



# Housing and Population Health



The State of Current Research Knowledge

# Housing and Population Health— The State of Current Research Knowledge

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## About the Canadian Population Health Initiative

The Canadian Population Health Initiative (CPHI), a part of the Canadian Institute for Health Information (CIHI), was created in 1999. The mission of CPHI is twofold: to foster a better understanding of factors that affect the health of individuals and communities, and to contribute to the development of policies that reduce inequities and improve the health and well-being of Canadians.

As a key actor in population health, CPHI:

- Provides analysis of Canadian and international population health evidence to inform policies that improve the health of Canadians.
- Commissions research and builds research partnerships to enhance understanding of research findings and to promote analysis of strategies that improve population health.
- Synthesizes evidence about policy experiences, analyses evidence on the effectiveness of policy initiatives, and develops policy options.
- Works to improve public knowledge and understanding of the determinants that affect individual and community health and well-being.

CPHI is interested in the impact of housing on population health as part of its focus on the relationship between place and health.

## About the National Housing Research Committee

The National Housing Research Committee (NHRC), established in December 1986, is an ongoing committee made up of federal, provincial, and territorial industry, social housing, and consumer representatives. Canada Mortgage and Housing Corporation (CMHC) co-chairs Full Committee meetings and most Working Groups, and provides a Secretariat function. The objectives of the NHRC are to:

- identify priority areas for housing-related research or demonstration,
- encourage greater cooperation,
- develop partnerships and minimize overlap in research activities,
- encourage support for housing research, and
- promote dissemination, application, and adoption of research results.

In addition to the Full Committee, the NHRC also operates through working groups to exchange information, discuss research gaps, and undertake research projects.

The NHRC became interested in population health and its links to housing in late 1999. Since then the Committee has set up a working group to look at the research potential of this topic. The group brings together researchers and practitioners, in housing and in health. One opportunity identified by housing practitioners was to summarize what research has been done to date in the area where housing and population health converge in plain language and in a format that could be used within the housing community and elsewhere outside the health field.

CPHI/CIHI, who are members of the working group, agreed to collaborate on this project with the NHRC and CHMC. While CPHI managed the research project, the NHRC Working Group on Housing and Population Health acted as the advisory group for the project and reviewed drafts of the report. The result of the collaboration is this research synthesis report.

## Preface

This research synthesis was written by Dr. Brent Moloughney, a lecturer at the University of Toronto in the Department of Public Health Sciences. The synthesis was commissioned by the Canadian Population Health Initiative (CPHI), part of the Canadian Institute for Health Information (CIHI), in cooperation with the National Housing Research Committee (NHRC).



## Executive Summary

Housing is the central hub of everyday living. It is a multi-dimensional concept that encompasses the characteristics of the house (physical structure and design); home (social and psychological features); and neighbourhood (physical and social characteristics, and local services). The central influence of housing on people's lives raises the possibility that housing could act as a pathway through which social and economic determinants of health influence population health. The purpose of this paper is to summarize what is currently known about the relationship between housing and health to inform policy development and the identification of future research priorities.

There is little doubt that shelter is a basic need for human life. However, beyond some specific population groups and settings in Canada, the relationships between housing and health that are currently being considered are focussed on the potential impact of *relative* degrees of housing deprivation. Numerous studies have found that residents of poor neighbourhoods suffer a diverse set of poorer health outcomes than those in richer neighbourhoods. It remains unclear, though, to what degree this association can be attributed to illness caused by poorer housing. A substantial challenge is that people living in poor housing often suffer a variety of deprivations, making assessment of the impact of any one risk factor on poor health extremely difficult.

Currently, the greatest level of evidence for the health effects of housing is for a variety of biological, chemical, and physical exposures. Many of these types of exposures can be readily measured and have well-established mechanisms for causing ill health. The strongest evidence for causal relationships exists for lead, radon, asbestos, allergens (house dust mites and cockroaches), and environmental tobacco smoke. A number of physical environmental factors also have strong supporting evidence: home safety, smoke detectors, and protection from extremes of cold and heat.

There are also a number of other housing characteristics that might influence health through a variety of psychosocial mechanisms. These include such factors as building type, floor level of apartment buildings, overcrowding, housing tenure (i.e. ownership), and housing satisfaction. There are currently a number of studies that provide weak, but inconclusive, evidence that factors such as these influence health.

Neighbourhoods are clearly associated with health outcomes of residents, but it is difficult to separate economic and social factors from housing-specific factors. Consistent associations have been observed between neighbourhood characteristics and child and adolescent well-being, including school readiness and achievement, behavioural and emotional problems, and sexuality and childbearing. Supporting evidence has begun to emerge from large-scale intervention studies in the United States that have shown improvements in housing quality, child behaviour, psychological and physical health outcomes, and lessened crime victimization following assisted relocation of families from high-poverty neighbourhoods.

Attempts to better understand the nature of the housing and health relationship have been stymied by weak research designs, flawed strategies for statistical analysis, and inconsistent results. Successful healthy public policies require adequate conceptual frameworks and plausible mechanisms linking socio-economic factors such as housing with health. A concerted effort would be required to address current gaps in knowledge and needs to involve the fields of housing and population health to identify priorities, sponsor research, and develop policy.

The following represent several areas for improved research on the housing and health relationship:

- More experimental and quasi-experimental studies of interventions;
- More comprehensive models to incorporate multiple exposures, multiple dimensions of housing, and an appropriate range of health outcomes;
- Inclusion of intermediate measures to further elucidate mechanisms;
- Longitudinal data to determine timelines of exposures and effects;
- Combination of quantitative and qualitative data collection;
- Data collection and analysis at multiple levels of housing, including at the individual, household, housing unit, and neighbourhood levels;
- More routine data collection on the housing and health relationship; and
- Greater multidisciplinary involvement.

Adequate support to implement these recommendations could result in a better understanding of how housing impacts health—and could form the basis for evidence-based housing policies to improve the population health of Canadians.

## Introduction

Housing is the central hub of everyday living. It is where one relaxes, entertains, sleeps, and raises a family. Housing influences the air that one breathes, the amount of individual space, the schools children go to, the financial pressures on the household budget, the availability of recreational space, and the safety and supportiveness of one's surroundings. These many interactions between housing and people's lives provide a multitude of ways that housing could affect health. The purpose of this paper is to describe what is currently known about the relationship between housing and population health and its implications for policy development and research.

## Population Health

Over the past few decades, health status reports have clearly shown that health is not equal among all Canadians.<sup>4-6</sup> Regardless of the measure of health chosen, there are differences among and within Canadian provinces and territories, and between different population groups. Health varies markedly with levels of education, employment, or income. These differences are not only limited to the extremes of the most rich and the least rich, but show a gradient across all levels. These observations have prompted the question of what makes some people healthy, and others not.

### Key Determinants of Health<sup>5</sup>

- Income and social status
- Social support networks
- Education and literacy
- Employment/working conditions
- Social environments
- Physical environments
- Personal health practices and coping skills
- Healthy child development
- Biology and genetic endowment
- Health services
- Gender
- Culture

It is increasingly understood that health is influenced by much more than simply individual health behaviours and the provision of health care services. A number of factors have been identified that, when present, contribute to good health and, when absent, increase the likelihood of ill health (see text box). The field of population health focuses on understanding how the determinants of health influence human development and contribute to health and health inequalities in order to inform action to improve health. While the list of determinants emphasizes the role of social, environmental, and economic factors in shaping human health and well-being, there are many unanswered questions regarding the pathways through which these factors shape the health status of individuals and populations. Housing's links to many of the determinants of health raises the possibility that it may be one of the pathways through which these determinants influence health.

## Housing

Housing is a multi-dimensional concept that is more than simply the provision of shelter.<sup>1</sup>

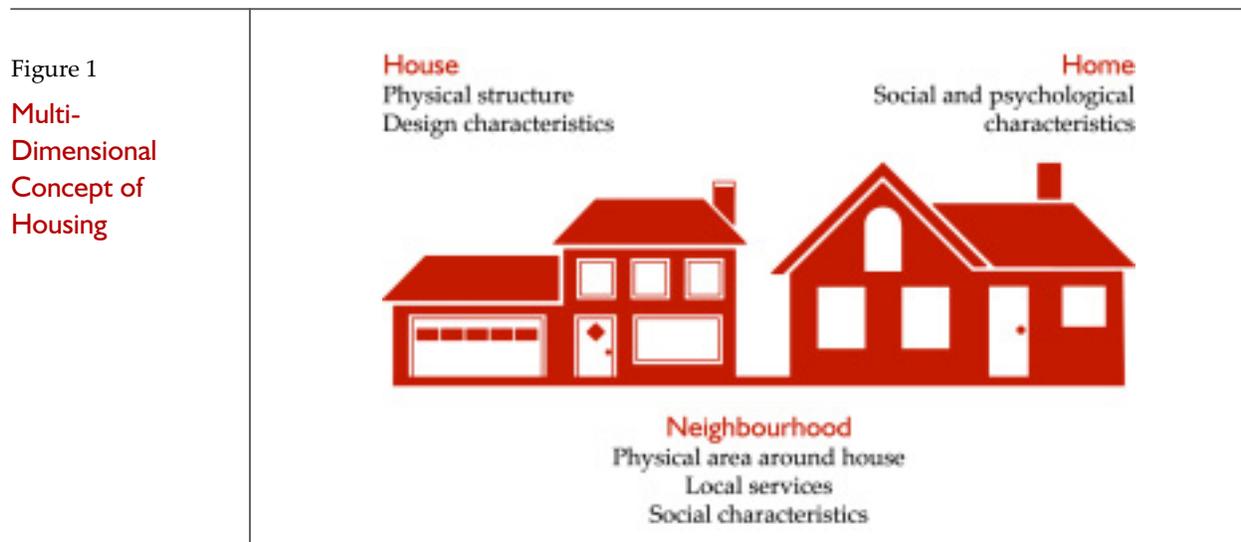


Figure 1 shows that there are at least three potential health dimensions of housing:

- **House:** The physical aspects of housing, which include the structural and design features, such as housing type, space, warmth, dryness, and fresh air.
- **Home:** The psychosocial dimension of housing, which includes concepts of security, control, sense of attachment, permanence, and continuity.<sup>7</sup> A home potentially has tremendous significance, as it is typically where people spend most of their time, is the venue for contact with the most important members of their social network, and often represents the most significant financial and personal investment of individuals and families.<sup>8</sup>
- **Neighbourhood:** The neighbourhood and community where housing is located, which influence the availability of health and social services, recreation, schools, and employment; the safety and security of people and property; and community norms towards a wide range of issues (e.g. child rearing, value of education, crime).

It is through these three dimensions that the health effects of housing need to be considered.

## Purpose and Scope of This Paper

The increased attention to population health and its focus on health inequalities makes the potential positive and negative health implications of housing a good choice for further examination.<sup>9</sup> There have been several recent reviews of current knowledge in this area.<sup>1, 8, 10-14</sup> The purpose of this paper is to summarize what is known about the relationship between housing and health for policy development and the identification of future research priorities.

The health and housing field is vast and diverse. This paper focuses on providing a high level overview of what is currently known about the population health effects of housing. There are many population groups that have group-specific health and housing inter-relationships. Examples include individuals with severe chronic mental health problems, those with significant physical disabilities and chronic conditions, as well as those wishing to die within their homes. Housing is an extremely important and complex issue facing Aboriginal peoples in this country, both on and off reserve. Homelessness is a concern across Canada, and the homeless face many threats to health and well-being that people who are housed do not face. The housing and health inter-relationship for each of these groups is substantive and has distinctive features. It was not feasible to specifically address the population health impacts of housing for these many groups in this paper, although they are discussed in greater detail elsewhere.<sup>15-22</sup>

The next section of this paper provides an overview of the evidence linking housing and health. This is followed by sections addressing specific components of the relationship and by a discussion of the current state of knowledge and areas requiring further attention.



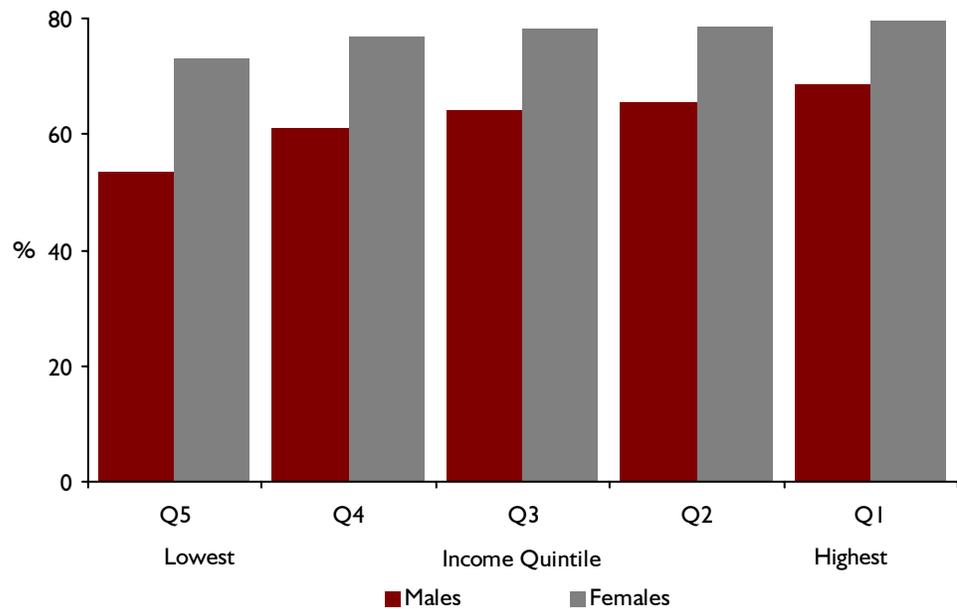
## Housing and Population Health: Describing the Relationship

Shelter has long been regarded as a basic need for human life.<sup>23</sup> Early public health interventions to provide clean water, ensure sanitation, and prevent pestilence were responsible for substantial gains in health. While these basic needs are not fully met in all settings in Canada, the relationships between housing and health that are currently being considered are substantially more complex than the provision of basic services. Instead, they are focussed on the potential impact of *relative* degrees of deprivation.

It seems almost natural to expect that housing interventions will not only improve housing availability, but also improve health, reduce social exclusion, reduce crime, improve safety and stimulate area regeneration.<sup>24</sup> Mere plausibility though, without evidence, is an insufficient basis for policy-making.<sup>25</sup> Interventions, particularly in complex systems, can have unforeseen effects. Outcomes may not be only neutral or positive, as the negative effects of some housing interventions have demonstrated.<sup>13</sup> For a given intervention, it is necessary to know how much good can be expected, at what cost, via what mechanisms, and for what population sub-groups.<sup>25</sup> Interventions need to be based on accurate research that identifies vulnerable sub-groups and the determinants that render these sub-groups at-risk.

Numerous studies have found that residents of poor neighbourhoods suffer a diverse set of poorer health outcomes than those in richer neighbourhoods.<sup>26</sup> These studies, whether based at a population or an individual level, form the basis for the recognition of the importance of socio-economic status (SES) on health. For example, in Canada, the probability of survival in 1996 to age 75 in males was 68.6% in the richest neighbourhoods and only 53.4% in the poorest (Figure 2).<sup>27</sup> For females, the probabilities were 79.7% and 73.0% respectively.

Figure 2  
**Probability of Survival to Age 75 by Neighbourhood Income Quintile, Urban Canada, 1996**

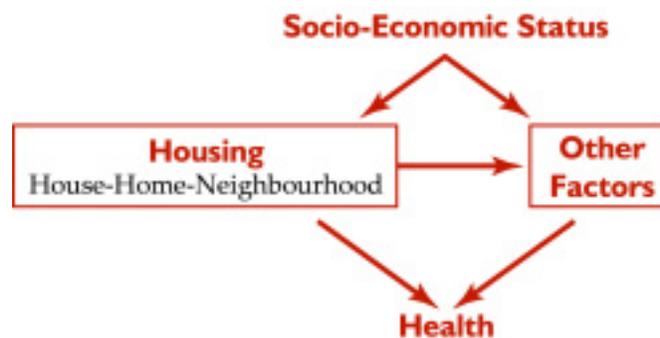


Source: R. Wilkins, J. M. Berthelot, and E. Ng, "Trends in Mortality by Neighbourhood Income in Urban Canada From 1971 to 1996," *Health Reports Supplement 13* (2002).

Household and neighbourhood SES levels appear to have separate effects on health outcomes, suggesting that the neighbourhood where one resides has an additional influence on health.<sup>28</sup>

While there is little doubt that persons occupying the poorest neighbourhoods have relatively high rates of illness, it is less clear how much of the association can be attributed to poor housing.<sup>29</sup> Part of the challenge is that people living in poor housing suffer a variety of deprivations, making assessment of the impact of any one risk factor on poor health extremely difficult.<sup>14</sup> SES clearly influences health outcomes and housing, but it is unclear to what degree housing mediates the SES and housing relationship (see Figure 3). Attempting to disentangle the effects of housing from other coexisting factors is a substantial methodological challenge. Inadequately designed research hinders

Figure 3  
**SES and Housing Relationship**



## Housing and Health: Association vs. Causality

There is no shortage of studies that have found an association between housing and health outcomes. An *association* means that two variables are statistically related. As one variable changes, so does the other. This does not necessarily mean that the change in one variable is *causing* the other to change. For example, home ownership is associated with better health outcomes.<sup>1</sup> It has been proposed that home ownership may give a greater sense of control and pride in one's home, leading to improved health. However, it could also be that homeowners are relatively wealthier than renters, better educated, have healthier behaviours, are not exposed to the stress of apartment living or public housing complexes, live in better neighbourhoods, etc.<sup>3</sup> Some of these other explanations, such as socio-economic status, are extremely powerful drivers of health status. Unless they are adequately assessed and controlled for, it is not possible to determine whether a particular association represents a causal relationship. The distinction between association and causality is of critical importance, since only an intervention against a causal factor will be able to influence the desired outcome.

the ability to distinguish mere statistical associations from the truly important causal relationships that are required for evidence-based policy development (see text box).

There are several reasons to suppose a relationship between housing and health. Housing is related to most of the determinants of health, including social support networks, quality of the physical environment, and healthy child development.<sup>1</sup> The potential of the psychosocial aspects of housing to have an important influence on health is suggested by the importance of such factors in other settings.<sup>10</sup> For example, in workplaces, the extent of demands placed on workers, the level of personal control to address the demands, and the presence of social supports have been identified as predictors of health outcomes.<sup>10</sup> The landmark Whitehall studies of British civil servants in London found that job class was highly predictive of dying of heart disease, even after controlling for all of the major risk factors for heart disease.<sup>30</sup> If the psychosocial aspects of the workplace can influence the risk of death, then, by analogy, one can begin to consider whether similar aspects within the home

environment can do so as well. Housing is associated with many concerns and demands (e.g. rent payments, crowding, noise, fear of crime), control issues (e.g. fear of eviction, lack of housing choices, lack of safe play space for children), and the presence or absence of social support.

Adverse exposures may not have immediate effects or affect everyone in the same way. There may be a lag time between exposure to adverse housing factors and the development of ill health. Even the age of exposure may be highly relevant. Studies have provided suggestive evidence that early life experiences can influence disease onset in later life.<sup>31</sup> The exposure to multiple negative influences early in life appears to affect the process of child development. Conversely, research suggests that higher SES buffers children from a variety of risks and vulnerabilities.<sup>10</sup> To fully assess the potential health impacts of housing, a longitudinal and life-cycle perspective is required.

The preceding paragraphs have outlined the reasons why a relationship between housing and health would be expected. The following sections of this paper will review the current levels of evidence for the health effects of specific aspects of housing.



## Biological, Chemical and Physical Exposures

The greatest level of evidence for the health effects of housing is for a variety of biological, chemical, and physical exposures.<sup>1</sup> Many of these types of exposures can be readily measured and have well-established mechanisms for causing ill health. For other exposures, their role in causing ill health remains unclear (Table 1).

Table 1	<b>Definitive/Strong</b>	<b>Possible</b>	<b>Weak</b>
<b>Strength of Evidence for Biological, Chemical and Physical Housing Exposures to Cause Ill Health</b>	Numerous or some well-designed studies showing the effect; most/all causal criteria met; preponderance of opinion among experts that a health effect exists.	Small number of studies showing the effect; some or few causal criteria met; no consensus among experts that a health effect exists.	Conflicting or negative evidence regarding the effect; few or no causal criteria met; consensus among experts that health effect is not proven or unlikely.
	<ul style="list-style-type: none"> <li>• Lead</li> <li>• Radon</li> <li>• Asbestos</li> <li>• House dust mites</li> <li>• Cockroaches</li> <li>• Home safety/stairs</li> <li>• Heating system</li> <li>• Smoke detectors</li> <li>• Environmental tobacco smoke</li> <li>• Cold and heat</li> </ul>	<ul style="list-style-type: none"> <li>• Urea formaldehyde foam insulation</li> <li>• Dampness/mould</li> <li>• Carbon monoxide detectors</li> <li>• Building type</li> <li>• Floor level</li> <li>• High-rise structure</li> <li>• Overcrowding</li> <li>• Volatile organic compounds</li> <li>• Housing tenure</li> <li>• Housing satisfaction</li> </ul>	<ul style="list-style-type: none"> <li>• Electromagnetic fields</li> </ul>

Source: S. Hwang, E. Fuller-Thomson, J. D. Hulchanski, T. Bryant, Y. Habib, and W. Regoeczi, *Housing and Population Health: A Review of the Literature* (Ottawa: Canada Mortgage and Housing Corporation, 1999).

## Lead

Lead exposures can come from a variety of sources, including lead paint chips and dust, older toys, drinking water, contaminated soil, and leaded gasoline. While lead paint and leaded gasoline are no longer used, contamination from these sources still remains. Children are more susceptible to lead exposure than adults, and ingestion can result in irreversible damage to intellectual growth and increased behavioural problems. This is further compounded by an increased risk for lead absorption in children with poor nutritional status. In the U.S., lead paint that has deteriorated into paint chips and dust is the most significant source of exposure. Lead exposure appears to be less widespread in Canada than the U.S., although reports of high lead exposures in certain neighbourhoods have been described, leading to recommendations for screening of children at high risk of exposure.<sup>32</sup>

## Asbestos and Radon

Asbestos and radon are recognized carcinogens, particularly for historical levels of exposures in occupational settings such as mining. The health effects due to asbestos found in buildings are difficult to quantify, but are thought likely to be extremely small.<sup>1</sup> Radon exposures vary in different parts of the country, as well as between homes. Less than 0.1% of Canadian homes have elevated radon levels,<sup>33</sup> and a large study conducted in Winnipeg found no increase in risk of lung cancer with radon exposure.<sup>34</sup>

## Electromagnetic Fields

Some types of exposures have generated considerable public concern and debate, despite the absence of clear health effects. For example, exposure to electromagnetic fields (EMF) has been a controversial subject for decades, but available evidence from several studies does not show a relationship between exposure and human health effects.<sup>1</sup>

## Urea Formaldehyde Foam Insulation

There is currently no consensus amongst researchers on whether there exists a causal link between urea formaldehyde foam insulation (UFFI) and health outcomes,<sup>1</sup> although current research is assessing a possible association between UFFI exposure and childhood asthma.<sup>35,36</sup>

## Dampness and Mould

Numerous studies have examined the potential association between damp housing conditions and respiratory ailments in occupants. The concept here is that increased humidity leads to increased mould growth and exposure, which could then lead to asthma and other respiratory conditions. The presence of home dampness and/or moulds has been reported to affect as many as 38% of Canadian homes.<sup>37</sup> Substantial problems have been identified in some First Nations communities due to a combination of

inappropriate housing design, poor construction, inadequate maintenance, and poor ventilation.<sup>38</sup> Children in particular appear more susceptible to exposure. A Canadian study found that children living in damp or mouldy homes were 32% more likely to have bronchitis.<sup>39</sup> The potential benefits of reducing mould in homes have not been evaluated.<sup>1</sup>

## House Dust Mites and Cockroaches

House dust mites (HDM) and cockroaches are examples of organisms that housing occupants can become sensitive to, resulting in worsening of asthma and other respiratory symptoms. HDMs thrive in the dust of homes, particularly in higher levels of indoor humidity. Cockroaches are implicated as a major cause of asthma among inner-city children in the U.S., resulting in increased hospital admissions, missed school, and unscheduled medical visits for asthma.<sup>40</sup>

The reduction of HDMs in houses requires substantive and comprehensive efforts. It is unclear whether these efforts provide sufficient benefit to be considered worthwhile by those who suffer from mite-sensitive asthma.<sup>41</sup> Part of the problem is that there are frequently multiple simultaneous exposure sources in homes (e.g. smoking, gas stoves, cockroaches, mice, mould, and heating systems), such that reducing just one exposure may not be of sufficient benefit.<sup>42,43</sup>

## Indoor Air Quality: Tobacco Smoke and Organic Solvents

There is a strong relationship between exposure to second-hand smoke in the home and serious adverse health outcomes, including lung cancer in adults and low birth weight, asthma, bronchitis, pneumonia, and ear infections in children.<sup>44-46</sup> Exposure to second-hand smoke is of particular importance, considering its higher prevalence in lower-income households.<sup>47</sup> Volatile organic compounds (VOCs) are also released into the air from most modern substances, such as furniture, rugs, and countertops. They are associated with exacerbation of respiratory symptoms, and other effects are under investigation.<sup>1, 48</sup>

## Temperature and Ventilation

Substantial shifts in indoor temperatures can be a health threat, particularly for vulnerable groups like the elderly, infants, the sick and the disabled.<sup>14, 49</sup> Excessive heat and lower winter temperatures are both risks for adverse health outcomes. Separating the effects of temperature from other aspects of inadequate housing is challenging. In one study, adverse health outcomes were not only associated with households that were unable to keep warm in winter, but also to worries about pressure at work and money.<sup>50</sup> Simply improving heat and cold in isolation of other health risks may not result in health improvements.<sup>51</sup>

The levels of pollutants and allergens in a home will be influenced by the extent of ventilation. The impact of improved home ventilation on health outcomes has not been well studied. For example, in one study, installing mechanical ventilation was associated with a decline in house dust mite counts, but had no impact on chronic asthma symptoms.<sup>52</sup> Researchers have suggested that houses need to be specifically designed for primary prevention of respiratory problems rather than using post hoc procedures to improve indoor climate as a secondary strategy.<sup>53</sup>

## Injuries

Existing studies document the importance of housing in the occurrence of injuries. Different age groups are at risk for different types of injuries and are vulnerable to particular hazards (e.g. small children and loose apartment window screens). Falls in the elderly are due to several factors, but modifying the physical environment is an important component of multi-faceted strategies to address this major cause of hospitalization and death.<sup>13</sup> Fire-related deaths are much more common in multi-disadvantaged neighbourhoods (i.e. less fire resistant housing, absent/defective smoke detectors, malfunctioning electrical and heating systems, use of space heaters and home-made heating devices, overcrowding, presence of vacant buildings, community disorganization, and less access to fire prevention services).<sup>54</sup> Interventions such as smoke alarms can reduce the risk of unintentional injury, although distribution of free fire alarms to high-risk communities has not been consistently associated with reduced fire-related injuries, due to a lack of either installation or maintenance.<sup>13, 55, 56</sup>

## Multiple Versus Single-Family Dwellings

Many studies have found an association between multi-dwelling housing and adverse mental health.<sup>8</sup> Many hypotheses have been suggested to explain this association, including social isolation in high-rise dwellings, lack of play space for children, fear of crime, and stigmatization related to building appearance. Some of this association may be caused by confusion due to the fact that SES is correlated with both housing quality and mental health.<sup>8</sup> Neighbourhood effects and housing tenure (i.e. ownership vs. renting) may also be factors. Several studies have found an association between higher floor level and poorer mental health.<sup>14</sup> However, similar to the studies of other potential causal factors, these studies suffer from weak research designs that do not control for all of the pertinent factors. The lack of inclusion of presumed intermediate variables (e.g. anxiety about falls/fires) creates uncertainty as to whether the observed association reflects a real causal relationship.<sup>8</sup>

## Density and Crowding

Individuals living in close proximity to each other will more easily spread infectious diseases. This was a major impetus to public health action on housing over a hundred years ago. There are still examples in particular settings where this is of significant concern in Canada (e.g. outbreaks of shigellosis and tuberculosis in Aboriginal communities).<sup>57, 58</sup> These studies of outbreaks on reserves find that increased housing density frequently co-exists with inadequate fresh water and sewage systems, low household income, and community isolation. Some 19% (almost one in five) of dwellings on reserves in Canada have more than one person per room, compared with 2% of dwellings for Canada as a whole.<sup>19</sup>

While household density has implications for the spread of infectious diseases, the subjective perception of crowding may also have an impact on mental health. This has been the subject of numerous studies, and, while many have found a positive relationship, some have not.<sup>11</sup> It appears that there are a number of contextual factors that influence the relationship—including the extent of other housing stressors, presence of social support, family responsibilities, and quarrels with family members.<sup>11</sup> There also appears to be a negative association between crowded apartment living and healthy child development.<sup>8, 59</sup> This is a complex area of research, and the studies performed to date have had difficulty unravelling the relative contributions of apartment living per se, versus crowding and other sources of stressors.<sup>1</sup> Lower housing density (i.e. isolation) can also be associated with high levels of psychological strain.<sup>11</sup> Lower housing density may reflect lower levels of social support and social networks leading to increased strain, but the lower density could also result from personality traits and psychological functioning that preclude close relationships.



## Social, Economic and Cultural Characteristics

The psychosocial dimensions of home and neighbourhood are potentially important pathways by which housing can impact health. This research area is less well developed and is further challenged by the need to assess the relative contribution of multiple inter-related factors such as income, social status, self-efficacy, social support, and community capacity.

### Housing Tenure: Ownership Versus Renting

Many studies have documented that home owners have better health than those who rent.<sup>3, 60</sup> It is unclear whether this association is due to the positive effects of ownership (e.g. sense of control, pride), versus ownership acting as a proxy measure of income and social status. Better designed studies are required to assess the relative contribution of several potential intermediate and confounding factors to provide greater insight into this association. These factors include economic, socio-demographic, and psychological factors, measures of housing condition, and the meaning of *home*.<sup>3, 61</sup>

### Housing Satisfaction

There are a number of studies suggesting that satisfaction with housing is associated with health.<sup>1</sup> Most of these studies have assessed satisfaction and health at the same time, so it is unclear which is actually affecting the other. Satisfaction may be influenced by a wide variety of factors, such as costs, perceived safety, play areas for children, structural quality, as well as the meaning and importance of housing to individuals and families. Satisfaction with housing could also be influenced by a person's health status. A better understanding of the nature and direction of the inter-relationships between housing satisfaction, health, and other factors would be useful.

### Housing Affordability

The affordability of housing is a potential stressor for individuals and families. Spending a greater proportion of household income on housing might be a mechanism by which SES influences health, since money spent on housing will not be available for other necessities (e.g. utilities, food, clothing, transportation, recreation). For example, in a study to improve housing quality during the Depression, the subsequent increases in housing costs led to worsening of health outcomes due to less available funds for adequate nutrition.<sup>62</sup> Examining only the proportion of household income spent on housing misses the other expenses within households and the decisions that individuals and families make to trade these off. Some of these costs may depend on the setting, as suggested by a California study, in which low SES families experienced higher mortality rates if they resided in high SES neighbourhoods compared to those who resided in low SES neighbourhoods.<sup>28</sup> Typically, a lower SES neighbourhood would exacerbate the negative effects of low individual SES and be associated with poorer health outcomes.

The authors of this study hypothesized that services were less accessible and affordable to the low SES families residing in the high SES neighbourhoods, leading to poorer outcomes.

## Neighbourhoods

Homes do not exist in isolation from their neighbourhoods. Long-term studies have observed that neighbourhood and community characteristics influence health outcomes, including mortality rates in residents.<sup>28</sup> There are also a wide variety of studies indicating consistent associations between neighbourhood characteristics and child and adolescent well-being, including:<sup>63</sup>

- School readiness and achievement;
- Behavioural and emotional problems; and
- Sexuality and childbearing.

Neighbourhood characteristics associated with these outcomes appear to be associated with institutional resources (e.g. quality, availability, and diversity of child care, schools, health care, employment, and recreation opportunities); relationships (e.g. parental characteristics, community support and behaviour, home quality and structure); and the norms and collective efficacy of the community (e.g. community institutions and informal efforts to support healthy growth, development, and behaviours of children and adolescents; and presence of physical risk in the community).

The increasing recognition of the health impact of neighbourhoods has prompted greater interest in the evidence for the effectiveness of community-level interventions.<sup>64</sup> There have been several studies that have found improvements in the mental health of residents associated with improvements in housing quality and neighbourhoods,<sup>65, 66</sup> but the absence of control groups prompts concerns regarding whether it was the actual housing changes that caused the improvement or some other unmeasured factor. While good quality evidence is not available for several types of interventions, increasing evidence is emerging on the impact of tenant-based rental assistance programs.<sup>67</sup>

Tenant rental assistance programs are based on the concept of assisting families to leave high-poverty neighbourhoods so that they can access private rental market housing in more affluent neighbourhoods. There have now been four large-scale tenant assistance intervention studies conducted in the U.S. These studies have provided consistent evidence of lessened crime victimization in the families who moved, and some studies have also shown improvement in housing quality, fewer behavioural problems (particularly in boys), and improved psychological and physical morbidity. The most recently published study is an evaluation of the Moving to Opportunity program in which families from poor neighbourhoods were randomly selected to receive housing vouchers (with or without relocation counselling) or to receive no intervention. Families who received housing vouchers and were provided counselling to find housing in a better neighbourhood had better health outcomes than those who did not receive

counselling, and both voucher groups had better outcomes than those who remained in the original neighbourhood. Further information on this program is provided in the accompanying text box.

There are some concerns relating to relocation programs regarding the idea that they may have adverse effects on the originating neighbourhood by removing the best functioning families, and the limits of housing markets to accommodate widespread implementation.<sup>67</sup> However, these issues have not been studied.<sup>68</sup> Ideally, one would be able to compare the relative cost-effectiveness of tenant rental assistance programs with other types of interventions. This will be possible only if

interventions are appropriately designed and evaluated, and if researchers take advantage of the many “natural experiments” that occur with ongoing housing interventions. For example, each time a new assisted housing development is opened or substantial changes are made to an existing development, a number of households will change from their current housing to a new housing circumstance. This forms the basis for making comparisons in exposures and health status before and after the housing change. Such a study is “natural” because the researchers do not initiate the intervention and it is an “experiment” because the researchers can assess the impact of the intervention on measures of housing and health.

## The Moving to Opportunity Project<sup>67</sup>

This is a large U.S. demonstration project in five cities in neighbourhoods with greater than 40% of households below the poverty line. Most families were single parent-headed households whose primary reason for relocating was to get away from drugs and gangs, and to achieve improvements in housing and school quality. Families were randomly allocated to three groups:

- Housing voucher, relocation to lower poverty neighbourhood, counselling assistance to search for housing;
- Housing voucher only; and
- No intervention.

Preliminary assessment after two years found improvements in the two intervention groups compared to controls for a wide variety of outcomes. The families who received counselling to find housing in another neighbourhood were more likely to do so and had greater benefits. Positive outcomes included children’s behaviour, injuries requiring medical attention, asthma attacks, security, and adult health. The analysis does not allow identification of the specific neighbourhood characteristics that produce the change in outcome, but rather the net impact of moves to better neighbourhoods.

## Interaction Between Potential Causes

The occurrence of ill health in association with poor housing is unlikely due to a single factor. Instead, the cumulative effect of multiple adverse exposures is likely important, and they can synergistically reinforce each other.<sup>1</sup> For example, children from low SES families are more likely to live in older, improperly maintained properties, leading to increased potential exposure to lead-contaminated paint, dust, and soil. Children with inadequate nutrition, who are more likely to be found in low SES neighbourhoods, are more likely to absorb and retain ingested lead. Within lower SES neighbourhoods, lead is but one risk to child development. Other risk factors include:

- Exposure to physical hazards (lead, cockroaches, mice, lack of or defective smoke detectors);
- Housing costs that impact availability of funds for other necessities;
- Chronic financial pressures that impact parenting behaviour/mood, affecting parent-child attachment;
- Exposure to violence/crime;
- Lack of safe outdoor recreation; and
- Lack of continuity and connectedness with community and schools due to frequency of moves because of housing insecurity.<sup>69</sup>

The increased frequency of infectious diseases in some Aboriginal communities provides an additional example of the interaction of exposures. A study of shigellosis on Manitoba reserves found that the First Nations population was 29 times more likely to become infected with this bacteria compared to the rest of the provincial population, and that this was due to the interaction of crowding, lack of running water and inadequate sewage disposal.<sup>58</sup> Most of the affected communities' water was trucked in or retrieved from standpipes; households used pails for indoor toilets; and they had an average of four or more people per household.

The co-occurrence and interaction of multiple exposures has implications for the extent of data collection required in research studies, as well as the need to consider comprehensive interventions.

## Vulnerable Populations

The preceding discussion has been focussed on the health impact of housing in general. There are several sub-populations that have unique housing needs and/or circumstances that would impact health-oriented housing policy development. There is insufficient space in this paper to attempt to describe the extent of housing issues faced by each of these groups. However, if housing has the potential to affect health in healthy populations, the following vulnerable groups are likely at even higher risk of adverse housing effects:

**Aboriginal peoples:** chronic problems of housing quality and affordability on and off reserve, poverty and housing discrimination within cities.<sup>10</sup>

**Individuals suffering from chronic mental health disorders and addictions:** appropriate housing is a major challenge for members of this group, who often face stigma and discrimination, resulting in less desirable settings, with crowding and safety issues (e.g. rooming houses).<sup>70</sup>

**Seniors:** multiple challenges include poverty for some seniors, high prevalence of chronic illnesses, social isolation, and risks of falls.<sup>71</sup>

**Individuals with disabilities or chronic illnesses:** appropriateness of housing options, costs for modifications, and potential social isolation.<sup>13</sup>

**Homeless:** difficulty of providing services, higher rates of mental health and addiction problems, exposure to risks of disease, violence, extreme weather, and lack of appropriate and accessible transportation.<sup>15,16</sup>

**Children:** the developmental stages of childhood and adolescence place them at risk of long-term physical and mental health effects from multiple adverse exposures.<sup>6, 63</sup>

**Women:** women are over-represented in many of these groups, including the frail elderly, women with disabilities, and lone-parent families (which are over-represented among the poor and working poor).<sup>72</sup>

The variation in needs and preferences across these and other groups requires a range of housing options to be available.



## Discussion and Author's Recommendations

Housing is an investment in physical, human and social capital and is important independent of any direct effects on health. However, if one wishes to make health-based housing policies and interventions, then the nature of the relationship between housing and health becomes highly relevant. Although improvements in the both the quantity and quality of housing are not certain to improve health, it is logical that they should do so.<sup>9</sup> Housing is a central focus of everyday life and is likely to influence the ways in which socio-economic factors impact health. Attempts to better understand the nature of the housing and health relationship have been stymied by weak research designs, flawed strategies for statistical analysis, and inconsistent results.<sup>73</sup> For example, studies assessing the relationship between housing characteristics and mental health have not taken into account other factors that might moderate the relationship and they generally have not assessed the underlying psychological processes that might explain how and why housing can affect mental health.<sup>8</sup>

The bulk of the existing evidence for the health effects of housing is for physical, biological and chemical exposures. This does not necessarily mean that these are the most important health-related housing factors, but rather that they are the easiest to measure and have understood mechanisms of action. The other dimensions of housing could be more important; however, better knowledge and evidence is required to make this assessment.<sup>11</sup>

Better research and evaluation data would identify which types of interventions are likely to have a greater health impact. Better data would also help to identify the impact of housing interventions on health relative to the impact of other types of intervention. If housing is a potential pathway by which SES influences health, then from a policy perspective, it would be helpful to know how much housing-focussed attention it would take to make measurable gains in population health independent of improving SES.<sup>11</sup> The policy implication is whether investment in better housing will be more cost-effective than more upstream interventions to increase the household income of individuals and families. The relative feasibility of different levels of interventions would also be a consideration.

The increasing attention to the determinants of health and inequalities of health outcomes in Canada and other countries is increasing the need for better information upon which to base decision-making. Successful healthy public policies require adequate conceptual frameworks and plausible mechanisms linking socio-economic factors, such as housing with health. This issue is critical if current social housing policies are increasing the prevalence of illness among the poor by concentrating them in neighbourhoods with relatively more hazards and relatively little social capital.<sup>29</sup> In other words, might assigning poor, but otherwise healthy, people to the least desired housing make them sick?<sup>29</sup> Similarly, to what degree can one expect individuals who are already ill (e.g. chronic mental illness) to improve if they also reside in the lowest quality housing?

The methodological challenges facing improved understanding of the housing and health relationship will not be met by conducting further studies with weak study designs. While it may never be possible to totally disentangle all of the inter-related factors, there is ample room for our current level of knowledge to be improved. The evaluation of the Moving to Opportunity project presents an example of a more sophisticated study design. The authors of the evaluation acknowledged that in the poorest of the poor neighbourhoods in the U.S., there are so many types of adverse exposure across all three housing dimensions that attempting to understand and change just a few was unlikely to be successful. Instead, they assisted families to move away from the exposures and, importantly, compared what happened to them with families who did not move. Assessing the impact of an intervention is one method to move from “association” towards “causality.” Not only is the Moving to Opportunity intervention based on what appears to be a plausible and consistent association, but it also allows researchers to assess whether the impacts occur as expected. This approach is similar to the actions of a London physician in the 1850s, who acted on an observed association between cholera cases and the water supplied by a particular water company—resulting in elimination of the outbreak (see text box).

### Moving From Association to Causality: Stopping a Cholera Outbreak in England

In 1854, London was experiencing a large cholera outbreak. A physician named John Snow performed a “natural experiment” by observing the rates of cholera in houses served by either of two different water companies. Most of the deaths were associated with one company, and removal of the company’s water pump handle resulted in the end of the outbreak. It is important to note that he did not know the exact mechanism of the outbreak, since the cholera bacterium would not be identified for another 30 years, and existing theories for cholera did not recognize sewage-contaminated drinking water. However, the existing evidence pointed to what the problem was; an intervention was made; and the results verified the observed association.<sup>2</sup>

A recent Canadian report by Dunn provides a framework for researching the health impacts of housing, including the identification of research questions across all of the housing dimensions. This report notes that a concerted effort is required to address current gaps in knowledge, including the following:<sup>10</sup>

- Multi-stakeholder involvement to identify priorities, sponsor research, and develop policy (this needs to include perspectives and expertise from the fields of housing and population health to maximize the opportunities for acquiring and using policy-relevant evidence); and
- Expanded research on housing and health in Canada (effective public policy requires evidence upon which to base recommendations and compare potential options; this requires an increase in capacity to support and perform housing and health research).

A common theme in Dunn's research framework and the many recent systematic reviews is the need for better designed studies. Key elements of these recommendations are summarized below.

**Need for more experimental and quasi-experimental studies of interventions:** Few studies have examined the effects of housing improvements on health, and the quality of the studies have been generally poor.<sup>12</sup> Housing interventions for non-health based reasons frequently occur. These are natural experiments that provide potential research opportunities to assess their impact on health.

**More comprehensive models are required to incorporate multiple exposures, multiple dimensions of housing and an appropriate range of health outcomes:** Most research has assessed individual risk factors. However, it is suspected that physical and social environmental exposures contribute to the link between SES and health through multiple types of exposures.<sup>74</sup> Causal models need to consider more than just a collection of individual risk factors and include the web of highly inter-related factors. More recent research is beginning to include measures of multiple potential exposures.<sup>75</sup> Comprehensive assessments need to continue and be expanded.

**Include intermediate measures to further elucidate mechanisms:** Measurement of theory-based intermediary measures is required to provide greater evidence that observed associations reflect actual causal mechanisms.

**Need longitudinal data to sort out timelines of exposures and effects:** Most housing and health studies have measured housing and health at the same time. Realistically, one would expect a time lag between many housing exposures and subsequent health effects. Households will need to be followed over time to achieve a better understanding of housing's effects on health.

**Need combination of quantitative and qualitative data collection:** The performance of quantitative research requires measurement of specific exposures and outcomes. However, understanding how housing characteristics influence health is still at an early stage for many exposures so that it is not always clear what questions should be asked. Qualitative research is needed to improve our understanding of how various factors, particularly social and psychological characteristics, interact for household members. This understanding can then guide the collection and interpretation of quantitative data.

**Need data collection and analysis at multiple levels:** The multi-dimensional nature of housing requires that data be collected and analyzed at the individual, household, housing unit (e.g. apartment, townhouse, duplex, single detached dwelling), and neighbourhood levels.

**Need more routine data collection on health and housing relationship:** Both the housing and health fields conduct routine population surveys. However, the housing surveys tend not to include health questions, and the health surveys tend not to include housing questions. These surveys, some of which are longitudinal, provide an opportunity for greater data collection in the future and collaboration on the development of pertinent questions.

**Need multidisciplinary involvement:** Existing knowledge is scattered across diverse fields of investigation.<sup>76</sup> Multi-disciplinary collaboration is required to integrate existing knowledge to design, conduct, and analyze new studies. A common understanding and vocabulary among disciplinary fields would facilitate the investigation of the relationships between housing and health. The importance of multi-disciplinary involvement is illustrated by an ongoing project in England assessing the relationship between health and the built environment by a group of architects, epidemiologists, clinicians and information scientists.<sup>77</sup>

Implementation of these recommendations will result in a better understanding of how housing impacts health and may form the basis for evidence-based housing policies to improve population health.

## Author's Conclusions

Housing plays a key and central role in the lives of Canadians. Although improvements in the quantity and quality of housing are not certain to improve health, it is logical that they should do so. The strong driving force of SES on the health of individuals and populations could be explained, at least in part, by housing. There are a multitude of potential pathways by which the three dimensions of housing (i.e. house, home, and neighbourhood) could influence health and contribute to the current inequalities in health outcomes among Canadians. An adequately supported, methodologically sound research initiative could improve our understanding of how housing influences health so that evidence-based housing policies might be used to improve the population health of Canadians.



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