies examine the overall socioeconomic status of a neighbourhood to study health. This approach fails to examine the full range of neighbourhood characteristics and physical resources that can either increase or decrease community health. For example, there is evidence that low income families face multiple health challenges related to food insecurity, poor housing quality, increased exposure to air pollution and heat, and decreased access to green space. This means that health inequalities associated with lower socioeconomic status are compounded by greater exposure to higher risk settings by people who may be more susceptible and least equipped to address them. More research and tools are needed to understand how the convergence of specific neighbourhood inequities impact health and how to address them.

4) **Lack of geographic (especially urban/rural) comparisons.** As demonstrated by White et al.[7] health inequalities require deeper examinations of the contextual determinants of health, including geographic differences across regions, such as urban and rural variations.

5) **Lack of research on heat-related illness and the built environment of deprived neighbourhoods.** The Canadian study by Bélanger et al.[44], was the first survey to assess the burden of perceived heat-related health effects in very deprived neighbourhoods of large cities in a developed country. This is surprising given the association between increased daily temperatures and increased counts of deaths, illnesses, and hospitalizations, particularly among older adults.[81] A review on heat–mortality relationships in cities found that in almost half of the locations studied, the risk of mortality increased by between 1% and 3% for every 1°C change in high temperature.[82] With growing heat waves in Canada, a rapidly growing aging population and evidence of heat-related health inequalities, strategies to provide relief from heat and heat stress are important to supporting health equity.

Review limitations

The vast heterogeneity of study disciplines, methods, topics and designs, makes direct comparisons of findings very difficult and therefore this review provides a synthesis of the overall scope of research as well as overall findings, trends, gaps and contradictions. Articles were appraised and accepted into the review if they met the basic quality criteria (see methods). Further assessment for bias or strength of evidence based on each of the varied study methods is beyond the scope of this review.

To manage the scope of this review, selected studies were limited to those published from the year 2010 to February 2016. The findings within this date range may not represent the full range of relevant findings that may have been found using a broader date range.

The subject of the built environment and health equity covers an enormous range of potential topics. Many research disciplines, such as planning and social work, study aspects of the built environment and health equity and use different terms than those used in public health research. As a result, our search may not have captured the full range of relevant studies and possible interventions that may support the health of vulnerable populations.

The evidence was categorized and summarized according to five distinct built environment categories, even though there is considerable interaction and overlap between them. While these categories assist to organize the evidence, strategies for action require an integrated approach where possible. For example, inequities related to housing clearly influence food security, air quality, susceptibility to extreme heat, and access to green space.

Lastly, this review is limited to empirical studies, which are predominantly outcome focused and either document observed measures of health inequities in the built environment or observed measures of health inequalities. While empirical studies generally help to show where inequities exist, and who may be affected, ideas for health interventions are often related to conceptual frameworks related to process, agency and social justice. Conceptual, theoretical and planning frameworks were not included in this review and may be essential to developing, testing and monitoring potentially transformative policy interventions.

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Appendix A – Search protocol and selection criteria

Inclusion criteria	Peer reviewed systematic or scoping reviews OR Canadian empirical studies on the relationship between the built environment and health equity published between the years 2010 and 2016. For this review the built environment encompasses five categories; these are: 1) Healthy Neighbourhood Design, 2) Healthy Transportation Networks; 3) Healthy Environments, 4) Healthy Food Systems and, 5) Healthy Housing.
Exclusion criteria	Non-empirical studies (theoretical or narrative articles that do not present original empirical data); Studies that investigate health equity but not connected to the built environment Studies that explore the relationship between health and the built environment but do not include an equity lens (i.e., do not explore difference between sub-populations) Articles written in languages other than English or French; Articles published before the year 2010
Keywords	health equit* OR health inequit* or health inequality* OR health equalit* AND (*Healthy Neighbourhood Design proxy terms):* built environment OR community design OR neighbourhood* OR connectivity OR land-use planning OR community planning OR playground OR recreational facilit* OR public space OR open space OR *(Healthy Transportation Networks proxy terms)* active transportation OR cycling OR bike lanes OR traffic OR public transit OR roads OR sidewalk* OR street* OR walkability OR accessibility OR mobility OR complete streets OR traffic safety OR *(Healthy Environments proxy terms)* green space OR park* OR garden* OR urban forest* OR nature OR air quality OR water quality OR waste OR sanitation OR contamina* OR toxic hazards OR chemical exposures OR heat OR heat island OR blue space OR natural space OR *(Healthy Food Systems proxy terms)* agriculture OR urban agriculture OR rural agriculture OR periurban agriculture OR community garden OR community kitchen OR food system

	OR local farming OR food insecurity OR food sovereignty OR food access OR food security OR food availability OR food retail OR food service OR farmers markets OR food stalls OR food stands OR produce stalls OR produce stands OR healthy corner store OR grocer* OR (community) food infrastructure OR institutional food OR school food OR food information OR menu label* OR food swamp OR food desert OR zoning and food OR bylaws and food OR *(Healthy Housing proxy terms*) hous* OR homeless* OR mold OR mould OR zoning
Electronic Databases (n= 4)	PubMed; Science Citation Index Expanded@ Web of Science; Social Sciences Citation Index @ Web of Science; Google Scholar
Quality Criteria	This review is designed to gather and draw from a very broad and diverse evidence base ranging from traditional epidemiologic studies to qualitative community based research. As a result, no single disciplinary appraisal standard can be applied, since each study would have to be assessed in its particular research tradition (see Wong et al 2013). Since time does not allow for such a lengthy process, articles were assessed based on meeting the inclusion criteria, and appraised further based on three key criteria (*drawn from Hannes, 2011*): a) *Credibility:* study must provide evidence of outside auditors or participants validating findings, such as peer debriefing or independent analysis of data by more than one researcher b) *Transferability:* study must provide details of the study participants and context, to enable reviewers to evaluate which target groups or context the study covers c) *Dependability:* study must provide clear documentation of methods with third party validation or peer review. Studies would need to meet all three of the above criteria to meet the quality standard of this review. Articles that meet all three criteria were rated as good quality and accepted into the review.

Appendix B – Studies by topic

Healthy Neighbourhood Design

Blair, A., G. Gariépy, and N. Schmitz. 2015. "The longitudinal effects of neighbourhood social and material deprivation change on psychological distress in urban, community-dwelling Canadian adults." *Public Health* 129 (7):932-940. http://dx.doi.org/10.1016/j.puhe.2015.05.011.

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Healthy Transportation

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Calancie, Larissa, Jennifer Leeman, Stephanie B. Jilcott Pitts, Laura Kettel Khan, Sheila Fleischhacker, Kelly R. Evenson, Michelle Schreiner, Carmen Byker, Clint Owens, Jared McGuirt, Ellen Barnidge, Wesley Dean, Donna Johnson, Jane Kolodinsky, Emily Piltch, Courtney Pinard, Emilee Quinn, Lauren Whetstone, Alice Ammerman, Stephanie B. Jilcott Pitts, Laura Kettel Khan, Sheila Fleischhacker, Kelly R. Evenson, Michelle Schreiner, Carmen Byker, Clint Owens, Jared McGuirt, Ellen Barnidge, Wesley Dean, Donna Johnson, Jane

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