HOUSING AND HEALTH OUTCOMES OF PUBLIC HOUSING APPLICANTS AND RESIDENTS: A POPULATION-BASED STUDY

By

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ABSTRACT

Public housing, a form of low income housing, is owned and managed by government. The goal of this research was to use linked population-based administrative databases to examine the associations among public housing and sociodemographic characteristics, health, healthcare use, and residential mobility. Four related studies were undertaken.

The first study determined the factors associated with applying to public housing. A cohort who applied in 2005 and 2006 was matched to a general population cohort. Individuals who applied tended to be in poorer health and were more frequent healthcare users compared to individuals with similar socioeconomic characteristics from the general population.

The second study tested the factors associated with moving out of public housing, while accounting for tenancy length. A cohort who moved in 2007 and 2008 was followed for seven years. Three groups were identified; voluntary movers, evicted movers, and non-movers. Socioeconomic characteristics of the cohort were associated with moving out voluntarily. Health and healthcare use were associated with eviction.

The third study describes healthcare use patterns in a cohort who moved into public housing in 2009 and 2010. Healthcare use was measured before and after the move-in date and the difference was tested. In general, there was an increase in use approximately three months before the move-in date and a decrease three months after. After this, use returned to pre-move-in levels.

The fourth study tested whether changes in healthcare use are unique to public housing residents. A cohort who moved into public housing in 2012 and 2013 was matched to a general population cohort and a move-in date was randomly assigned. Different types of healthcare use were measured before and after the move-in date. The public housing cohort used healthcare

services more frequently. For most healthcare measures, changes in use were similar between the two cohorts.

This research demonstrates that public housing is used by low income individuals who often have health conditions. This form of housing may represent a social safety net for users. Public housing can be used to deliver programs to improve health and wellness and address issues of housing instability.

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CHAPTER 1 : INTRODUCTION

Housing is a necessity for functioning in society (Bryant, Raphael, Schrecker, & Labonte, 2011), and is at the base level of Maslow's hierarchy of needs. Housing enables the provision of safe water, disposal of sewage, and protects against temperature extremes (Krieger & Higgins, 2002; Matte & Jacobs, 2000). It is connected to all aspects of life; aptly stated: "Housing fits in the middle of everything" (Manitoba Housing, 2009). Without housing it is difficult to obtain and maintain employment, attend school, be food secure, attend appointments, maintain health, and in general, to participate in society.

1.1 Housing is a Social Determinant of Health

Canada recognizes housing as a fundamental human right (Thiele, 2002) and a social determinant of health (Dunn, 2004). Social determinants of health are the "societal factors – and the unequal distribution of these factors – that contribute to both the overall health and existing health inequalities among Canadians" (Manzano & Raphael, 2010, p. 399). There are numerous models of the social determinants of health, all of which either explicitly or implicitly include housing (Bryant et al., 2011). In addition to health, the social determinants of health "determine the extent to which a person possesses the physical, social, and personal resources to identify and achieve personal aspirations, satisfy needs, and cope with the environment" (Raphael, 2009, p. 2). One Canadian model, developed in 2002, identifies twelve social determinants of health: Aboriginal status, disability, early life, education, employment and working conditions, food insecurity, health services, gender, housing, income and income distribution, social exclusion, society safety net, unemployment and job security (Raphael, 2009); it was later expanded to include disability and race (Mikkonen & Raphael, 2010). Housing is a nexus through which the other social determinants of health operate (Raphael, 2009).

1.2 Relationship between Housing and Health and the Theoretical Model

There is evidence that housing affects health. For example, in an ecological study, Jacobs, Wilson, Dixon, Smith, and Evens (2009) observed that housing trends coincided with health trends (e.g., housing age and lead poisoning, ventilation and asthma, community measures (noise, smells) and blood pressure). Using longitudinal survey data, Marsh, Gordon, Heslop, and Pantazis (2000) found that after controlling for covariates, individuals experiencing housing deprivation over time were at an increased risk of suffering from disability or severe ill health. Their housing deprivation index included the quality of housing as well as satisfaction with both the housing and the neighbourhood (Marsh et al., 2000).

In fact, many researchers have examined the connection between housing and health. The results of these studies are well illustrated by the conceptual model proposed by Hwang et al. (1999). Housing influences health in many ways (Mikkonen & Raphael, 2010), though the reverse is also true, health can also influence housing. We experience housing at multiple levels (individual, neighbourhood, community/social-structural) (Rauh, Landrigan, & Claudio, 2008) for different lengths of time over the life course. Hwang et al.'s (1999) model captures the two-way nature of this housing-health relationship as well as represents housing as a multidimensional concept that includes the physical structure, psychological and social components, the neighbourhood, and community, all of which may support or negatively affect health (see Figure 1) (Moloughney, 2004; Rauh et al., 2008).

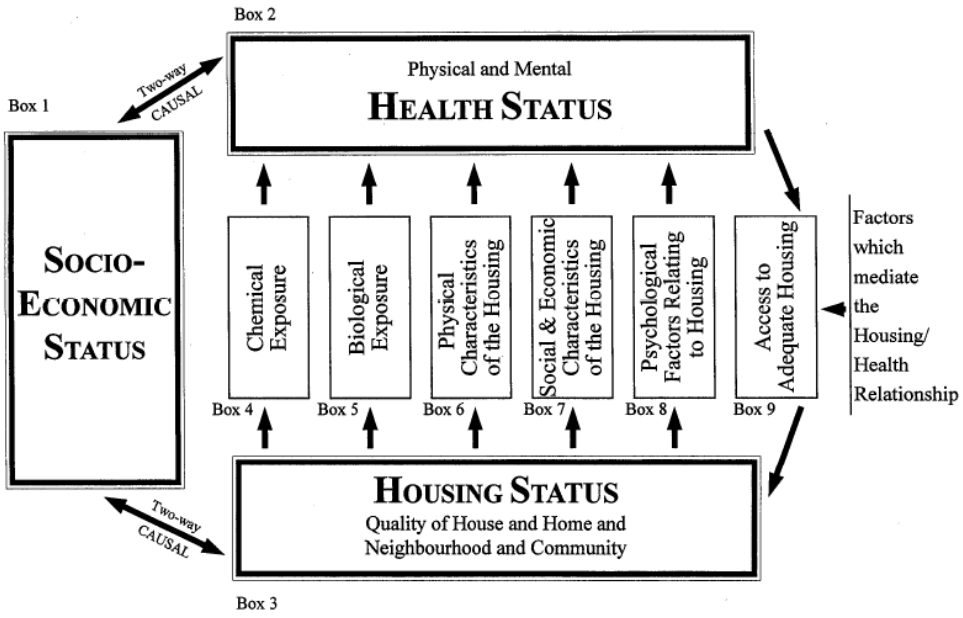

Figure 1-1. Conceptual model of the housing-health relationship

Individuals living in poor quality housing may be exposed to chemical (e.g., lead, radon, asbestos, formaldehyde, environmental tobacco smoke) and biological (e.g., dampness, mold, mites, cockroaches, mice) agents that negatively affect health (e.g., cancer, respiratory illness, cognitive functioning) (Krieger & Higgins, 2002; Matte & Jacobs, 2000; Moloughney, 2004; Rauh et al., 2008). Physical features of the house also affect health, such as structural defects, the presence of smoke and carbon monoxide detectors, heating systems, ventilation, insulation, storage, and overcrowding. These may contribute to injuries (e.g., falls, fires, poisonings) (Matte & Jacobs, 2000), respiratory illnesses, cardiovascular disease, cancer, and poor mental health (Krieger & Higgins, 2002; Moloughney, 2004). Psychological aspects of home pertain to the meaning of home (Moloughney, 2004); a place of shelter and refuge (Dunn, 2004), a source of stability, permanence, and safety (Dunn, 2004; Rauh et al, 2008), a source of pride and prestige or stigma (Dunn 2004), the foundation for family life and connection for social ties (Dunn 2004), and providing the inhabitant(s) with a sense of control and a level of satisfaction (Dunn, 2004; Moloughney, 2004).

Not only do features of the house and meaning of home affect health, but so do neighbourhood and community-level factors, including housing affordability, accessibility of health and social services, child care, food sources, recreation facilities, parks and green spaces, and schools; the availability of employment opportunities and transportation; residential stability and vacancy rates; migration; urban design and renewal efforts; pest control; utility costs; housing code regulations; norms about crime and safety; proximity to noise and emissions (Moloughney 2004; Rauh et al 2008, Dunn, 2004; Krieger & Higgins 2002). Exposure to health harming or health protective effects can occur at multiple levels and are not evenly distributed (Rauh et al 2008), making certain groups more vulnerable or at-risk (Krieger & Higgins, 2002; Raphael, 2009). The multiple levels of exposure/influence interact and "synergistically reinforce each other" (Moloughney, 2004).

Socioeconomic status is an intervening factor in this relationship that affects the type, quality, and location of housing individuals are able to obtain and maintain (Rauh et al., 2008). Housing affordability may be a source of stress and may affect one's ability to afford other basic necessities (Bryant et al., 2011; Krieger & Higgins, 2002; Moloughney, 2004). Individuals may or may not be able to afford repairs or to move to a better housing situation (Krieger & Higgins, 2002; Rauh et al., 2008). Wealthier individuals may have more knowledge about the harmful effects of exposure to various toxins and have greater capacity to address the problem than poorer people. Additionally, wealthier people are less likely to move when their health worsens. Low income individuals with health conditions, such as HIV and mental illness, may have difficulty accessing affordable housing and be more likely to move to poor quality housing. In summary, poor health may lead to poor quality housing and poor quality housing may worsen health. Poor health may exacerbate one's life situation (i.e., cannot work) (Hwang et al., 1999).

There is evidence that mortality and morbidity differ by homeownership. Compared to renters, home owners in Scotland reported better mental health and respiratory function, fewer chronic illnesses, and had lower blood pressure and a smaller hip-to-waist ratio. After controlling for age, sex, and income, all but blood pressure were significantly associated with homeownership status (Macintyre, Ellaway, Der, Ford, & Hunt, 1998). To tease apart the relationship between homeownership and health further, using Canadian data from the General Social Survey, Cairney and Boyle (2004) examined the relationship between psychological distress and housing status, where housing status was categorized as: renters, homeowners with a mortgage, and homeowners without a mortgage. They found that renters expressed the most psychological distress, while homeowners without a mortgage had the least, and this relationship persisted after controlling for socioeconomic characteristics (Cairney & Boyle, 2004). Bloze and Skak (2012) also found that Danish homeowners expressed less psychological distress than renters after controlling for socioeconomic characteristics, housing type, and distance to neighbours; however, this relationship was not significant for high income earners when the analysis was stratified by income (Bloze & Skak, 2012). Using linked Finnish data, Laaksonen, Tarkiainen, and Martikainen (2009) found that although the relationship weakened with the inclusion of various sociodemographic and housing wealth measures, there was a significant association between homeownership and mortality; specifically government subsidized renters were more likely to die than homeowners, but private renters also had a higher likelihood of dying than homeowners (Laaksonen et al., 2009). In a more recent Australian study, Tranter and Donoghue (2016) examined the relationship between various health measures and homeownership, where homeownership was categorized as: public and private renters, homeowners with and without a mortgage, and other housing. After controlling for various

socioeconomic and health measures, public renters and homeowners with a mortgage were more likely to be obese, public and private renters were more likely to report poorer general health, and public renters were more likely report a disability/illness and low levels of exercise than homeowners who own their home outright. Renters and homeowners with a mortgage were also more likely to report being daily smokers compared to homeowners with no mortgage. These results suggest a health gradient across homeownership categories, such that on average, public renters report the poorest health and homeowners without a mortgage report the best. A number of explanations are proposed, including the psychological benefits of homeownership (e.g., pride, sense of control, well-being), and housing is health selective (i.e., homeownership may not be feasible for people with health problems) (Moloughney, 2004; Smith et al 2003).

1.3 Social Housing and Public Housing

1.3.1 Social Housing and Public Housing Defined

Social housing is an umbrella term for housing subsidized by governments, which includes public housing directly managed by the government and housing run by cooperatives and non-profit organizations that receive government funding. Social housing is intended for individuals who cannot afford to live in adequate housing in the private market. According to the Canada Mortgage and Housing Corporation (2011), social housing may be "designed to promote community integration and wellbeing". In Canada, social housing represents about five percent of the overall housing stock (Mikkonen & Raphael, 2010) with public housing making up about two percent of the Canadian housing stock. The goal of public housing is to provide affordable quality housing to those in need, those who would be spending more than 30 percent of their income on housing in the private market (Mulligan, 2008). In public housing, rent is a percentage (less than 30 percent) of the before-tax total household income.

There are different styles of public housing, including low and high rise apartments, garden-style apartments, and detached and non-detached houses/townhouses. One study described public housing as barrack style buildings (Nebbitt, Lombe, Yu, Vaughn, & Stokes, 2012). Within a city, public housing may be clustered to form a community ('project') or be dispersed. Nebbitt et al's (2012) described public housing developments in three US cities as encompassing up to 10 square city blocks and housing up to 3000 families. In the Radburn Estate design, popular in the 1960s and 1970s in Sydney, Australia, the dwellings face each other around an open space with parking on the outside (Weatherburn, Lind, & Ku, 1999). Buildings may be designated as elderly only, for families, for individuals with disabilities, or for a mixed population.

1.3.2 Manitoba Housing

Manitoba Housing is the provincial department responsible for Manitoba's housing portfolio (CCPA MB, 2011). Manitoba Housing is mandated to:

a) enhance the affordability of, and accessibility to, adequate housing for Manitobans, particularly those of low to moderate incomes or those with specialized needs;
b) maintain and improve the condition of existing housing stock;
c) ensure there is an adequate supply of housing stock in Manitoba; and
d) stimulate and influence the activities of the housing market to the benefit of Manitobans as a whole (Manitoba Housing and Community Development, 2011).

Manitoba Housing owns 17,600 housing units and directly manages 13,100 of them (i.e., public housing). The rest (i.e., 4,500 units) are operated by property management agencies, non-profit groups, and cooperative sponsor groups (CCPA MB 2011). Additionally, Manitoba Housing provides subsidies to 17,300 households (CCPA MB 2011). In total, Manitoba Housing

provides subsidies or support to approximately 34,900 households through its housing programs (Manitoba Housing and Community Development, 2011) (CCPA MB, 2011). According to the Manitoba Housing website (http://www.gov.mb.ca/housing/mh/progs/pil.html#social), the eligibility criteria for receiving housing support include:

- Be a Canadian citizen, landed immigrant or refugee;
- Be a person 18 years of age or older;
- Be able to live independently in a self-contained unit;
- Have a good rental history including past and present landlord reference checks; and
- Meet the program income limits.

Income limits vary by geography and number of required bedrooms (based on National Occupancy Standards). For example, the income limit for a Winnipeg household requiring one bedroom is $35,000 and the income limit for a Winkler household requiring two bedrooms is $31,500.

1.4 Housing Policy

1.4.1 A Brief Summary of the History of Canadian (Social) Housing Policy

A brief description of Canadian housing policy is provided below; for a more extensive description and analysis, consult Carter (1997), Carroll and Jones (2000), and Leone and Carroll (2010). Canadian housing policy has been characterized as a series of six stages: economic development (1946 to 1968), social development (1968 to 1978), fiscal restraint (1978 to 1986), disentanglement (1986 to 1994), disengagement and privatization (1994 to 2001), and reengagement (2001 to the present) (Leone & Carroll, 2010). According to the CMHC (2011), social housing in Canada has been constantly evolving.

The federal government entered into housing in 1919 when it introduced a $25 million housing scheme. Funding for social housing was first addressed by the National Housing Act of 1938. The CMHC, founded in 1946, initially focused on helping war veterans find housing, but later became responsible for public housing programs (Leone & Carroll, 2010). Benny Farm, the first subsidized housing development was completed in Montreal in 1946, followed by Regent Park in Toronto. The National Housing Act was amended in 1949 and the public housing program was introduced. Between 1949 and 1963, 12,000 public housing units were built. According to Hulchanski (2002), "there was no significant federal role in social housing" before 1964. The NHA was amended in 1964. According to Carter and Polevychok (2004), the amendments to the NHA marked a change; until then, the federal government had "no clear announced housing goals". The amendments to the NHA created a "federally-funded, municipally-administered public housing program" (Hulchanski, 2002).

Provincial housing corporations were established in the mid 1960s to "take advantage of a revised federal public housing programme" (Wolfe, 1998, p. 122). In 1967, under the Housing and Renewal Corporation Act, the Manitoba Housing and Renewal Corporation (MHRC) was created. It "operates as a delivery arm for federal/provincial cost-shared social housing programs and other capital programming provided by the province" (Mulligan, 2008).

In Canada, approximately 200,000 public housing units were built between 1964 and the mid-1970s (Hulchanski, 2002). Key features of this period were cooperation between the three levels of government and growth in social policies. According to Hulchanski (2007), the social housing program was modest "because the broader policy objective was to leave as much of the housing system in the market sector as possible" (p. 1-2).

In the late 1970s to the mid 1980s, the federal government began to shift federally administered programs and services to provincial and municipal governments as measures of fiscal management and restraint. According to Leone and Carroll (2010), this period can be characterized as a "transition between strong federal control to weak or nonexistent federal control" (p. 396). From the mid 1980s to 1994, an era of disentanglement, there was limited overlap between the federal and provincial governments (Leone & Carroll, 2010). The lead role for the delivery and administration of new social housing was transferred to the provinces under a series of agreements in 1986 (Wolfe 1998). Interestingly, the federal government increased funding for social housing during this period. According to Carter (1997), "funding to subsidize the operation of the social federal-provincial housing portfolio surged to just over $2 billion in 1990" (p. 603). But, by 1993, the federal government had withdrawn most of their support for housing, no new housing units were being built, and in 1993, the federal government eliminated all new social housing commitments from 1994 onwards. This equated to approximately $2 billion being withdrawn from social housing between 1993 and 1998 (Carter & Polevychok, 2004). In 1992, there were approximately 652,000 social housing units in Canada. Before the federal government withdrew from housing, up to 10% of new housing built was earmarked for lower income households, but after, less than 1% of new housing was for low income households. It is not surprising that Leone and Carroll (2010) refer to this period as one of "divestment and disengagement".

In 1996, the federal government transferred the management of all social housing to the provincial housing corporations as a cost savings measure, and the federal government suggested that housing is a provincial responsibility (Carter & Polevychok, 2004). This included non-profit, cooperative, and public housing programs. Ontario passed on the responsibility for housing to

the municipalities (Carter & Polevychok, 2004). The Canadian Housing and Mortgage Corporation (CMHC) transferred responsibility for 17,500 social housing units under various programs to the Manitoba government in 1998. Responsibility for social assistance and social services was also transferred to the provinces/territories (under Canada Health and Social Transfer) (Mulligan, 2008). Carter and Polevychok (2004) write, "The period 1993 to 1998 was one of the weakest from a social housing policy perspective in recent Canadian history: no national policy; virtually no federal funding; limited provincial funding; and a debate on who should do what as opposed to what should be done" (p. 3-4). Similarly, in 1998, Wolfe wrote "It was never imagined that a system that had taken 50 years to build-up could be dismantled so rapidly. Social housing policy in Canada now consists of a checker-board of 12 provincial and territorial policies, and innumerable local policies" (p. 131). Many scholars claim the government's action created a 'housing crisis' and a led to a rise in homelessness (Hulchanski, 2007). In 1999, due to pressure to respond, a national homelessness strategy was implemented (Bryant et al, 2011) and in 2001 the Affordable Housing Initiative (AHI) was introduced, beginning a phase of 'reengagement' (Leone & Carroll, 2010). The AHI is an agreement whereby the provincial and municipal governments cost-match a federal grant. Under this arrangement, new housing has been built; however, certain populations (i.e., seniors, rural areas) have benefitted more than others (i.e., new immigrants, individuals with mental health conditions). More recently, there has been renewed interest in housing at both the provincial and federal levels. The 2016 federal budget, for example, included $2.3 billion over three years for housing and homelessness (MacLeod, Worton, & Nelson, 2016).

According to Carter and Polevychok (2004), responsibility for the delivery of social housing and the development of social housing policy has shifted over time from the federal

government, to increasing provincial involvement in the 1970s, to a joint initiative between the federal and provincial governments and non-profit sector in the 1980s, to a time when the federal government pulled out of housing in the 1990s, and then began to re-invest in the 2000s. This represents a progression of shifting responsibility. Leone and Carroll (2010) believe that it will be difficult to create a national housing policy now as it means needing all of the provinces and territories to be onboard. They write "some of the decisions that lead down a particular path are hard to undo. Province building has essentially led to provincial government growth, and this growth has effectively erected institutional barriers that make recentralisation difficult to envision" (p. 402). As of 2011, under the Social Housing Agreements, approximately 80% of the social housing stock is administered by the provinces and territories, reflecting the belief that housing needs and conditions are more easily addressed at a local level.

1.4.2 Current Approaches to Public Housing in Canada

In the last decade, the Manitoba government has been reinvesting in social housing. In April 2007, Manitoba announced HOUSING First, a four pillar housing strategy, which included BUILDINGFoundation focusing on revitalizing existing public housing (MB, 2008/09 annual report). In 2009, Manitoba announced AllAboard, a multi-faceted long term poverty reduction and social inclusion strategy (Manitoba Government, 2010a;Torjman, Battle, & Mendelson, 2009). Safe, affordable housing in supportive communities was one of the four pillars. HOMEWorks! was a low income housing strategy and a $378 million two-year investment plan (April 2009 to March 2011) which supported AllAboard. During the 2009/10 fiscal year, initiatives to improve heating/cooling efficiency and cost effectiveness (i.e., 'green initiatives) were implemented, which included 5,600 units receiving new windows, 100 receiving new roofs, and 47 new heating and ventilation projects (MB Housing Annual report 2009/10). In a

September 2010 press release, the federal and provincial governments jointly announced $102 million in funding to develop 235 new affordable rental units and the repairs for 9,489 social housing units (Manitoba Government, 2010b). As of March 2011, $78.6 million was spent on renovating 1,305 social housing units, which included public, non-profit, co-operatives, and rural and native housing, and $117 million was spent on building improvements (Manitoba Housing and Community Development, 2011). According to the 2011/12 Manitoba Housing Annual Report, 1,600 units were renovated in twelve housing projects, $600,000 was invested in improving security systems, and the common areas in 83 buildings were refreshed as were the exteriors on 77 buildings. There were also millions of dollars allocated to improving units when tenants moved out. Similar deep refreshes, modernizations, and improvement projects are reported in the 2012/13, 2013/14, 2014/15, and 2015/16 annual reports. In 2013/14, Manitoba Housing pilot tested a non-smoking policy among new tenants and in multi-unit buildings that had been renovated. Over the years, Manitoba Housing also provided funding to 20+ tenant associations, 10+ resource centres, supported a food program, and provided funding for recreational, cultural, and education programming.

Gilbert Park, one of the largest public housing developments in Winnipeg, was a beneficiary of this refresh approach. The revitalization efforts have been broader than just upgrading the housing stock. A February 2008 press release outlined some of the efforts. New playground equipment (including a special toddler play structure) was installed, and a basketball court and mini skateboard park were built (Manitoba Government, 2008). Security measures were improved (e.g., better lighting, foot patrols, and cameras). Fences were built to give each household its own yard. The exterior of the housing units were painted. Sidewalks were fixed and trees were planted. Tenants received new high efficiency washing machines and dryers.

Gilbert Park now has community gardens. Residents were consulted extensively about these refresh initiatives. Manitoba Housing has an office onsite to address tenants' concerns and develop better relations with tenants.

Not all jurisdictions in Canada are taking the same approach as Manitoba. Several public housing developments in Toronto and Vancouver are being/have been demolished and redeveloped into mixed income communities (e.g., Don Mount Court in Toronto was redeveloped between 2004 and 2010, Toronto's Regent Park is being redeveloped in six phases over 15 years (CMHC, 2011), and Little Mountain in Vancouver). Often, tenants are either temporarily or permanently displaced when public housing is renovated and redeveloped (CMHC, 2011). The academic critique on these initiatives is mixed.

In a study on the effects of redevelopment efforts on tenants who remained in Don Mount Court, August (2016) argues that "mixed-income public housing redevelopment is fundamentally ill-suited to meaningfully address the social and economic problems facing public housing and its residents" (p. 3420). She concludes that "planners and policy makers should discontinue efforts to experiment in this way on poor people and their communities" (August, 2016, p. 3406).

Rosol's (2015) description and critique of the redevelopment of Little Mountain public housing in Vancouver, British Columbia's oldest public housing development, is equally negative. In the name of 'social mixing' and densification, the land was sold to a private developer to build condominiums; the agreement also included the replacement of public housing units one for one (though, not of the same unit sizes). There were no community consultations and residents were forced to leave. Rosol (2015) writes "Little Mountain was supposed to set a precedent for the further privatization of public housing estates in the province… so far it has been a fiasco … If it serves as a precedent, one can hope that only by

showing how not to do redevelopment" (p. 159). Rosol (2015) provides excellent arguments against the private sale and redevelopment of public housing: "The destruction and inadequate replacement of post-war social housing units is particularly problematic in times without a (federal) public housing program. All the public housing still existing is a remnant of long-gone times. Instead of keeping and preserving those remnants as one of the few tools to mitigate the housing crisis in metropolitan city-regions, they are attacked by the vary agencies that should preserve them and whose mandate should be to provide housing for the population that cannot afford market prices. Selling public land to private developers furthermore does not only affect the housing supply today. It also means that the government gives away an important tool and options for action concerning the housing crisis in the future" (p. 160).

Rowe and Dunn (2015) interviewed both market owners/renters and subsidized renters residing in new buildings in Regent Park. Positive aspects of the redevelopment included: the appearance of the neighbourhood "drastically improved", there were more services (e.g., coffee shop, grocery store, bank), and returning residents perceived a reduction in crime and antisocial behaviour. While there was limited interaction between tenants of different incomes (market renters/owners resided in different buildings than subsidized renters), no one reported conflicts. Subsidized renters were more likely to report problems with the quality of their building (e.g., non-functioning elevator, plumbing problems, and building staff were unresponsive to complaints); none of the private renters/owners reported these problems. Rowe and Dunn (2015) note their results are "arguably more positive than would be expected from much previously published data on tenure mix" (p. 1276).

1.4.3 Current Approaches to Public Housing in the United States

In recent decades, in an effort to deconcentrate poverty, the United States response to public housing has largely been to demolish it (Oakley, Ward, Reid, & Ruel, 2011). Critics blame the decline in public housing to the physical design of the developments, lack of funding for repair and maintenance, and the change in the sociodemographic profile of residents. Originally public housing was built for the working poor, but by the 1960s, families on welfare entered public housing due to preferential rules to house the neediest families. Public housing was protected under the Housing Act of 1937 and strengthened in 1969 by an amendment that required that units are replaced on a one-for-one basis (Goetz, 2012). Between the 1950 and 1970s, African Americans became the largest racial group in public housing. A number of factors contributed to the racialization of public housing, including residential segregation rules and racism in the housing market. Also, during this time, public housing was primarily built in black and racially mixed neighbourhoods. As the sociodemographic profile of the residents changed, political support for public housing waned. This resulted in severe underfunding and corners were cut in building new public housing. Goetz (2011) writes that by the 1980s, "public housing projects in major cities were often the epicenter of high concentrations of poverty, violent crime, joblessness, and social breakdown" (p. 269). Additionally, the decline in public housing was blamed for the decline of surrounding communities (e.g., housing prices fell, businesses pulled out). This led to large areas of concentrated poverty in urban centres.

In 1992, a national commission estimated that six percent of the public housing stock (approximately 86,000 units) was 'severely depressed'. The government responded in a number of ways; most notable are the mobility programs (e.g., Moving to Opportunity for Fair Housing Demonstration and the Gautreaux Program in Chicago) in which families received Section 8

housing vouchers to use in the private market (Leventhal & Brooks-Gunn, 2003). The assumption of these mobility programs was that low income households would fare better in less disadvantaged neighbourhoods (Oakley et al., 2011). The HOPE VI program, created the by US Department of Housing and Urban Development (HUD), was enacted by Congress in 1992, with the goal of demolishing large developments and replacing them with mixed income housing (Hanlon, 2012; Oakley et al., 2011). The HOPE VI program gave funds to local housing authorities to demolish and redevelop public housing developments. Of great importance, Congress suspended the requirement of replacing public housing units on a one-for-one basis (Goetz, 2012; Hanlon, 2012). Housing authorities were encouraged to be innovative and entrepreneurial (Goetz, 2012). To receive HOPE VI funding, the housing authority has to prove the public housing development was in 'severe distress'. The HOPE VI program was originally meant for the 40 largest public housing authorities, but was opened to all public housing authorities. More than $6 billion HOPE VI grants were awarded to 190 housing authorities between 1993 and 2005, but HUD also allowed for private sector financing. Approximately 20 percent of new units were for low income households (Oakley et al., 2011). Affected families/individuals were either moved to another public housing development or given vouchers to rent in the private market. The percentage of the public housing stock demolished under HOPE VI varied by city (e.g., New York City has demolished less than one percent, while Atlanta demolished all of their public housing by 2011) (Goetz, 2011; Oakley et al., 2011). Nationwide, 150,000 public housing units were demolished (or sold) (Oakley et al., 2011); others estimate the number as high as 200,000 units (Jourdan, 2012) and 260,000 units (Goetz, 2012). However, Goetz (2012) notes that more public housing units have been sold or demolished outside the HOPE VI program (i.e., Demolition/Deposition) than part of it. This resulted in a

lack of replacement public housing units being built since this was not a requirement of non-HOPE VI demolition activities (Hanlon, 2012). In fact, Hanlon (2012) writes "the country's public housing inventory [has been reduced] to such a degree that the future of public housing in the U.S. is now in question" (p. 374-375). However, not all jurisdictions have taken this approach. Some public housing has been saved by placement on the National Register of Historic Places (Jourdan, 2012). Sunnydale, a public housing development in San Francisco, is being redeveloped into a mixed income community; however, the many stakeholders involved in the redevelopment are committed to keeping residents in place and improving access to social services during the lengthy transition (Jutte, LeWinn, Hutson, Dare, & Falk, 2011).

1.5 Methodological Limitations of Previous Studies on the Health Status and Healthcare Use of Public Housing Residents

Many studies exist on the health status and healthcare use of public housing residents. These studies often focus on a specific health issue (e.g., physical activity, drug and alcohol use, mental illness) and do not provide a broad picture of the health of public housing residents. Most studies are cross-sectional and based on survey data obtained from one or several housing developments, sometimes within one city or from a couple of cities. Often when comparison statistics were provided, they were obtained from other studies (e.g., Wiggers et al., 2001). In general, there are few population-based studies that use linked administrative data to examine the health of public housing residents. These types of studies have also been lacking in areas of homelessness and health, as Wood et al. (2016) writes: "One of the gaps in the literature to-date is larger scale studies that have accessed linked housing and medical record data to examine the link between homelessness, housing and health" (p.14). Dunn (2004) advocates for using administrative data to examine the relationship between housing and health; he writes "the use of

health care administrative records should be incorporated in study designs where links can be made to the housing circumstances of the health care users" (p. 3). Olver (2014) explains: "The ability to link datasets is key to providing the evidence to direct health policy towards achieving better medical outcomes… linked datasets are a valuable tool for health services planning… Digital health records are now essential for providing the large datasets necessary for gaining high-quality evidence through data linkage" (p. 368).

In addition to methodological challenges, the majority of studies about the health and healthcare use of public housing residents were conducted in the United States and Australia; few Canadian studies have been conducted. Due to differences in context (e.g., racialization of public housing in the United States, differences in access to healthcare due to differences in healthcare systems, differences in other social welfare policies), the generalizability of American studies to a Canadian setting may be limited.

1.6 Summary

In summary, given the methodological challenges of previous studies about the population in public housing, the dearth of Canadian studies, and the potential lack of generalizability of findings from research about public housing residents from other countries, Canadian population-based longitudinal research on health and housing outcomes of public housing applicants and residents can provide important information for policy development and decision making. Additionally, with various jurisdictions approaching public housing differently and the fact that evidence for these other approaches is mixed (Clampet-Lundquist, Edin, Kling, & Duncan, 2011;Clampet-Lundquist, 2007), it is timely to conduct this research in a jurisdiction that is investing in its public housing residents and public housing stock.

1.7 Purpose & Objectives

The research purpose was to use linkable population-based administrative databases from Manitoba to examine the associations among public housing and sociodemographic characteristics, health status, health service use, and housing stability. The objectives were to:

1. Identify predictors of an application for public housing.
2. Identify predictors of moving out of public housing.
3. Test for change in healthcare use before and after individuals move into public housing, and to examine trends in healthcare use in each of the before and after periods
4. Test for differences in healthcare use between public housing tenants and non-public housing tenants over time.

1.8 Organization of Thesis

This thesis includes four related manuscripts; each manuscript addresses a research objective. In the first manuscript (Chapter 2), a cohort of individuals who applied to public housing in 2005 and 2006 are compared to a cohort from the general population matched on age, sex, receipt of income assistance, and health region of residence. Socioeconomic, health status, and health service use characteristics were defined in the year before they applied. The association between applying to public housing and these characteristics is then examined and then validated using a cohort of individuals who applied to public housing in 2011 and 2012. We found evidence that public housing applicants, in general, were in poorer health and were higher users of healthcare services than the general population cohort. Additionally, physical health, mental health, and health service use were significantly associated with applying to public housing, after controlling for individual and area-level income. We were able conduct this study because we could identify all public housing applicants and were able to link their housing

records to various health databases. The general consensus in the literature is that on average, individuals in public housing are in poorer health compared to the general population, but there was little known about their health status and health care use prior to moving in. One of the strengths of this study was the ability to validate the findings using a more recent cohort and finding that the results persisted despite any potential policy changes. The demographic and health profile of people who apply to public housing may be valuable to policy makers for ensuring appropriate resources are in place so new residents have successful tenancies.

The second manuscript (Chapter 3) follows a cohort of individuals who moved into public housing in 2007 and 2008 over a seven year period to determine tenancy length. We then compared the socioeconomic, health, and health care use characteristics of tenants who moved out of public housing on their own with tenants evicted during the observation period and tested which cohort characteristics were associated with the different move-out reasons. We found that socioeconomic characteristics were associated with moving out of public housing voluntarily, and health status and healthcare utilization were associated with being evicted. While other researchers have also examined the factors associated with moving out of public housing, our study was novel by including health and health service use factors as well as examining differences in characteristics by move-out reason. This study may be helpful to policymakers and service providers in identifying those experiencing housing problems and thus assist them in providing targeted support to individuals at-risk of having an unsuccessful tenancy. Generally, the findings also provide insight into understanding tenancy behaviour, planning for tenancy turnover, and understanding future need for public housing since the public housing stock is finite.

The third manuscript (Chapter 4) describes healthcare use patterns in a cohort of individuals who moved into public housing in 2009 and 2010. Specifically, patterns in health care use (i.e., hospitalizations, emergency department visits, specialist and family physicians, and prescription drug use) were examined over the twelve 30 day periods (i.e., one year) before and the twelve 30 day periods after individuals moved into public housing. We used these short time intervals to determine if there was evidence that a health event precedes tenancy in public housing and to determine if an immediate change in healthcare use followed a move into public housing. Additionally, we tested for differences in healthcare utilization in the year before and year after individuals moved into public housing. In general, healthcare increased in the year before the move-in date and was highest approximately three months prior to the move-in date. Healthcare use decreased after the move-in date, but rebounded to the pre-move-in date levels for some healthcare services. The likelihood of being hospitalized and the specialist visit rate was significantly lower in the period after the move-in date. This study is the among the first to examine healthcare use over time in a cohort of public housing residents and to determine if a change in use coincided with the public housing move-in date. In general, few researchers have examined healthcare use for this population, let alone whether use varies across different health services and over time.

The fourth manuscript (Chapter 5) compared healthcare use over time in a cohort who moved into public housing in 2012 and 2013 to a cohort from the general population matched on sex, age, receipt of income assistance, and health region of residence. Healthcare use (i.e., hospitalizations, inpatient days, emergency department visits, specialist and family physicians, and prescription drug use) was measured in the year before and year after the move-in date. The matched cohort was randomly assigned a move-in date in 2012 or 2013. The cohorts are

described in terms of their socioeconomic and health status characteristics. Our primary interest was to determine if there was an interaction between time period (i.e., before and after the move-in date) and cohort, as we expected that healthcare use may change over time for the public housing cohort but not for the matched cohort. Previous studies have examined how residence in public housing affects employment, education, and future housing prospects, but few studies exist on how public housing affects healthcare use. We found that for most of the healthcare measures, changes in use by the public housing cohort were mirrored by the general population cohort. Housing advocates could use these results to support their arguments about the value of public housing. Additionally, health and social service providers may be able to reference these results to make the case for funding to deliver programs in public housing developments.

The final chapter (Chapter 6) provides a summary of the findings and directions for future research.

Approvals to conduct this research were obtained from the University of Manitoba Health Research Ethics Board, the Health Information Privacy Committee, the Winnipeg Regional Health Authority, Manitoba Housing, and Manitoba Jobs and the Economy. Later, approval was obtained from the Department of Families.

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CHAPTER 2 : HEALTH AND SOCIAL PREDICTORS OF APPLICATIONS TO PUBLIC HOUSING: A POPULATION-BASED ANALYSIS

2.1 Chapter Overview

This manuscript describes the socioeconomic and health characteristics of a cohort of individuals who applied to public housing in 2005 and 2005 and a cohort from the general population matched one-to-one based on sex, age, receipt of income assistance, and health region of residence. The health and social predictors of applying to public housing are examined using conditional logistic regression and the results are validated using a cohort who applied to public housing in 2011 and 2012. This study shows that in general, individuals who apply to public housing tend to be in poorer health and are more frequent healthcare users compared to individuals who are similar on socioeconomic characteristics. This is one of the first studies to examine the health status and healthcare use of public housing applicants. It is potentially useful for policy makers in understanding the needs of people who are applying to public housing and in planning so the appropriate supports are in place so new tenants have successful tenancies. This study may also be useful to housing advocates in demonstrating the need for low income housing.

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2.2 Abstract

Background: Residents of public housing are often in poor health. However, it is unclear whether poor health precedes residency in public housing. We compared the health of people who applied to public housing to people who did not apply and had similar socioeconomic characteristics.

Methods: Population-based administrative databases from Manitoba, Canada containing health, housing, and income assistance information were used to identify a cohort of individuals who applied to public housing and a matched cohort from the general population. Conditional logistic regression was used to test the association between a public housing application and health status and health service use, after controlling for income.

Results: There were 10,324 individuals in each of the public housing applicant and matched cohorts; the majority were female, young, urban residents, and received income assistance. A higher percent of the public housing cohort had physician diagnosed physical and mental health conditions compared to the matched cohort. Physical health, mental health, and health service use were significantly associated with applying to public housing, after controlling for individual and area-level income.

Conclusion: Applicants to public housing were in poorer health compared to people of the same income level who did not apply to public housing. These health issues may affect the long term stability of their tenancy if appropriate services and supports are not provided. Additionally, preventing ill health, better management of mental health, and additional supports may reduce the need for public housing, which in turn would alleviate the pressure on governments to provide this form of housing.

What is already known on this subject

- Residents of public housing are in poor health compared to the general population. Often public housing is criticized for causing poor health. However, little is known about public housing residents' health prior to their tenancy.

What this study adds

- We found that applicants to public housing were in poorer physical and mental health compared to others of the same socioeconomic status. Supports to better manage mental health, and prevent or alleviate physical health problems may reduce the need for public housing. Health care and social supports in public housing may be necessary to ensure residents have successful tenancies.

2.3 Introduction

Public housing is a form of social housing for low income individuals and families that is owned and managed by the government (provincial/state or municipal). Other forms of social housing include non-profit and co-operative housing, and rent supplements. Residents of public housing tend to be in poorer health than non-residents (Theodos, Popkin, Parilla, & Getsinger, 2012). When compared to the general population, public housing residents are more likely to die prematurely (Smith et al., 2013), have lower self-rated health (Buchner, Nicola, Martin, & Patrick, 1997; Digenis-Bury, Brooks, Chen, Ostrem, & Horsburgh, 2008; Wiggers et al., 2001), and have a greater probability of having a chronic disease, including diabetes, hypertension, and asthma, (Digenis-Bury et al., 2008) and mental illness (B. S. Black et al., 1998; Betty Smith Black, Rabins, German, McGuire, & Roca, 1997; Rabins et al., 1996; Simning, van Wijngaarden, & Conwell, 2011; Smith et al., 2013). Public housing residents are also more likely to engage in risky health behaviors (Cummings, Cooper, & Johnson, 2013; Dekeseredy, Schwartz, Alvi, & Tomaszewski, 2003; Digenis-Bury et al., 2008; Sikkema et al., 1995; Wiggers et al., 2001; Williams & Adams-Campbell, 2000).

Not clear from the literature, however, is whether poor health comes before or during tenure in public housing. Rabins et al. (1996) hypothesized that for many, psychiatric illness predated residency in public housing given their short tenancies and reported lifetime illness (Rabins et al., 1996). Ruel et al. (2010) found that the majority of public housing residents were diagnosed with chronic conditions, such as asthma, diabetes, arthritis, and hypertension, prior to moving into public housing; although stroke was more common after moving in (Ruel, Oakley, Wilson, & Maddox, 2010).

Not all low income individuals apply for public housing. Public housing may be an address of last resort, having exhausted other options, for those in poor health and a worsening socioeconomic outlook. Alternatively, public housing may be an appealing low income housing option due to the proximately of services and additional supports (Hynes, Brugge, Watts, & Lally, 2000). Finlayson et al. (2013) found that the most common reasons cited for applying to public housing were overcrowded current living conditions (26.4%) and an inability to afford current rent and/or utilities (25.2%) (Finlayson et al., 2013). Affordability has also been cited as the primary reason for use of public housing (Ruel et al., 2010). In Park et al.'s (2014) study, receipt of welfare, being homeless at some point, and having a low household income were associated with use of public housing (Park, Fertig, & Metraux, 2014). Other reasons for applying to public housing include: health reasons, wanting to be closer to education/employment/family, and wanting to be closer to medical and essential services (Finlayson et al., 2013).

We sought to determine what characteristics distinguish those who apply from those who do not. We hypothesized that individuals who are sicker are more likely to apply to public housing as they may be less able to meet their basic needs. This study tests the association between health and applications to public housing using a unique set of population-based administrative databases.

2.4 Methods

2.4.1 Data Sources

The province of Manitoba, in Canada, has an ethnically-diverse population of 1.2 million. Manitoba has a public health insurance system, so that virtually all residents of the province receive coverage; residents new to the province and those insured federally (i.e., military

personnel, Royal Canadian Mounted Police, and inmates), who account for less than 1% of the total population, are not covered (Roos & Nicol, 1999). Services covered include: physician visits, inpatient and outpatient hospital visits, and x-rays and laboratory services, while other health services, such as dental and psychologist visits and some medications, are not covered.

Manitoba has a rich collection of anonymized administrative databases housed in the Manitoba Centre for Health Policy Research Data Repository; the majority are updated annually (Manitoba Centre for Health Policy, 2015; Roos et al., 2008). The data is owned and managed by provincial government departments for administrative purposes (e.g., physician reimbursement) and thus are of high quality with no missing information in the main fields (Roos et al., 2008; Roos, Gupta, Soodeen, & Jebamani, 2005; Roos & Nicol, 1999). The databases are linkable at the individual level using a unique scrambled personal health identification number. The study data sources were the Tenant Management System (TMS), population registry, Social Assistance Management Information Network (SAMIN), physician billing claims, emergency department (ED) records, hospital discharge abstract, prescription drug records, and Statistics Canada Census data. The TMS was used to identify applicants to Manitoba Housing, a provincial government department. The population registry was used to obtain information on demographic characteristics, place of residence, and health insurance coverage. The registry is updated every six months (June and December), so that snapshots of residential histories can be created (Roos & Nicol, 1999). The SAMIN database was used to obtain information on households receiving financial support under the provincial Employment and Income Assistance program. The hospital discharge abstract database was used to obtain information on discharges from all acute and chronic care facilities in Manitoba. Before April 2004, up to 16 diagnosis codes based on the International Classification of Diseases, 9th revision, Clinical Modification (ICD-9-CM) were

recorded and after March 31, 2004 up to 25 diagnosis codes based on ICD-10-CA were recorded. The physician billing claims database captures all fee-for-service visits to physicians; it was used to obtain diagnostic information. While some Manitoba physicians are salaried (Watson et al., 2004), more than 90% submit parallel billing claims (i.e., shadow billing) (Lix et al., 2008). Thus, the repository contains data on virtually all contacts with physicians in Manitoba. A single diagnosis is recorded on each claim using three-digit ICD-9-CM code. ED records were captured from the admission, discharge and transfer and E-Triage databases available only for residents of Winnipeg, the provincial capital. The Drug Program Information Network database contains information on prescriptions filled by community pharmacies; prescriptions dispensed in hospital or at nursing stations are not included. Each approved drug in Canada is assigned an 8-digit drug identification number (DIN).

Data from the 2006 Canadian Census were used to create a dissemination area (DA) level measure of income (i.e., income quintile), based on average household income. The DA is the smallest unit of analysis for which Census data are released; each DA contains 400 to 700 individuals.

2.4.2 Study Cohort

The public housing applicant cohort included all adults (18+ years) listed as primary applicants to Manitoba Housing in calendar years 2005 and 2006 and registered with the Manitoba Health Insurance Services Plan in the application year and the prior year. Residents of Churchill, a remote northern community (population approximately 1000), were excluded; this community has a high rate of public housing residency and a lack of private housing options,(Finlayson et al., 2013) limiting the ability to select a matched cohort. Current Manitoba Housing residents were also excluded.

The matched cohort consisted of all individuals not applying to Manitoba Housing in 2004 to 2006, not listed on a Manitoba Housing application as co-habitants, not residing in Manitoba public housing or in Churchill during that time, and continuously covered by the Manitoba Health Insurance Services Plan. Prior to matching, all eligible individuals were randomly assigned an application date between January 1, 2005 and December 31, 2006. Matching was one-to-one based on sex, age and region of residence (i.e., 10 health regions) as of the application date, and receipt of income assistance of any type (by the applicant or a household member) at least once in the year prior to the application date.

The models were validated using a new public housing applicant cohort. It consisted of all adults who were primary applicants to Manitoba Housing in calendar years 2011 and 2012. The original public housing applicant cohort (2005/2006) and the validation public housing applicant cohort (2011/2012) contained independent populations.

2.4.3 Study Variables

Study variables included demographic, geographic, economic, heath status, and health service use characteristics. Demographic variables included sex, age, and family composition as of the application date. Location of residence at the application date was determined from the 6-digit postal code obtained from the population registry. Region of residence was assigned as urban and rural (i.e., Winnipeg and non-Winnipeg).

Residential mobility in the year prior to the application date was determined from changes in 6-digit postal code. Individuals changing postal code were classified as movers and those not changing postal code were classified as non-movers (DeVerteuil et al., 2007; Lix et al., 2006).

Economic variables included income quintile and receipt of income assistance. Each quintile represents approximately 20% of the population. Individuals were classified as recipients of income assistance if they or a member of their household received any form of income assistance at least once in the year prior to the application date (Heaman et al., 2012). The different forms of income assistance were grouped as: single parent, disability, general, and other. Members of households may qualify for multiple types of assistance. Each type of income assistance is based on financial need plus additional eligibility criteria. General assistance includes single people or couples without dependents or two parent families. Other assistance is a combination types, including special cases and assistance for a child whose parents are deceased (Wall-Wieler, 2015).

Health status was determined by (a) the presence of diagnoses for selected conditions in hospital abstracts and physician billing claims (Table 1), (b) Aggregated Diagnostic Groups (ADGs), and (c) Resource Utilization Bands (RUBs) in the year prior to the application date (Austin, van Walraven, Wodchis, Newman, & Anderson, 2011; Roos, Walld, & Witt, 2014). Mental disorders included: schizophrenia, substance abuse disorders, and affective disorders, which included mood and anxiety disorders. Physical health conditions included respiratory illness (asthma, bronchitis, and emphysema), diabetes, hypertension, ischemic heart disease, and cancer. ADGs are groups of ICD-9-CM/ICD-10-CA codes that represent clinically similar diagnoses based on the Johns Hopkins Adjusted Clinical Groups® (ACG®) Case-Mix System version 9. A higher ADG score indicates greater comorbidity. RUBs are also part of the Johns Hopkins Adjusted Clinical Groups® (ACG®) Case-Mix System (Carmona et al., 2013). Individuals are classified into one of six mutually exclusive categories based on their expected demands on the health care system irrespective of illness. The RUB categories range from non-

users to very high health service users. The number of hospitalizations, emergency department visits, ambulatory (i.e., clinic) physician visits, and different drugs in the year prior to the application date were also determined.

2.4.4 Statistical Analysis

The cohorts were described on all explanatory variables. Then, χ^2 tests of independence and Wilcoxon Rank Sum tests were used to assess if the cohorts differed on the explanatory variables. Unadjusted and adjusted conditional logistic regression models were fit to the data. In the latter, variables were entered sequentially by type (i.e., economic, residential mobility, and health). The final model includes all of the explanatory variables. Models were compared using the c-statistic, which is equivalent to the area under the receiver operator curve.(Kansagara et al., 2011) A c-statistic of 0.50 indicates that the model performs no better than chance, 0.70 to 0.80 indicates "modest or acceptable discriminative ability", and greater than 0.80 indicates "good discriminative ability".

Descriptive and inference statistics were used to assess goodness of fit, including the Likelihood Ratio Test (LRT) (Fry et al., 2007; Lix, Quail, Fadahunsi, & Teare, 2013), which follows a χ^2 distribution with degrees of freedom equal to the difference in degrees of freedom between nested models.

The final model was also fit to the 2011/2012 public housing applicant and matched cohorts. All data management and analyses were completed using SAS 9.3 (SAS Institute Inc, 2011). Statistical significance was assessed using $\alpha = 0.05$.

2.5 Results

2.5.1 Cohort Characteristics

The public housing applicant cohort consisted of 10,324 individuals matched one-to-one with individuals from the general population. Figure 2-1 illustrates how the public housing applicant cohort was constructed.

The public housing applicant and matched cohorts were equivalent on sex, age, residence location, and receipt of income assistance (Table 2-2). The two cohorts were predominately female (72.4%), young to mid adult age (24.8% ages 18 to 24 years, 37.2% ages 25 to 40 years), and living in Winnipeg (61.2%). Approximately half (52.8%) of the cohorts received income assistance. However, the two cohorts differed on type of income assistance. A higher percentage of the public housing applicants received single parent assistance and general assistance in the year prior to their application. There was an income quintile gradient for both cohorts; however the gradient was steeper for the public housing applicant cohort, with 46.8% versus 31.0% living in the lowest income areas. Income quintile could not be assigned in less than 3% of the cohorts. Almost one-third of public housing applicants moved at least once in the year prior to applying for public housing compared to 20.0% of the matched cohort. A total of 90.9% and 85.2% of the public housing applicant and matched cohorts were the family head, respectively. The sociodemographic characteristics for the validation cohorts are presented in supplementary table 2-1.

Table 2-3 summarizes the health status and health care use of the two cohorts in the year prior to their application. A higher percentage of the public housing applicants had diabetes, hypertension, ischemic heart disease, and respiratory illness compared to the matched cohort, while there was no difference between the two groups on cancer diagnosis. Similarly, a higher

percentage of the public housing applicant cohort had a mental disorder than the matched cohort. Also, the public housing applicant cohort had a greater average number of ADGs (mean = 4.3, standard deviation (SD) = 3.0) than the matched controls (mean = 3.3, SD = 2.7). Based on RUBs, the public housing applicant cohort required more health resources than the matched cohort. The health status and health service use characteristics of the validation cohorts are presented in supplementary table 2-2.

The public housing applicant cohort used more health services than the matched cohort in the year before their application. The public housing applicant cohort filled more prescriptions (mean = 28.4, SD = 57.8) than the matched cohort (mean = 23.6, SD = 69.7). The public housing applicant cohort visited physicians more frequently in one year than the matched cohort. The public housing applicant cohort visited a greater number of general practitioners (mean = 2.8, SD = 2.0, N=9,241) than the matched cohort (mean = 2.2, SD = 1.6, N = 8,658). A smaller percentage of the public housing applicant cohort received the majority of their care from a single physician.

A higher percentage of the public housing applicant cohort was hospitalized in one year and members of this cohort were hospitalized more often than the matched cohort. Also, the public housing applicant cohort spent more days in hospital (mean = 18.0, SD = 35.4, N = 1,643) than the matched cohort (mean = 14.7, SD = 34.6, N= 925) in a one year period. A higher percentage of the public housing applicant cohort visited an ED and visited more frequently in one year compared to the matched cohort.

2.5.2 Predictors of Applications to Public Housing

In the conditional logistic model with the income and residential mobility variables, the AIC was 12864.66 and the LRT(df = 10) was 1467.45 ($p < 0.001$). Adding the health variables

improved model fit (AIC = 12207.44; LRT= 2148.67, df=22, $p < 0.001$). The c-statistic for the full model was 0.65, indicating modest discriminative ability.

Table 2-4 presents the unadjusted and adjusted odds ratios (ORs) from the conditional logistic regression models. With no missing data every model included 10,324 individuals from each cohort. Individuals residing in the poorest income areas had higher adjusted odds of applying to public housing than individuals in the wealthiest income areas. The association between income quintile and applying to public housing was stronger as income decreased. Individuals receiving single parent or general income assistance had higher adjusted odds of applying to public housing. Movers were significantly more likely to apply to public housing than the non-movers. Individuals with cancer were significantly less likely to apply to public housing, while those with a respiratory illness and/or diabetes had higher adjusted odds of applying. Individuals with schizophrenia, affective disorders, and/or substance abuse disorders were significantly more likely to apply to public housing than individuals without these conditions. Individuals with more morbidities/severe illness were significantly more likely to apply to public housing than those without any health conditions. Results were similar for the validation cohort, including the discriminative performance (c-statistic = 0.65).

2.6 Discussion

This study identified a cohort of individuals who applied to public housing and compared their characteristics to a matched cohort from the general population of Manitoba. Consistent with other studies, a high proportion of the public housing applicant cohort was female (Apparicio & Seguin, 2006; Dockery, Ong, Whelan, & Wood, 2008; Finlayson et al., 2013). Despite matching on receipt of income assistance, the public housing applicant cohort was more likely to live in lower income areas the year before their application date. Applicants to public

housing were in poor health compared to the matched cohorts, as they were more likely to have a chronic physical health condition, a mental illness, fill more prescriptions, visit physicians more frequently, and be hospitalized.

It is not surprising that other researchers have found that residents of public housing are in poorer health than the general population. For example, Digenis-Bury et al. (2008) reported that public housing residents had a higher prevalence of chronic diseases, such as hypertension, diabetes, and asthma, compared to the general population (Digenis-Bury et al., 2008). Similarly, Bazagaran et al. (2005) found that on average, public housing residents (with at least one child) had two chronic conditions (Bazargan et al., 2005). Simning et al. (2011) found that residency in public housing was associated with increased risk of any lifetime psychiatric disorder, lifetime anxiety disorders, 12-month substance use, and lifetime substance use (Simning et al., 2011). Park et al. (2014) examined individual, family, and community-level factors associated with receiving housing assistance (i.e., public housing and housing vouchers) among household heads who were part of the US Fragile Families and Child Wellbeing Study (Park et al., 2014). In our analysis, individuals residing in low socioeconomic areas, and those receiving general income assistance or single parent income assistance were significantly more likely to apply to public housing, which is consistent with Park et al (2014). In contrast, in Park et al's (2014) study, health status was not significantly associated with receiving housing assistance. Finally, our findings were validated in the 2011/2012 cohort, demonstrating that they endured over time.

There are a number of policy implications from this research. Firstly, given that people are not healthy prior to moving into public housing, supports (e.g., clinics and social services) may be necessary to ensure successful tenancies. Public housing is often designed so that many individuals reside in a small geographic area, allowing for efficient service delivery (Hynes et

al., 2000). By treating mental health earlier and providing increased care for chronic conditions to the economically disadvantaged, health care service providers may be able to reduce the need for public housing, which would be particularly important in jurisdictions with long wait lists.

This study has a number of strengths. First, we were able to identify a population-based cohort of individuals, ensuring generalizability across the population. Additionally, we created a matched comparison group from the general population that was similar to the public housing applicants in terms of their socioeconomic characteristics. Finally, we were able to validate our results using a population-based cohort of individuals who applied to public housing five years later. Thus, despite potential changes in policy, the characteristics of those who apply to public housing were similar over time

This study was limited in only including applicants to public housing; partners and dependents were excluded. The health of other household members may be associated with applying to public housing. The number and age-sex distribution of children of applicants, which may be important due to occupancy standards, was not included in our analyses as this information was not available in the data (Fertig & Reingold, 2007). Residential mobility was determined from changes in postal codes reported to Manitoba Health; mobility may be underestimated if address changes are not reported. Lastly, public housing owned and managed by municipal, provincial/state, or federal governments are just one form of low income housing. Other forms of social housing, such as those managed by non-profit groups, could not be included.

Future research examining health trajectories among public housing applicants could help determine whether a significant health event prompted an application to public housing. A

geographic analysis of where applicants reside, prior to their public housing application, may assist in determining where supports could be placed to reduce their need for public housing.

2.7 Summary

In summary, individuals who apply to public housing are less healthy and use more health services than individuals who do not apply to public housing, but who are similar in terms of their socioeconomic status. Additionally, several measures of ill health, including the presence of mental illness and chronic diseases, were more common amongst public housing applicants, even after controlling for socioeconomic differences. Our study demonstrates that poor health precedes tenancy in public housing, and the unhealthy poor, arguably in high need of affordable low income housing, are most likely to apply to public housing. Our results support the idea that public housing is a safety net (Bazargan et al., 2005; Ruel et al., 2010).

Disclaimer

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Ethics Approval

Ethics approval was obtained from the University of Manitoba Health Research Ethics Board. Data access was approved by the Manitoba Health Information Privacy Committee.

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Authors' Contributions

AMH, LML, BB, JD, and LR contributed to the study conception, design, interpretation of the data, drafting and critical revision of the manuscript. AMH contributed to the data analysis, interpretation of the data, and writing and revision of the manuscript. All authors participated in editing and revising the manuscript. All authors read and approved the final manuscript.

2.8 References

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Table 2-1. ICD Codes Used to Define Physical Health Conditions and Mental Disorders.

Conditions	ICD-9-CM	ICD-10-CA
Respiratory Illness (e.g., asthma, bronchitis)	466, 490 – 493, 496	J20, J21, J40 – J45
Diabetes	250	E10 – E14
Hypertension	401 – 405	I10 – I15
Ischemic Heart Disease	410 – 413	I20 – I25
Cancer	14 – 20	C00 – C97
Schizophrenia	295	F20, F21, F25, F232
Affective Disorders (e.g., anxiety disorders, depression)*	296, 300, 309, 311	F31 – F33, F40 – F42, F44, F48, F99, F341, F380, F381, F410, F411, F412, F413, F418, F419, F431, F432, F438, F450, F451, F452, F530, F680, F930
Substance Abuse Disorders	291, 292, 303 - 305	F10 – F19, F55

Note: *In defining affective disorders using the hospital discharge abstracts, the following four digit ICD-9-CM codes were used 296.1 to 296.8, 300.0, 300.2 to 300.4, and 300.7.

Table 2-2. Sociodemographic Characteristics (%) of the Public Housing Applicant Cohort and Matched Cohort at the Housing Application Date.

Variables	**Categories**	**Public Housing Applicant Cohort** (*N*=10,324)	**Matched Cohort** (*N*=10,324)
Sex	Males	27.6	27.6
	Females	72.4	72.4
Age (years)	18 – 24	24.8	24.8
	25 – 39	37.2	37.2
	40 – 64	28.9	28.9
	65+	9.2	9.2
Region of Residence	Non-Winnipeg	38.8	38.8
	Winnipeg	61.2	61.2
Income Assistance[†]	Yes	52.8	52.8
	No	47.2	47.2
Single Parent Assistance[†]	Yes	24.8	17.8[£]
	No	75.2	82.2
General Assistance[†]	Yes	18.6	16.9[£]
	No	81.4	83.1
Disability Assistance[†]	Yes	18.3	23.5[£]
	No	81.7	76.5
Other Income Assistance[†]	Yes	0.2	0.2
	No	99.8	99.9
Income Quintile	Q1 (poorest)	46.8	31.0[£]
	Q2	20.7	21.2
	Q3	15.6	17.5
	Q4	10.3	15.3
	Q5 (affluent)	5.8	12.4
	NF[*]	0.9	2.7
Change in Postal Code[†]	Yes	32.1	20.0[£]
	No	67.9	80.0
Relationship to Family Head	Family head	90.9	85.2[£]
	Spouse	8.8	14.3
	Other	0.3	0.5

Note: *NF = Missing due to postal codes not assigned to a DA or a DA having a small non-institutionalized population; [†]In the year prior to the housing application date; [£]$p<0.05$

Table 2-3. Health Status and Health Service Use of the Public Housing Applicant Cohort and Matched Cohort in the Year Prior to the Housing Application Date.

Variable	Category	Public Housing Applicant Cohort (*N*=10,324)	Matched Cohort (*N*=10,324)
Physical Health Conditions[‡]	Respiratory Illness	18.8	14.1[£]
	Diabetes	8.7	5.9[£]
	Hypertension	10.3	9.6
	IHD	1.5	0.9[£]
	Cancer	1.9	1.9
Mental Disorder Diagnosis[‡]	Schizophrenia	3.2	2.5[£]
	Affective Disorders	31.1	22.1[£]
	Substance Abuse Disorders	6.6	3.2[£]
Resource Utilization Bands[‡]	Non/Healthy Users	11.6	19.8
	Low Morbidity	15.7	20.4
	Moderate Morbidity	49.0	46.4
	High Morbidity	19.2	11.2
	Very High Morbidity	4.6	2.2
Visits to a General Practitioner	Mean (SD)	7.1 (7.1)	5.2 (5.9)
	Median	5	4[£]
	IQR	8	6
Visits to a Specialist	Mean (SD)	2.1 (4.1)	1.5 (3.8)
	Median	0	0[£]
	IQR	2	2
Majority of Care Received from the Same General Practitioner[‡◊]	Yes	78.5	84.5[£]
	No	21.5	15.6
Hospitalizations[‡]	0	84.1	90.8[£]
	1	10.9	6.9
	2+	5.1	2.3
ED Visits[‡]* (N = 6317)	0	58.5	72.9[£]
	1	20.6	15.8
	2+	20.9	11.3

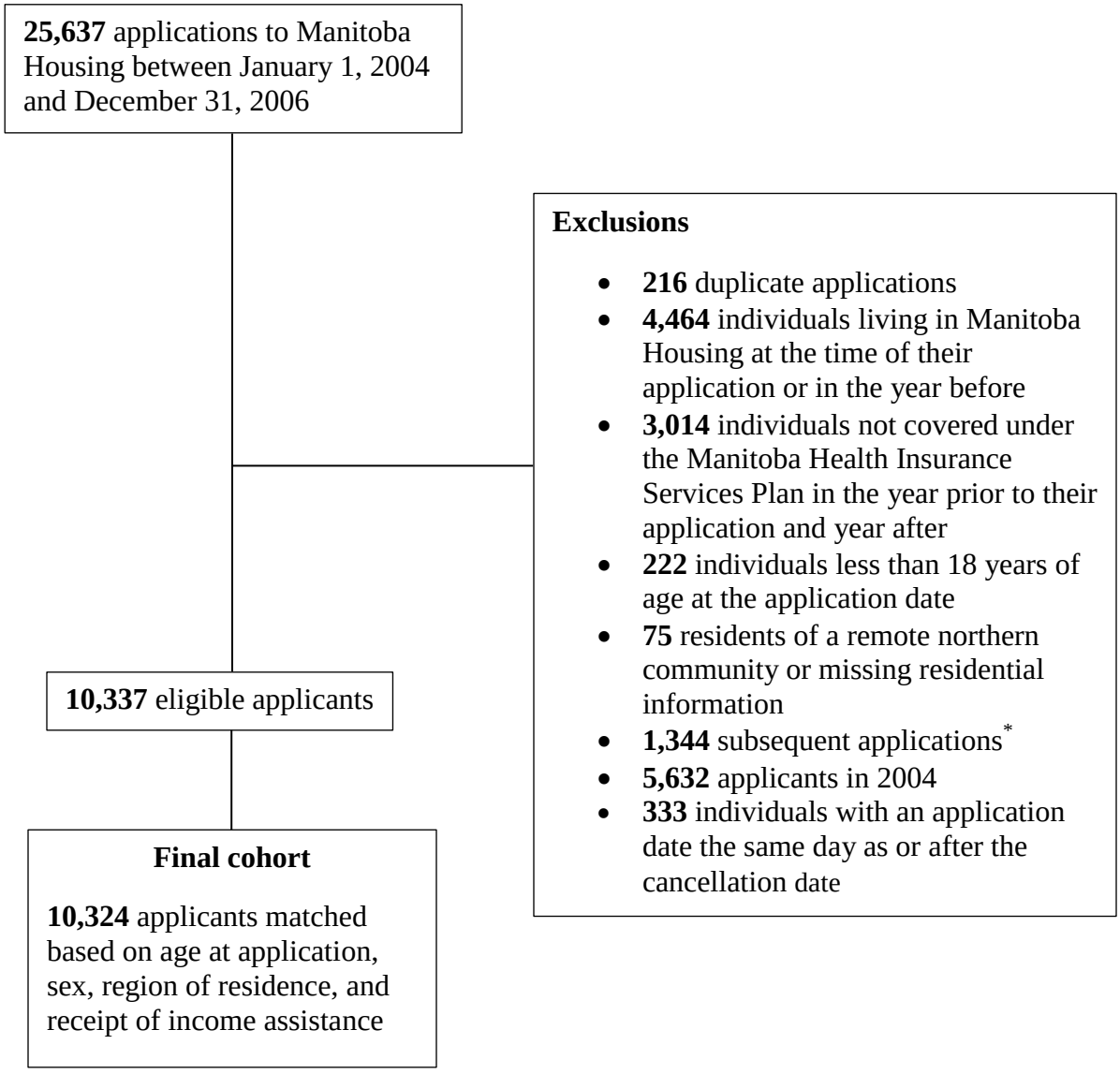
Note: IHD = Ischemic Heart Disease; SD = standard deviation; IQR = interquartile range; [‡]values represent percentages (%); *Urban residents only; [◊]Public Housing Applicant Cohort N = 8329, Matched Cohort N = 7390; [£]$p<0.05$

Table 2-4. Odds ratios (ORs) and 95% confidence intervals (CIs) for Applying to Public Housing.

Variable	Category	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
Income-Related Measures			
Income quintile	Q1 (poorest)	**3.87 (3.44,4.35)**	**3.57 (3.15,4.04)**
	Q2	**2.40 (2.13,2.72)**	**2.35 (2.07,2.68)**
	Q3	**2.13 (1.88,2.42)**	**2.09 (1.83,2.39)**
	Q4	**1.51 (1.32,1.71)**	**1.52 (1.33,1.74)**
	NF*	0.2 (0.62,1.70)	0.99 (0.73,1.32)
	Q5 (affluent)	Ref	Ref
Single Parent Assistance	Yes	**2.19 (1.99,2.41)**	**2.74 (2.35,3.20)**
	No	Ref	Ref
General Assistance	Yes	**1.16 (1.07,1.26)**	**1.32 (1.16,1.51)**
	No	Ref	Ref
Disability Assistance	Yes	**0.61 (0.56,0.66)**	0.95 (0.82,1.10)
	No	Ref	Ref
Other Assistance	Yes	1.07 (0.52,2.22)	1.32 (0.57,3.05)
	No	Ref	Ref
Residential Mobility Variable			
Change in Postal Code	Yes	**1.99 (1.86,2.13)**	**1.70 (1.57,1.83)**
	No	Ref	Ref
Health Condition Variables			
Respiratory Illness	Yes	**1.42 (1.32,1.53)**	**1.14 (1.05,1.25)**
	No	Ref	Ref
Hypertension	Yes	1.11 (1.00,1.22)	0.92 (0.82,1.03)
	No	Ref	Ref
Ischemic Heart Disease	Yes	**1.63 (1.26,2.12)**	1.01 (0.76,1.35)
	No	Ref	Ref
Diabetes	Yes	**1.56 (1.39,1.74)**	**1.24 (1.09,1.40)**
	No	Ref	Ref
Cancer	Yes	0.98 (0.80,1.21)	**0.76 (0.61,0.96)**
	No	Ref	Ref
Schizophrenia	Yes	**1.34 (1.14,1.59)**	**1.58 (1.30,1.92)**
	No	Ref	Ref
Affective Disorders	Yes	**1.62 (1.52,1.73)**	**1.37 (1.27,1.48)**
	No	Ref	Ref
Substance Abuse Disorders	Yes	**2.15 (1.88,2.47)**	**1.46 (1.25,1.71)**
	No	Ref	Ref
Resource Utilization Bands (RUBs)	Very High Morbidity	**4.22 (3.51,5.07)**	**3.38 (2.73,4.18)**
	High Morbidity	**3.24 (2.91,3.62)**	**2.54 (2.25,2.88)**
	Moderate Morbidity	**1.97 (1.81,2.15)**	**1.71 (1.55,1.90)**
	Low Morbidity	**1.36 (1.23,1.50)**	**1.30 (1.17,1.45)**
	Non/Healthy Users	Ref	Ref

Note: *NF = Missing. Bolded values are statistically significant at $\alpha = .05$.

Figure 2-1. Flow chart for construction of the public housing applicant cohort.



*Some individuals applied to Manitoba Housing more than once. Only their first application in the period 2005 to 2006 was retained in this study.

Appendix. Supplementary Tables

Supplementary Table 1. Sociodemographic Characteristics (%) of the Public Housing Applicant and Matched Validation Cohorts at the Housing Application Date.

Variables	Categories	Public Housing Applicant Cohort (*N*=7592)	Matched Cohort (*N*=7592)
Sex	Males	29.5	29.5
	Females	70.5	70.5
Age (years)	18 – 24	20.6	20.6
	25 – 39	35.6	35.6
	40 – 64	33.3	33.3
	65+	10.6	10.6
Region of Residence	Non-Winnipeg	49.0	49.0
	Winnipeg	51.0	51.0
Income Assistance†	Yes	55.3	55.3
	No	44.7	44.7
Single Parent Assistance†	Yes	24.2	16.1£
	No	75.8	83.9
General Assistance†	Yes	20.3	19.0
	No	79.7	81.0
Disability Assistance†	Yes	20.5	25.8£
	No	79.5	74.2
Other Income Assistance†	Yes	s	s
	No	100.0	100.0
Income Quintile	Q1 (poorest)	43.7	30.7£
	Q2	23.2	22.3
	Q3	15.1	18.2
	Q4	11.0	14.1
	Q5 (affluent)	5.4	12.7
	NF*	1.6	2.0
Change in Postal Code†	Yes	27.9	17.0£
	No	72.1	83.0
Relationship to Family Head	Family head	93.9	87.6£
	Spouse	5.9	12.1
	Other	0.2	0.3

Note: *NF = Missing due to postal codes not assigned to a DA or a DA having a small non-institutionalized population; †In the year prior to the housing application date; s = suppressed due to small values (1-5); £$p<0.05$.

Supplementary Table 2. Health Status and Health Service Use of the Public Housing Applicant and Matched Validation Cohorts in the Year Prior to the Housing Application Date.

Variable	Category	Public Housing Applicant Cohort (*N*=7592)	Matched Cohort (*N*=7592)
Physical Health Conditions‡	Respiratory Illness	16.4	12.5£
	Diabetes	11.2	7.7£
	Hypertension	12.5	11.3£
	IHD	1.8	0.9£
	Cancer	2.3	2.6
Mental Disorder Diagnosis‡	Schizophrenia	3.1	2.5£
	Affective Disorders	31.9	23.8£
	Substance Abuse Disorders	7.8	4.7£
Resource Utilization Bands‡	Non/Healthy Users	11.6	18.9
	Low Morbidity	13.4	18.0
	Moderate Morbidity	49.1	48.0
	High Morbidity	20.4	12.5
	Very High Morbidity	5.5	2.7
Visits to a General Practitioner	Mean (SD)	6.9 (7.0)	5.3 (6.2)
	Median	5	4£
	IQR	8	6
Visits to a Specialist	Mean (SD)	2.1 (4.9)	1.5 (3.5)
	Median	0	0£
	IQR	2	2
Majority of Care Received from the Same General Practitioner‡◊	Yes	79.5	85.8£
	No	20.5	14.2
Hospitalizations‡	0	84.2	90.2£
	1	10.8	7.2
	2+	5.0	2.6
ED Visits‡* (N = 3871)	0	54.0	68.5£
	1	20.8	16.2
	2+	25.2	15.3

Note: IHD = Ischemic Heart Disease; SD = standard deviation; IQR = interquartile range; ‡values represent percentages (%); *Urban residents only; ◊Public Housing Applicant Cohort N = 6033, Matched Cohort N = 5388; £$p<0.05$

CHAPTER 3 : DURATION OF PUBLIC HOUSING: A POPULATION-BASED INVESTIGATION

3.1 Chapter Overview

This manuscript describes the socioeconomic and health characteristics of a cohort of individuals who moved into public housing in 2007 and 2008. This cohort is followed for seven years to determine length of tenancy and move-out reason. The socioeconomic and health characteristics of tenants who moved out on their own are compared to tenants who did not move out and tenants who were evicted. The cohort characteristics associated with the different move-out reasons are identified. This study shows that on average, individuals who are evicted tend to have poorer health than the other two groups, and that in general socioeconomic characteristics are associated with moving out of public housing, but health characteristics are associated with being evicted. This study is the first to investigate whether health and healthcare use variables are associated with moving out of public housing and whether the factors associated with moving out of public housing vary by move-out reason. This study is potentially useful for policy makers in understanding tenancy behaviour so as to plan for tenant turn-over and in identifying who might be most at risk of having an unsuccessful tenancy so as to provide targeted support.

Publication Details

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3.2 Abstract

This study tested the association between tenancy status in public housing and demographic, geographic, socioeconomic, health status, and health service use characteristics using linked population-based administrative data from Manitoba, Canada. The data were analyzed using multivariable Cox proportional hazards regression. Age, residence location, receipt of income assistance, residential mobility, being diagnosed with a substance abuse disorder, and continuity of care were significantly associated with moving. Voluntary moves were only associated with socioeconomic characteristics, while eviction was also associated with health status and health service use characteristics. Public housing authorities can benefit from this profile of resident characteristics in order to identify who may need supports to have a successful tenancy.

3.3 Background

Public housing is a form of low income housing that is owned and managed by the government. For some people, public housing may be a "stepping stone to economic independence", while for others, public housing is a "legitimate long-term" housing option (Whelan, 2009, p.173). Residents may live in public housing indefinitely provided they respect the terms of their lease and continue to meet eligibility criteria. Unlike other forms of assistance, public housing is rationed due to the finite available housing stock (Dockery, Ong, Whelan, & Wood, 2008).

To date, there is a dearth of Canadian studies about health and housing outcomes of public housing residents; most of the research is from the United States and Australia. Due to housing policy differences over time between the United States and Canada, which are highlighted by Vakili-Zad (2002), American research findings may not generalize to the Canadian setting. Of particular note in recent decades are mobility programs in the United States. These programs have displaced public housing tenants in order to demolish and redevelop public housing. Affected households are either moved to another public housing development or given vouchers to rent in the private market. Consequently, many American public housing residents have experienced forced residential mobility. There is mixed evidence as to whether these moves improve health and other outcomes (Clampet-Lundquist, 2007; Clampet-Lundquist, Edin, Kling, & Duncan, 2011). While several jurisdictions in Canada have taken a similar approach (e.g., the redevelopment of Don Mount Court and Regent Park in Toronto into mixed income communities) (August, 2008; August, 2014), Manitoba has not. In the last decade, Manitoba has renovated and refurbished its public housing stock and made improvements to the physical

environment, but the number of buildings and units as well as the number of people in housing has remained constant (Finlayson et al., 2013).

Manitoba Housing directly manages more than 13,000 public housing units, located in every health region of the province (Finlayson et al., 2013). There are a variety of housing types including single family dwellings, semi-detached units, townhouses, and apartments. In a given year, more than 30,000 individuals reside in public housing, with approximately half under 20 years of age (Finlayson et al., 2013).

The duration of tenancy in public housing varies; however, most studies report an average or median tenancy of less than five years (Berger, Heintze, Naidich, & Meyers, 2008; Dockery et al., 2008; Finlayson et al., 2013; Freeman, 1998; Martens et al., 2014). Two Canadian studies report tenancy duration. In Martens et al's (2014) study, the mean and median length of tenancy among a cohort of youth residing in public housing in Manitoba was 3.55 and 2.33 years, respectively. Finlayson et al (2013) found that 81% of public housing tenants in Manitoba reside for more than a year and 19% reside less than a year. To understand the magnitude of this, according to the 2011 Canadian Census, 38.6% of the population moved in a five-year period (Statistics Canada, 2015). Several studies noted much longer tenancies (Bahchieva & Hosier, 2001; Ruel, Oakley, Wilson, & Maddox, 2010). Tenancy duration varies by household type. One US study calculated a median tenancy duration of 4.69 years, but this was shorter for families with children (3.39 years), and longer for those with a disability (4.05 years) and those who were elderly (8.44 years) (Lubell, Shroder, & Steffen, 2003). Tenancy duration also varied by source and amount of income. Another study found that families and single parents were more likely to have longer stays, while those with a disability status were more likely to have shorter tenancies (Whelan, 2009).

Several researchers have examined additional factors associated with moving out of public housing, such as age, marital status, receipt of income assistance, and household type (Bahchieva & Hosier, 2001; Freeman, 1998; Hungerford, 1996). Sex, prior residency in public housing, work experience, education level, housing market factors, income, and residence size have also demonstrated associations with moving out (Bahchieva & Hosier, 2001; Freeman, 1998; Hungerford, 1996). We are not aware of any study that has examined the association between health and moving out of public housing.

Some tenancies may terminate in a 'disorderly' way, through abandonment or eviction (Pawson & Munro, 2010). In general, eviction rates vary by housing type and geographic region (Lapointe, 2004; van Laere, de Wit, & Klazinga, 2008). For example, one Canadian study reported that approximately 13% of public housing applicants were evicted in a ten year period (Finlayson et al., 2013), while another Canadian study estimated about 18% of households received a Notice of Termination but only between 0.3% and 0.5% were actually evicted due to eviction prevention efforts, such as rent repayment plans (Lapointe, 2004). Often households at risk of eviction experience a multitude of challenges (Portfolio Services and Strategic Projects Division, 2006). Risk factors for eviction include financial mismanagement (Portfolio Services and Strategic Projects Division, 2006; van Laere, de Wit, & Klazinga, 2009b), uncontrolled mental health problems (Crane, Warnes, & Fu, 2006; Portfolio Services and Strategic Projects Division, 2006; Rodriguez et al., 2012; van Laere et al., 2009b), addiction (van Laere, de Wit, & Klazinga, 2009b), antisocial behavior (Lapointe, 2004), domestic violence management (Acacia Consulting and Research, 2006), hygiene problems (Lapointe, 2004), racism (Acacia Consulting and Research, 2006), and an inability to access income supports (Acacia Consulting and Research, 2006).

There are health, psychological, social, and economic costs to moving (Desmond & Kimbro, 2015; Distasio & McCullough, 2016; H. Pawson & Munro, 2010), especially when moves are unanticipated and unwanted (Smith, Alexander, & Easterlow, 1997). One study found that mothers who were evicted and their children experienced negative effects, such as difficulty obtaining basic necessities, depression and parental stress, and poor self-rated health (Desmond & Kimbro, 2015). Additionally, forced moves may lead to individuals accepting subsequent substandard housing (Canadian Mortgage and Housing Corporation, 2005; Desmond, Gershenson, & Kiviat, 2015), experiencing increased residential mobility (Desmond et al., 2015), experiencing disruptions in social networks, social isolation, and/or becoming homeless (Burt, Pearson, & Montgomery, 2007; van Laere et al., 2009a). Landlords also experience social and economic losses when tenants move (e.g., fix and clean units, lose rent, legal fees) (Canadian Mortgage and Housing Corporation, 2005; Crane et al., 2006; Distasio & McCullough, 2016; Pawson & Munro, 2010). Neighbourhoods with high turnover rates may be susceptible to a lack of social cohesion due to little interest by neighbours in each other and in their community, which may lead to crime and social disorder (Pawson & Munro, 2010). Therefore, there are many reasons why eviction should be prevented and thus individuals at-risk of eviction need to be identified.

While researchers have examined the association between various socioeconomic factors and moving out of public housing, little is known about whether health and healthcare use are also factors associated with moving out. We tested the association between moving out and demographic, geographic, economic, health status, and healthcare use characteristics. Additionally, we sought to determine whether there were differences in variable associations for intended and unintended (i.e., eviction) moves.

3.4 Methods

3.4.1 Study Cohort

The cohort included all adults (18+ years) listed as the primary applicant on an application to Manitoba Housing's rental housing and who moved in between January 1, 2007 and December 31, 2008. Manitoba is a Canadian province with an ethnically diverse population of 1.2 million. All cohort members had health coverage in the year prior to their move-in date. Residents of Churchill, a remote northern community, were excluded because public housing is used to supplement the shortage of affordable market housing; it is difficult to distinguish between those who rent at a market rate and those who live in subsidized units (Finlayson et al., 2013). Public housing residents who reapplied (i.e., to move within public housing) and individuals who resided in public housing within two years of their 2007/2008 move-in date were also excluded to limit our focus to new applicants as a previous study found that repeat public housing tenants were less likely to move out (Freeman, 1998).

3.4.2 Data Sources

Study data were administrative data in the Population Research Data Repository housed at the Manitoba Centre for Health Policy. The Repository is a rich collection of anonymized health and social administrative databases linkable at the individual level via a unique scrambled personal health identification number.

The Tenant Management System (TMS) was used to identify applicants to and residents of Manitoba Housing's rental housing, public housing managed by the provincial government (approximately 2,300 buildings and 13,000 units); it does not capture social housing managed by co-operatives and non-profit groups. The Population Registry contains information on all Manitoba residents registered with the Manitoba Health Insurance Services Plan (excludes

military personnel, the RCMP, and those new to Manitoba) and was used to obtain information on demographic characteristics, place of residence, and health insurance coverage. The Registry is updated every six months (June and December), so that these "snapshots" enable residential histories to be created and changes in health coverage can be monitored. Information on households receiving financial support under the provincial Employment and Income Assistance program was acquired from the Social Assistance Management Information Network database. Data from the 2006 Canadian Census was used to create a dissemination area (DA) level measure of income.

Information on discharges from all acute and chronic care facilities was obtained from the hospital discharge abstracts database. Up to 25 diagnosis codes based on the International Classification of Diseases (ICD) system are recorded (ICD-10-CA). The physician billing claims data captures the majority of ambulatory physician visits, as most physicians in Manitoba are reimbursed on a fee-for-service basis. One three-digit ICD-9-CM diagnostic code, the code for the diagnosis most relevant to the visit, is recorded. The admission, discharge, and transfer and E-Triage databases were used to identify visits to adult emergency departments (EDs) in Winnipeg; there is no corresponding data available on ED visits outside of Winnipeg. Information about prescription drugs dispensed from community pharmacies was obtained from the Drug Program Information Network database.

3.4.3 Study Variables

The study observation period was from January 1, 2007 to March 31, 2013. Tenancy duration was calculated as the number of days between the move-in and move-out dates. Eviction was identified from the move-out reason variable.

Study variables were defined in the 365 days prior to the move-in date and were time-invariant. They included demographic, geographic, economic, residential mobility, heath status, and healthcare use characteristics. Demographic variables included sex and age group (18-24, 25-39, 40-64, 65+ years). The location of residence was determined from the six-digit postal code. Region of residence was assigned as urban and rural (i.e., Winnipeg and non-Winnipeg). Residential mobility was determined from changes in six-digit postal code. Individuals were classified as either movers or non-movers (DeVerteuil et al., 2007; Lix et al., 2006). Economic variables included income quintile (IQ) and receipt of income assistance (IA). IQ, an area-level measure, was created from the average household income of the DAs (Roos & Mustard, 1997). The DAs are sorted from poorest to wealthiest and grouped into quintiles such that each quintile represents approximately 20% of the population. Different cut-offs are used for urban and rural areas. Individuals were classified as recipients of IA if they or a member of their household received IA at least once in the 365 days prior to the move-in date (Heaman et al., 2012). The following forms of IA were used: single parent (mother and father assistance), disability, general assistance, and other. The IA types are not mutually exclusive as there may be more than one individual in a household who received IA. Each form of IA is based on financial need in addition to other eligibility criteria.

Health status was determined by the presence of ICD codes for selected conditions in physician billing claims and hospital discharge abstracts (Appendix 1) as well by Aggregated Diagnostic Groups (ADGs). Schizophrenia and affective (mood and anxiety) disorders comprised the mental disorder category. The presence of diagnoses for the following chronic physical health conditions was identified: respiratory illness (e.g., asthma chronic obstructive pulmonary disease, bronchitis, emphysema), diabetes, hypertension, and ischemic heart disease.

Substance abuse disorder and injury diagnosis codes were also identified. ADGs are groups of ICD-9-CM/ICD-10-CA codes that represent diagnoses that are clinically similar and for which the expected or actual use of health care services is similar (Austin, van Walraven, Wodchis, Newman, & Anderson, 2011; Roos, Walld, & Witt, 2014). The John Hopkins Adjusted Clinical Groups® (ACG®) Case-Mix System version 9 clusters the ICD codes into 32 mutually exclusive ADGs. A higher ADG score indicates more comorbidities.

Several measures of healthcare use were examined, including length of hospital stay, the numbers inpatient hospitalizations, the number of ED visits in Winnipeg, the number of ambulatory (e.g., outpatient) physician visits, the majority of physician care, and the number of different prescription drugs based on the third-level of the ATC classification system. Hospitalizations and physician visits were classified into stays/visits for a mental health or physical health reason. Mental health reasons were defined as all disorders listed in ICD-9 chapter "Mental Disorders" excluding those listed under "mental retardation" and in ICD-10 chapter "Mental, Behavioral and Neurodevelopmental disorders" excluding intellectual disabilities and developmental disorders. Any stay/visit not classified as mental health was classified as physical health. Only the first diagnosis field listed on the hospital record (i.e., the most responsible diagnosis) was used to assign reason. Separate counts of the number of general practitioner (GP) and specialist (i.e., psychiatrists, pediatricians, obstetricians and gynecologists, medical specialists, general surgeons, and surgical specialists) visits were made. The majority of physician care received was defined as: (a) the number of different GPs visited, and (b) continuity of care. Continuity of care was defined as having at least 50% of ambulatory physician visits to the same GP (Martens et al., 2009). Cohort members were classified as having

continuous care (≥0.50), not having continuous care (<0.05), or not applicable (<3 physician GP ambulatory visits).

3.4.4 Statistical Analysis

The cohort was divided into non-movers and all movers, and the all mover group was further divided into voluntary movers (moved-on-own) and involuntary movers (evicted). Descriptive statistics, including means, standard deviations, and frequency distributions were used to characterize the groups. Chi-square tests of homogeneity were used to test the association between group membership and each of the categorical variables. Histograms, normal probability plots, and skewness and kurtosis were used to determine whether the continuous variables were normally distributed. Since all of the variables were skewed, Wilcoxon rank-sum tests were used to test between-group differences. For each variable, inferential analyses were conducted for all-movers versus non-movers, voluntary movers versus non-movers, and involuntary movers versus non-movers.

Cox proportional hazards regression models were used to test the association of demographic, geographic, economic, residential mobility, health status, and health service use characteristics with move-out status. Censoring occurred when a tenant moved out, lost health coverage, died, or the study period ended (March 31, 2013). Three models were fit to the data. The first included all members of the cohort, regardless of the reason for moving, the second excluded individuals who were evicted, and the third excluded voluntary movers. Unadjusted and adjusted hazard ratios (HRs) and 95% confidence intervals (95% CIs) are reported. Our primary interest was the associations between moving out of public housing and the health conditions and healthcare use. We entered the health conditions and healthcare use measures to the model after controlling for the socioeconomic measures. Variables were removed from the

model due to multicollinearity and lack of statistical significance. Covariates that violated the proportionality assumption, as assessed by the Schoenfeld residuals, were included in the model as an interaction with time. The generalized R^2, proposed by Allison (2010), was calculated for each of the three full models. Goodness of fit statistics were used to evaluate model fit. All analyses were conducted using SAS version 9.4 (SAS Institute Inc., Cary NC, USA).

3.5 Results

After exclusions, the cohort comprised 3131 (65.4%) of the 4789 adult primary applicants to Manitoba Housing's rental housing and who moved in between January 1, 2007 and December 31, 2008 (Figure 1). Close to half of the cohort moved out of public housing on their own (48.6%) and another 14.2% were evicted. Those who moved out on their own resided an average of 719.8 days (SD = 520.2; median = 608), while those who were evicted resided an average of 674.1 days (SD = 469.6; median = 573). Few cohort members (0.8%) died while residing in public housing.

3.5.1 Sociodemographic Characteristics

Sociodemographic characteristics of the cohort are presented in Table 3-1. Movers were significantly younger than non-movers. The majority were urban residents; the moved-on-own group was less likely while the evicted group was more likely to be urban residents compared to the non-movers. There was an income quintile gradient for movers and non-movers; the gradient was steepest for those who were evicted. Approximately two-thirds of households of movers and non-movers received IA in the 365 days prior to moving in; while 82% of the evicted households and only 60% of the moved-on-own households received IA. Single parent assistance was the most common form of IA for all groups. The evicted group was significantly more likely to receive all forms of IA, except disability IA, than the non-mover group, while the moved-on-own

group was significantly less likely to receive disability IA. A higher percentage of the movers, particularly the evicted group, than the non-movers had a postal code change.

3.5.2 Health Status and Health Service Use Characteristics

Table 3-2 describes the health status and health service use characteristics of the groups. Approximately one-third of the cohort had a physician-diagnosed chronic physical illness and a mental disorder in the 365 days prior to moving into public housing; the groups did not differ significantly. Although a higher percentage of the movers had an injury and a substance abuse disorder than the non-movers, only the evicted group differed statistically from the non-movers. In fact, the evicted group (11.0%) had more than twice the percent who had a substance abuse disorder compared to the non-mover group (5.0%). On average, non-movers (M = 4.3) had fewer ADGs than movers (M = 4.5); however, only the evicted group differed statistically from the non-movers.

There were few statistically significant differences between the groups on the health service use variables. The cohort, on average, filled approximately five prescriptions in the year prior to moving into public housing. The distribution of physician visits was similar across the groups, with approximately 15% seeing a physician none or one time and 48% seeing a physician seven or more times in the year prior to moving into public housing. The cohort was more likely to see a physician for a physical health reason than a mental health reason. Approximately three-quarters of the groups saw a physician for a mental health reason none or one times, while approximately 18% visited a physician none or one time for a physical health reason. On average, the groups had approximately seven and 2.5 GP and specialist visits, respectively. There were two measures of continuous care. On average, all groups visited more than two GPs, with all three mover groups differing significantly from the non-movers. A higher

percentage of the non-movers (75.6%) received the majority of care from the same GP compared to the three mover groups. Although a higher percentage of the mover groups were hospitalized in the year prior to moving into public housing and had longer hospital stays, only the evicted group (5.2%) differed significantly from the non-mover group (2.5%) on hospitalization for a mental health reason. Approximately 64% of the non-movers, 59% of voluntary movers, and 53% of involuntary movers did not visit an ED in the year prior to moving into public housing. The distribution of ED visits between the evicted and non-mover groups differed statistically.

Table 3-3 shows the HRs and 95% CIs for the unadjusted and adjusted Cox proportional hazard models for the entire cohort. An analysis of the Schoenfeld residuals indicated that the proportionality assumption for the region variable was violated, so the interaction between region and time in public housing was included in the final model. The generalized R^2 statistic for the full model was 0.045. Sex, IQ, presence of a chronic physical illness, presence of an injury, a mental disorder, and health service use were not associated with moving out of public housing, while age, region of residence, receipt of IA, residential mobility, having a physician diagnosed substance abuse disorder, and continuity of care were significantly associated with moving out. Younger individuals, those who were residentially mobile, those who had a substance abuse disorder, and who lacked continuous care were significantly more likely to move out of public housing. Residents of Winnipeg and recipients of IA were significantly less likely to move out. That is, individuals who received IA in the year prior to moving into public housing were 21% less likely to move out at any point in time.

Table 3-4 shows the HRs and 95% CIs for the unadjusted and adjusted models when the evicted individuals were excluded. An analysis of the Schoenfeld residuals indicated that the proportionality assumption for the region variable was violated, so the interaction between

region and time in public housing was included in the final model. The generalized R^2 statistic for the full model was 0.044. Sex, IQ, health status, and health service use characteristics were not associated with moving out of public housing voluntarily, while age, region of residence, receipt of IA, and residential mobility were significantly associated with moving out voluntarily. Younger individuals and those who were residentially mobile were significantly more likely to move out of public housing voluntarily, while Winnipeg residents and those who received IA were significantly less likely to move out.

Table 3-5 shows the HRs and 95% CIs for the unadjusted and adjusted Cox proportional hazards model when the voluntary movers were excluded. The generalized R^2 statistic for the full model was 0.113. Region of residence, IQ, and receipt of IA were not significantly associated with being evicted from public housing, while sex, age, and residential mobility were significantly associated with being evicted. Males were 1.4 times more likely to be evicted than females. Younger tenants and those who were residentially mobile in the year prior to moving into public housing were more significantly more likely to be evicted. Three of the four health status measures were significantly associated being evicted. Specifically, tenants who had a chronic physical illness, were injured in the year prior to moving into public housing, and had a substance abuse disorder were significantly more likely to be evicted, while having a mental disorder was not significantly associated with being evicted. Tenants who were hospitalized in the year prior to moving into public housing were 1.38 times more likely to be evicted and those who lacked continuous care from the same GP were 1.35 times more likely to be evicted, while number of physician visits was not significantly associated with being evicted.

3.6 Discussion

Tenancy duration varied among the cohort, but the average duration among the movers was less than two years, which is consistent with several other studies (Dockery et al., 2008; Martens et al., 2014). As in other studies, our cohort was predominantly female (Apparicio & Seguin, 2006; Finlayson et al., 2013) and the majority resided in the poorest areas and received IA. The groups did not differ with respect to the sex distribution, but compared to non-movers, movers were younger and more residentially mobile in the year prior to moving into public housing. There were some notable distinctions in socioeconomic characteristics between the evicted group and the other groups. The evicted group was more likely to live in Winnipeg and more likely to reside in the poorest income areas compared to the non-movers, while the voluntary movers were less likely to live in Winnipeg but did not differ with respect to the IQ distribution. These findings require further exploration, but one potential explanation may be that the demand for public housing is greater in Winnipeg than in other areas and the density of households is greater, so disruptive behavior is noticed more and tolerated less.

Non-movers and movers did not differ with respect to receipt of IA; however, when the mover group was divided, the voluntary movers were less likely and the involuntary movers were more likely to receive IA compared to the non-movers. Single parent IA was the most common form of IA. Almost half of households from the evicted group received single parent IA and 23% received disability IA in the year prior to moving into public housing, which is concerning but needs to be interpreted with caution since receipt of IA was determined at the household level. Thus, the applicant to public housing in this study was not necessarily the recipient of IA in the year prior to moving into public housing. Further study is needed to determine the household composition of those evicted.

In general, the cohort was in relatively poor health, which is consistent with other studies (Digenis-Bury, Brooks, Chen, Ostrem, & Horsburgh, 2008). The average number of ADGs for all groups was more than four, indicating that on average public housing applicants had more than four different health conditions, more conditions than reported in other studies (Bazargan et al., 2005; Black, Rabins, German, McGuire, & Roca, 1997; Black et al., 1998). Approximately one-third of the cohort had a chronic physical illness and a mental disorder, and more than 20% had an injury requiring medical attention in the year prior to moving into public housing. Other studies have also reported a high prevalence of mental illness among public housing residents (Black et al., 1997, Black et al., 1998; Cook, Black, Rabins, & German, 2000; Cummings, Cooper, & Johnson, 2013; Gonyea & Bachman, 2008; Rabins et al., 1996; Simning, van Wijngaarden, & Conwell, 2011; Simning, van Wijngaarden, Fisher, Richardson, & Conwell, 2012). In our study, approximately 5% of the non-movers and voluntary movers had a physician-diagnosed substance abuse disorder, a percentage similar to the general population of Manitoba (Fransoo et al, 2013); however, involuntary movers had more than double the percent with a substance abuse disorder. Other studies report a high level of drug and alcohol use among public housing residents (Cummings et al., 2013; Dekersedy, Schwartz, Alvi, & Tomaszewski, 2003; Williams & Adams-Campbell, 2000; Wiggers et al., 2001).

While Digenis-Bury et al. (2008) found that public housing residents did not differ from other Boston residents on many measures of health service use after adjusting for differences in demographic characteristics, we found a high use of health care. The groups averaged more than seven GP visits and more than two specialist visits in the year prior to moving into public housing. In Manitoba, the average number of ambulatory care physician visits is 4.43 per year (Fransoo et al., 2013). Compared to the non-movers, the mover groups lacked continuity of care.

On average, the mover groups saw more GPs than the non-movers. Also, more than 16% of the cohort was hospitalized and among those hospitalized, the average length of stay was 20 or more days. In Manitoba, the percentage of individuals hospitalized at least once is less than 7% (Fransoo et al., 2013). A slightly higher percentage of the evicted group was hospitalized for a mental health reason compared to the non-movers. In general, individuals who were evicted tended to be worse off in terms of their health status and their health service use patterns differed from those who remained in public housing. It is worth noting that in our study, health status and health service use were defined in the year prior to the move-in date, suggesting that applicants are moving into public housing with poor mental and physical health and have a high need for health care, and therefore may benefit from health care services strategically located within public housing developments.

Age and residentially mobility prior to moving into public housing were consistently associated with moving out of public housing. Younger tenants were more likely to move out voluntarily and be evicted than older individuals. Our results for age are consistent with previous research (Bahchieva & Hosier, 2001; Freeman, 1998; Hungerford, 1996). Region of residence and receipt of income assistance were significantly associated with voluntarily moving out of public housing, but not with eviction. Specifically, urban residents and IA recipients were less likely to move out of public housing voluntarily. Previous research has also found that recipients of IA were less likely to move (Bahchieva & Hosier, 2001; Hungerford, 1996). While previous research has found sex to be associated with moving out of public housing (Hungerford, 1996), sex was only associated with eviction in our study.

Health status and healthcare use factors were significantly associated with being evicted from public housing, but were not significantly associated with moving out voluntarily.

Specifically, tenants treated for an injury in the year prior to moving into public housing, those who had a physician diagnosed chronic physical health condition, and those diagnosed with a substance abuse disorder were significantly more likely to be evicted. Additionally, tenants lacking continuous care from the same GP and those hospitalized were more likely to be evicted. None of the health status or health service use variables were significantly associated with moving out voluntarily, suggesting the significant relationships observed in the all-mover model was being driven by those who were evicted. Interestingly, having a mental health disorder was not significantly associated with moving out of public housing in any of the models and receipt of IA was not associated with being evicted. These findings suggest that socioeconomic factors may be helpful in identifying who will move out of public housing in general and by extension who will have short versus long tenancies, while health and healthcare use factors may be useful in identifying individuals at-risk of eviction.

3.6.1 Policy Implications

This research is important since estimating tenancy duration has implications for the overall need for public housing, for developing policies on where to assign people to housing units, and for allocating services (Dockery et al., 2008). Since the public housing stock is limited, programs that support individuals to become self-sufficient may help free units for others in need (Freeman, 1998).

Additionally, identifying early who is likely to experience housing problems is critical in order to mitigate them; eviction is amendable to intervention. Each step in the eviction process represents an opportunity to intervene; however, the earlier the intervention, the greater the chance of prevention. Acacia Consulting and Research (2006) depict housing instability as a cycle with eight stages: safe tenancy, arrears/default, notice, application, dispute, eviction order,

housing loss, and housing search. Eviction prevention programs may be universally administered or directed to at-risk tenants (Crane et al., 2006), and offer a range of support and services, including providing information and advice, conflict resolution and mediation, legal representation, and emergency financial assistance (Acacia Consulting and Research, 2006; Burt, Pearson, & Montgomery, 2007; Canadian Mortgage and Housing Corporation, 2005; Distasio & McCullough, 2016; Theodos, Popkin, Parilla, & Getsinger, 2012; van Laere et al., 2008; van Laere, De Wit, & Klazinga, 2009b). There are also longer term eviction prevention initiatives, such as providing mental health services, supportive housing services, and rent subsidies (Burt et al., 2007). In our analysis, health status and health service use were significantly associated with eviction. Thus, in addition to providing mental health supports, services to address physical health challenges may also be beneficial. Physicians may have a role in identifying individuals at-risk of eviction and to refer patients to the appropriate services. Furthermore, the significance of substance abuse in our analysis suggests there is a need to provide training to tenants in harm reduction strategies and for landlords to support a Housing First approach so individuals can obtain and maintain housing. The evidence is strong that a Housing First approach works in keeping individuals who were homeless and have a mental illness housed and that when individuals are stably housed, their functioning improves (Roy et al., 2015; Stergiopoulos et al., 2015; Tsemberis, 1999; Tsemberis, Gulcur, & Nakae, 2004). The Community Wellness Initiative is an example of an eviction prevention program in Winnipeg; it is a partnership between the Winnipeg Regional Health Authority and Manitoba Housing that began in 2005 and includes outreach and group programs offered in several Manitoba Housing buildings. The Outreach program involves a housing support worker in regular contact on a one-on-one basis for up to a

year with a Manitoba Housing tenant who is at-risk of being evicted to help the tenant maintain his/her tenancy and improve quality of life.

3.6.2 Study Strengths

This study has a number of strengths. We were able to link public housing data to health data at an individual-level, and to our knowledge, no other study has examined the association between move-out status and health characteristics. Additionally, we distinguished between movers who moved on their own and movers who were evicted. This was important as these two groups differed on socioeconomic, health, and health service use characteristics.

3.6.3 Study Limitations

There are also a number of limitations to this study. Firstly, Manitoba Housing directly manages more than 13,000 public housing units. A total of 4,500 other social housing units are operated by cooperatives, non-profit groups, and property management agencies. As well, Manitoba Housing provides housing subsidies to 17,300 households. Individual-level administrative data are only available for tenants residing in public housing that Manitoba Housing directly manages, and not for tenants residing in other forms of housing.

Although there were numerous statistically significant associations, many of the HRs were small to moderate in size and the generalized R^2 values were small. These findings may arise due to measurement error in the outcome variable. Duration of tenancy and move-out status were based on the move-in and move-out dates recorded by Manitoba Housing. To move to a new residence within Manitoba Housing, individuals have to reapply, which may result in some misclassification.

There may also be measurement error in some of the covariates. The diagnoses of the health conditions are based on physician visits and hospitalizations in the 365 days prior to

moving into public housing. Only one diagnosis code is recorded for each physician visit. Consequently, the number of people with any of the health conditions may be underestimated. Residential mobility may have been underestimated if address changes were not reported to Manitoba Health.

Additionally, there are a number of variables that we could not measure due to the lack of available data, such as the vacancy rate in public housing and the availability of other affordable low-income housing (Dockery et al., 2008; Freeman, 1998; Pawson & Munro, 2010). Also, we did not include characteristics of other household members or household-level characteristics, such as the presence of children, family size, the sex-age distribution of dependents, or a history of being homeless (Bahchieva & Hosier, 2001; Freeman, 1998; Hungerford, 1996). These could be examined in future research along with determining whether status changes (i.e., marital status, household size, disease diagnosis) spark a move.

Finally, our data do not indicate reasons for a move, other than eviction. Moving may have a positive impact if individuals move to a better housing situation, are more conveniently located to services, employment, and/or school (Pawson & Munro, 2010). Moving may have a negative impact if individuals are forced to move. A qualitative study could shed additional light on the impact of moving, beyond that ascertained from this population-based study.

3.7 Conclusion

In summary, individuals moving into public housing tend to be in poor health; thus, mental and physical health services strategically located in public housing developments would be wise. Additionally, since health status and health service use were associated with being evicted, physicians may have a role to play in identifying who is at-risk of eviction and to coordinate the appropriate supports for these tenants, including educate them on harm reduction

strategies. In general, programs should be implemented to assist tenants become self-sufficient and address the issues that contribute to them experiencing housing instability. Finally, since the socioeconomic and health characteristics of tenants who moved on their own differed from people who were evicted, future studies examining tenancy behavior should account for move-out reason.

Disclaimer

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Ethics Approval

Ethics approval was obtained from the University of Manitoba Health Research Ethics Board. Data access was approved by the Manitoba Health Information Privacy Committee.

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Authors' Contributions

AMH, LML, BB, JD, and LR contributed to the study conception, design, interpretation of the data, drafting and critical revision of the manuscript. AMH contributed to the data analysis, interpretation of the data, and writing and revision of the manuscript. All authors participated in editing and revising the manuscript. All authors read and approved the final manuscript.

3.8 References

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Table 3-1. Socio-Demographic Characteristics in the 365 Days Prior to Moving into Public Housing among New Public Housing Residents by Move-Out Status.

Characteristic	Moved						Non-Movers (N = 1165)	
	All Movers (N = 1966)		On Own (N = 1521)		Evicted (N = 445)			
	N	%	N	%	N	%	N	%
Sex								
Male	490	24.9	373	24.5	117	26.3	328	28.2
Female	1476	75.1	1148	75.5	328	73.7	837	71.9
Age (years)								
18 – 24	530	27.0***	381	25.1***	149	33.5***	190	16.3
25 – 39	689	35.1	518	34.1	171	38.4	385	33.1
40 – 64	507	25.8	390	25.6	117	26.3	415	35.6
65+	240	12.2	232	15.3	8	1.8	175	15.0
Region								
Winnipeg	1091	55.5	781	51.4*	310	69.7***	668	57.3
Non-Winnipeg	875	44.5	740	48.7	135	30.3	497	42.7
Income Quintile‡								
Q1 (lowest)	944	48.0	695	45.7	249	56.0*	514	44.1
Q2	376	19.1	303	19.9	73	16.4	266	22.8
Q3	331	16.8	269	17.7	62	13.9	210	18.0
Q4	185	9.4	147	9.7	38	8.5	114	9.8
Q5 (highest)	101	5.1	83	5.5	18	4.0	48	4.1
Income Assistance†								
Yes	1279	65.1	914	60.1**	365	82.0***	777	66.7
No	687	34.9	607	39.9	80	18.0	388	33.3
Single Parent Assistance								
Yes	780	39.7*	569	37.4	211	47.4***	404	34.7
No	1186	60.3	952	62.6	234	52.6	761	65.3
General Assistance								
Yes	378	19.2	252	16.6	126	28.3***	202	17.3
No	1588	80.8	1269	83.4	319	71.7	963	82.7
Disability Assistance								
Yes	349	17.8***	245	16.1***	104	23.4	284	24.4
No	1617	82.3	1276	83.9	341	76.6	881	75.6
Residential Mobility								
Yes	668	34.0***	486	32.0*	182	40.9***	304	26.1
No	1298	66.0	1035	68.1	263	59.1	861	73.9

Note. ‡Does not sum to the total due to missing values.
†Single parent, general, and disability are types of income assistance. These categories are not mutually exclusive.
* $p < 0.01$, ** $p < 0.001$, *** $p < 0.0001$

Table 3-2. Health Status and Health Service Use in the 365 Days prior to Moving into Public Housing among New Residents of Public Housing by Move-Out Status.

Characteristics	Moved							
	All Movers (N = 1966)		On Own (N = 1521)		Evicted (N = 445)		Non-Movers (N = 1165)	
	N	%	N	%	N	%	N	%
Chronic Physical Illness	621	31.6	486	32.0	135	30.3	393	33.7
Injury	474	24.1	341	22.4	133	29.9**	254	21.8
Mental Disorder	638	32.5	481	31.6	157	35.3	360	30.9
Substance Abuse Disorder	128	6.5	79	5.2	49	11.0***	58	5.0
ADGs	4.5	(3.0)	4.4	(3.0)	4.8	(3.1) *	4.3	(2.9)
Mean # of Different Drugs (SD)	5.1	(4.1)	5.0	(4.0)	5.4	(4.2)	5.2	(4.3)
# of Physician Visits								
0 – 1	302	15.4	236	15.5	66	14.8	169	14.5
2 – 6	726	36.9	558	36.7	168	37.8	414	35.5
7+	938	47.7	727	47.8	211	47.4	582	50.0
# of Physician Visits for a Mental Health Reason								
0 – 1	1503	76.5	1175	77.3	328	73.7	916	78.6
2 – 6	350	17.8	265	17.4	85	19.1	173	14.9
7+	113	5.8	81	5.3	32	7.2	73	6.5
# of Physician Visits for a Physical Health Reason								
0 – 1	356	18.1	276	18.2	80	18.0	213	18.3
2 – 6	827	42.1	635	41.8	192	43.2	465	39.9
7+	783	39.8	610	40.1	173	38.9	487	41.8
Mean # of GP Visits (SD)	7.2	(7.0)	7.0	(6.6)	7.9	(8.3)	6.8	(6.2)
Mean # of Specialist Visits (SD)	2.3	(4.7)	2.3	(4.8)	2.6	(4.3)	2.6	(5.1)
Mean # of GPs Seen (SD)	2.7	(2.2) ***	2.6	(2.2) **	2.9	(2.3) ***	2.3	(1.9)
Continuity of Care								
No	391	19.9**	283	18.6*	108	24.3***	163	14.0
NA	190	9.7	143	9.4	47	10.6	121	10.4
Yes	1385	70.5	1095	72.0	290	65.2	881	75.6
Hospitalization								
No	1637	83.3	1272	83.6	365	82.0	989	84.9
Yes	329	16.7	249	16.4	80	18.0	176	15.1
Hospitalization for a Mental Health Reason								
No	1902	97.5	1480	97.3	422	94.8*	1136	97.5
Yes	64	3.3	41	2.7	23	5.2	29	2.5
Hospitalization for a Physical Health Reason								
No	1683	85.6	1300	85.5	383	86.1	1009	86.6
Yes	283	14.4	221	14.5	62	13.9	156	13.4
Mean # of Inpatient Hospital Days	24.4	(49.6)	24.4	(50.0)	24.4	(48.6)	19.4	(34.9)
# Emergency Department Visits†								
0	624	57.2	461	59.0	163	52.6*	426	63.8
1	234	21.5	162	20.7	72	23.2	126	18.9
2+	233	21.4	158	20.2	75	24.2	116	17.4

Note. GP = general practitioner; [†]Winnipeg residents only.
* $p < 0.01$, ** $p < 0.001$, *** $p < 0.0001$

Table 3-3. Unadjusted and Adjusted Cox Proportional Hazards Ratios (HRs) and 95% Confidence Intervals (CIs) for Moving Out of Public Housing (N = 3131).

Characteristic		Unadjusted HR (95% CI)	Adjusted HR (95% CI)
Sex	Male	0.92 (0.83,1.02)	1.07 (0.95,1.19)
	Female	Ref	Ref
Age (years)	18 – 24	**1.51 (1.30,1.76)**	**1.87 (1.53,2.28)**
	25 – 39	**1.17 (1.01,1.35)**	**1.44 (1.19,1.73)**
	40 – 64	0.93 (0.79,1.08)	1.09 (0.91,1.30)
	65+	Ref	Ref
Region	Winnipeg	**0.90 (0.83,0.99)**	**0.70 (0.60,0.83)**
	Non-Winnipeg	Ref	Ref
Income Quintile	NF*	0.96 (0.64,1.45)	1.11 (0.73, 1.69)
	Q1	0.94 (0.76,1.15)	0.98 (0.79,1.21)
	Q2	0.80 (0.64,1.00)	0.86 (0.69,1.07)
	Q3	0.85 (0.68,1.06)	0.91 (0.73,1.14)
	Q4	0.90 (0.71,1.15)	0.96 (0.75,1.23)
	Q5	Ref	Ref
Income Assistance	Yes	0.94 (0.86,1.03)	**0.79 (0.71,0.89)**
	No	Ref	Ref
Residential Mobility	Yes	**1.24 (1.13,1.36)**	**1.17 (1.06,1.30)**
	No	Ref	Ref
Chronic Physical Illness	Yes	0.95 (0.87,1.05)	1.09 (0.97,1.21)
	No	Ref	Ref
Injury	Yes	1.10 (0.99,1.22)	1.09 (0.98,1.22)
	No	Ref	Ref
Mental Disorder	Yes	1.04 (0.95,1.14)	1.09 (0.98,1.21)
	No	Ref	Ref
Substance Abuse Disorder	Yes	1.20 (1.00,1.43)	**1.21 (1.01,1.47)**
	No	Ref	Ref
Hospitalization	Yes	1.11 (0.98,1.25)	1.13 (1.00,1.28)
	No	Ref	Ref
Continuity of Care	No	**1.25 (1.12,1.40)**	**1.15 (1.02,1.29)**
	NA	1.01 (0.87,1.18)	0.96 (0.80,1.16)
	Yes	Ref	Ref
# of Physician Visits	7+	0.92 (0.81,1.05)	0.84 (0.70,1.01)
	2 – 6	0.95 (0.83,1.09)	0.88 (0.74,1.04)
	0 – 1	Ref	Ref

Note. Bold values denote statistically significant results. *NF = Missing. Region x Time in public housing included in the model.

Table 3-4. Unadjusted and Adjusted Cox Proportional Hazards Ratios (HRs) and 95% Confidence Intervals (CIs) for Moving Out of Public Housing, Excluding Evicted Individuals (N = 2686).

Characteristic		Unadjusted HR (95% CI)	Adjusted HR (95% CI)
Sex	Male	0.91 (0.81,1.02)	1.02 (0.90,1.16)
	Female	Ref	Ref
Age (years)	18 – 24	**1.29 (1.09,1.51)**	**1.69 (1.36,2.10)**
	25 – 39	1.01 (0.86,1.17)	**1.32 (1.08,1.61)**
	40 – 64	**0.79 (0.67,0.93)**	1.01 (0.83,1.21)
	65+	Ref	Ref
Region	Winnipeg	**0.81 (0.73,0.89)**	**0.64 (0.54,0.77)**
	Non-Winnipeg	Ref	Ref
Income Quintile	NF*	1.01 (0.64,1.59)	1.28 (0.81,2.04)
	Q1	0.89 (0.71,1.12)	0.99 (0.79,1.25)
	Q2	0.80 (0.63,1.02)	0.89 (0.68,1.13)
	Q3	0.84 (0.66,1.08)	0.91 (0.71,1.16)
	Q4	0.90 (0.69,1.18)	0.97 (0.74,1.27)
	Q5	Ref	Ref
Income Assistance	Yes	**0.82 (0.74,0.90)**	**0.72 (0.64,0.82)**
	No	Ref	Ref
Residential Mobility	Yes	**1.18 (1.06,1.31)**	**1.18 (1.05,1.32)**
	No	Ref	Ref
Chronic Physical Illness	Yes	0.95 (0.86,1.06)	1.05 (0.92,1.19)
	No	Ref	Ref
Injury	Yes	1.03 (0.91,1.16)	1.03 (0.91,1.18)
	No	Ref	Ref
Mental Disorder	Yes	1.01 (0.91,1.13)	1.09 (0.97,1.23)
	No	Ref	Ref
Substance Abuse Disorder	Yes	1.03 (0.82,1.29)	1.11 (0.87,1.40)
	No	Ref	Ref
Hospitalization	Yes	1.08 (0.94,1.24)	1.08 (0.93,1.25)
	No	Ref	Ref
Continuity of Care	No	**1.20 (1.05,1.37)**	1.13 (0.98,1.29)
	NA	0.97 (0.82, 1.16)	0.91 (0.73,1.13)
	Yes	Ref	Ref
# of Physician Visits	7+	0.91 (0.79,1.06)	0.86 (0.70,1.05)
	2 – 6	0.94 (0.81,1.10)	0.87 (0.72,1.05)
	0 – 1	Ref	Ref

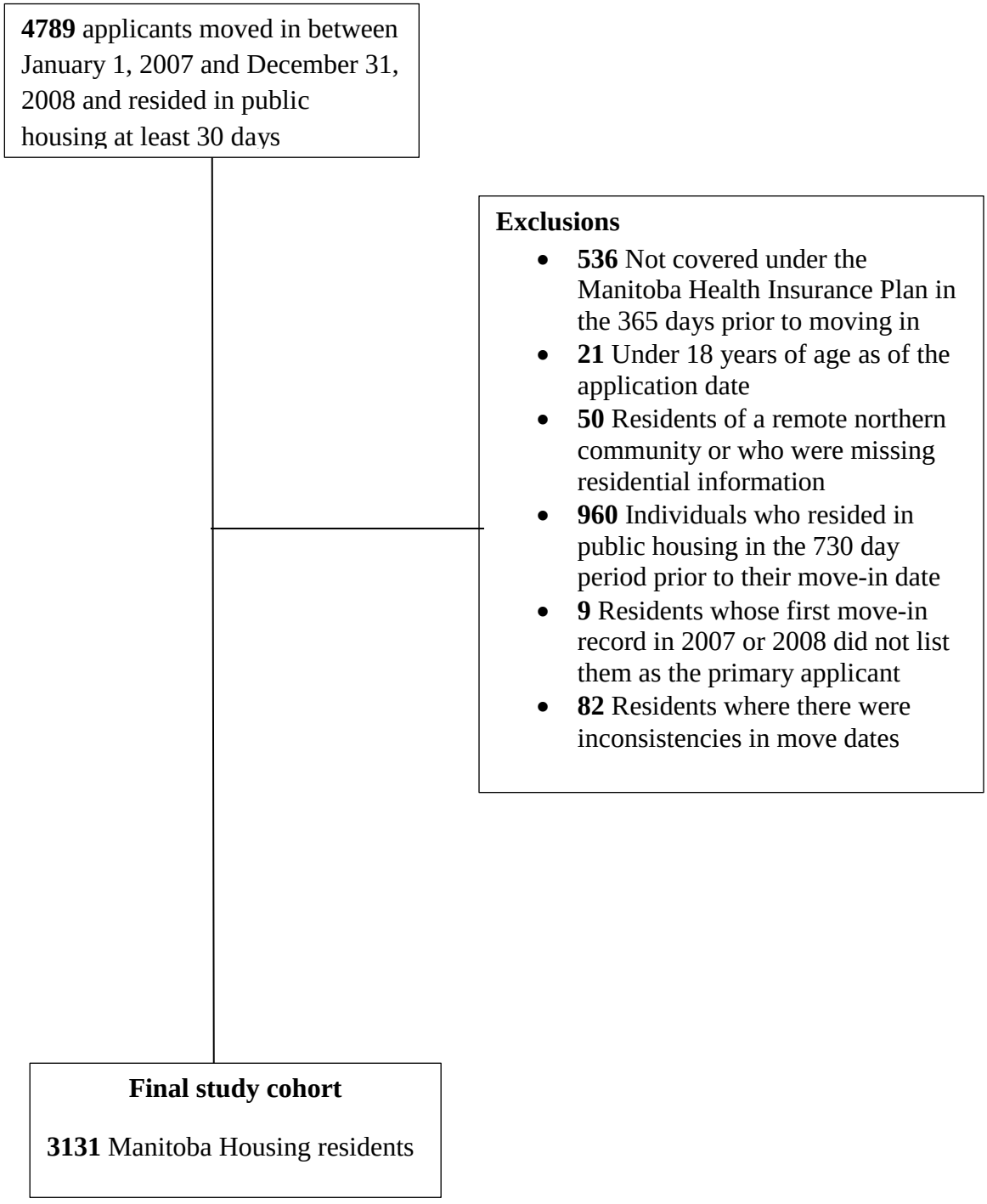
Note. Bold values denote statistically significant results. *NF = Missing. Region x Time in public housing included in the model.

Table 3-5. Unadjusted and Adjusted Cox Proportional Hazards Ratios (HRs) and 95% Confidence Intervals (CIs) for Moving Out of Public Housing, Excluding Voluntary Movers (N = 1610).

Characteristic		Unadjusted HR (95% CI)	Adjusted HR (95% CI)
Sex	Male	0.93 (0.75,1.14)	**1.37 (1.08,1.74)**
	Female	Ref	Ref
Age (years)	18 – 24	**12.73 (6.25,25.91)**	**12.41 (5.70,27.02)**
	25 – 39	**7.95 (3.92,16.15)**	**7.67 (3.59,16.40)**
	40 – 64	**5.46 (2.67,11.16)**	**4.50 (2.13,9.54)**
	65+	Ref	Ref
Region	Winnipeg	**1.55 (1.27,1.90)**	1.15 (0.92,1.43)
	Non-Winnipeg	Ref	Ref
Income Quintile	NF*	0.96 (0.36,2.58)	0.74 (0.27,2.03)
	Q1	1.18 (0.73,1.91)	0.95 (0.58,1.56)
	Q2	0.74 (0.44,1.24)	0.70 (0.42,1.19)
	Q3	0.80 (0.47,1.35)	0.88 (0.52,1.50)
	Q4	0.86 (0.49,1.51)	0.90 (0.51,1.59)
	Q5	Ref	Ref
Income Assistance	Yes	**2.03 (1.59,2.58)**	1.09 (0.84,1.42)
	No	Ref	Ref
Residential Mobility	Yes	**1.78 (1.47,2.14)**	**1.25 (1.02,1.53)**
	No	Ref	Ref
Chronic Physical Illness	Yes	0.88 (0.72,1.08)	**1.33 (1.06,1.66)**
	No	Ref	Ref
Injury	Yes	**1.46 (1.19,1.78)**	**1.36 (1.09,1.70)**
	No	Ref	Ref
Mental Disorder	Yes	1.19 (0.98,1.45)	1.09 (0.88,1.36)
	No	Ref	Ref
Substance Abuse Disorder	Yes	**2.02 (1.50,2.72)**	**1.66 (1.20,2.28)**
	No	Ref	Ref
Hospitalization	Yes	1.24 (0.97,1.58)	**1.38 (1.07,1.79)**
	No	Ref	Ref
Continuity of Care	No	**1.78 (1.42,2.22)**	**1.35 (1.07,1.71)**
	NA	1.15 (0.85,1.57)	1.18 (0.79,1.74)
	Yes	Ref	Ref
# of Physician Visits	7+	0.94 (0.71,1.24)	0.75 (0.50,1.11)
	2 – 6	1.03 (0.77,1.37)	0.89 (0.62,1.29)
	0 – 1	Ref	Ref

Note. Bold values denote statistically significant results. *NF = Missing.

Figure 3-1. Flow chart for the construction of the study cohort.



Appendix. Supplementary Table

Table. ICD Codes Used to Define Physical and Mental Disorders.

Condition	ICD-9-CM	ICD-10-CA
Injury	80 – 99	S00 – S99, T00 – T98
Chronic Physical		
Respiratory Illness	466, 490 – 493, 496	J20, J21, J40 – J45
Diabetes	250	E10 – E14
Hypertension	401 – 405	I10 – I15
Ischemic Heart Disease	410 – 413	I20 – I25
Mental Disorder		
Schizophrenia	295	F20, F21, F25, F232
Affective Disorder	296, 300, 309, 311	F31 – F33, F40 – F42, F44, F48, F99, F341, F380, F381, F410, F411, F412, F413, F418, F419, F431, F432, F438, F450, F451, F452, F530, F680, F930
Substance Abuse Disorder	291, 292, 303 – 305	F10 – F19, F55

Note: *In defining affective disorders using the hospital discharge abstracts, the following four digit ICD-9-CM codes were used 296.1 to 296.8, 300.0, 300.2 to 300.4, and 300.7.

CHAPTER 4 : CHANGES IN HEALTHCARE USE AMONG INDIVIDUALS WHO MOVE INTO PUBLIC HOUSING: A POPULATION-BASED INVESTIGATION

4.1 Chapter Overview

This manuscript describes healthcare use patterns of a cohort of individuals who moved into public housing in 2009 and 2010. Healthcare use was defined in the twelve 30-day periods (i.e., one year) before and the twelve 30-day periods after individuals moved into public housing. Different types of healthcare were examined: hospitalizations, emergency department visits, family and specialist physician visits, and prescription drug use. This study showed that healthcare use varied over time and differed by type. This is one of the first studies to examine healthcare use patterns of public housing residents. In general, healthcare use increased in the two to three months prior to the move-in date which may indicate that a health event prompted individuals to apply to public housing. Healthcare use declined in the few months immediately following the move-in date; this may indicate that housing was a stabilizing factor for health or that the transition to a new residence resulted in decreased access to healthcare providers.

Publication Details

Submitted to *BMC Health Services Research*

4.2 Abstract

Introduction

Residence in public housing, a subsidized and managed government program, may affect both health and healthcare utilization. We compared healthcare use in the year prior to individuals moving into public housing with usage during the first year of tenancy. We also described trends in use over time.

Method

We used linked population-based administrative data housed in the Population Research Data Repository at the Manitoba Centre for Health Policy. The cohort consisted of individuals who moved into public housing in 2009 and 2010. We determined the number of healthcare contacts in the twelve 30-day periods immediately preceding and immediately following the public housing move-in date. Generalized linear models with generalized estimating equations tested for differences in healthcare use in the pre- and post-move-in date periods. Odds ratios (ORs) or incident rate ratios (IRRs) are reported, along with 95% confidence intervals (95% CIs).

Results

The cohort included 1942 individuals; the majority were female (73.4%) who lived in low income areas and received government assistance (68.1%). On average, the cohort had more than four health conditions; affective disorders (32.9%) and arthritis (26.3%) were the most common conditions. In a 30-day period, between 37.0 and 43.0%, 10.0 and 14.0%, 6.0 and 10.0%, and 1.0 and 5.0% visited a general practitioner (GP), specialist physician, emergency department (ED), and were hospitalized, respectively. These percentages were highest in the few months before the move-in date and lowest in the few months after the move. The period by month interaction was significant for hospitalizations, GP visits, ED visits, and prescription drug use.

Discussion

Use of some healthcare services declined after people moved in; however, the decrease was only observed in the first few months and utilization rebounded. Knowledge of healthcare trends before individuals move in are informative for ensuring that appropriate supports are available to new public housing residents. Further study is needed to determine if decreased healthcare utilization following a move to public housing is attributable to decreased access.

4.3 Introduction

Public housing is a form of subsidized housing owned and/or managed by government (municipal, provincial/state, or federal). Public housing tenants pay rent geared to income - - usually 30 percent of the household income (Canada Mortgage and Housing Corporation, 2014). The intent of public housing is to offer a broad safety net to the economically disadvantaged (Dockery, Ong, Whelan, & Wood, 2008).

Public housing residents tend to be in poorer health compared to the general population, with lower self-reported health (Buchner, Nicola, Martin, & Patrick, 1997; Digenis-Bury, Brooks, Chen, Ostrem, & Horsburgh, 2008; Wiggers et al., 2001), a higher prevalence of chronic diseases (including diabetes, hypertension, asthma) (Bazargan et al., 2005; Digenis-Bury et al., 2008; Lambertino, Turyk, Curtis, & Persky, 2009; M. Smith et al., 2013), injuries (M. Smith et al., 2013), and mental health disorders (Gonyea & Bachman, 2008; Rabins et al., 1996; Simning, van Wijngaarden, & Conwell, 2011a; M. Smith et al., 2013). Public housing residents are more likely to engage in risky health behaviors, including smoking, alcohol and drug use, as well as risky sexual behaviors (Cummings, Cooper, & Johnson, 2013; Dekeseredy, Schwartz, Alvi, & Tomaszewski, 2003; Digenis-Bury et al., 2008; Sikkema et al., 1995, 2000; Wiggers et al., 2001; Williams & Adams-Campbell, 2000; Yu, Nebbitt, Lombe, Pitner, & Salas-Wright, 2012), and generally have lower levels of physical activity (Bennett et al., 2007; Buchner et al., 1997; Heinrich et al., 2007; Lee, Mama, Mcalexander, Adamus, & Medina, 2011; Lewis, Raczynsid, Heath, Levinson, & Cutter, 1993; Roman, Knight, Chalfin, & Popkin, 2009; Scammell et al., 2015; Shelton et al., 2011). There is evidence, however, that residents' poor health precedes their application for public housing (Hinds, Bechtel, Distasio, Roos, & Lix, 2016).

Research about healthcare use among public housing residents is limited and inconsistent. McNeill et al. (2009) found that 87% of a sample of 1554 individuals residing in twelve public housing sites in Massachusetts reported having access to a regular health care provider. In Black et al.'s two studies (Black et al., 1998; Black, Rabins, German, McGuire, & Roca, 1997), 90% of the older adult public housing residents had received medical care in the past six months, averaging six medical visits during this time, but only 43% of residents had obtained care from a private physician (the rest obtained care from a clinic or hospital-based provider). After adjusting for demographic, health, hospital, and neighbourhood characteristics, children in public housing that had not been redeveloped were significantly more likely to have recurrent use of acute care services when compared with children not residing in public housing or in public housing that had been renovated and redeveloped as part of the Housing Opportunities for People Everywhere (HOPE VI) program (Kersten, LeWinn, Gottlieb, Jutte, & Adler, 2014).

We endeavored to determine the effect public housing has on healthcare use in the short-term (i.e., one year). Our research objectives were to examine trends in healthcare use before and after individuals move into public housing. We tested for a change in healthcare use between the two periods. We hypothesized that a health event would prompt an application to public housing and there may be an increase in the use of healthcare services before the move-in date. We also hypothesized that healthcare use would decrease after the move-in date. The reasons for this decrease are potentially multi-faceted and could include reduced access to healthcare, an adjustment period after moving, or to a better housing and financial situation; these factors may improve health temporarily. We suspected that healthcare use may not stay at a reduced level since public housing residents often have chronic conditions which require ongoing care.

4.4 Methods

4.4.1 Study Cohort

Manitoba is an ethnically diverse Canadian province with a population of 1.3 million, with 56% residing in the City of Winnipeg, the capital. The cohort included all adults (18+ years) who moved into public housing provided by the provincial ministry, Manitoba Housing, between January 1, 2009 and December 31, 2010 and were listed as the primary applicant. There are approximately 35,000 social housing units in Manitoba, of which approximately 13,000 are public housing units spread throughout the province that are directly managed by Manitoba Housing (Finlayson et al., 2013). More than 30,000 individuals reside in public housing units in a year, with approximately half under the age of 20 years (Finlayson et al., 2013).

The cohort included individuals registered with the Manitoba Health Services Insurance Plan in the year prior to and in the year following their public housing move-in date. Only new applicants were included; individuals residing in public housing within two years of their 2009/2010 move-in date were excluded. In Churchill, a remote northern Manitoba community, public housing is used to supplement the shortage of affordable market housing. Residents of that community were excluded as it is not possible to distinguish between those paying market rate rents and those living in subsidized units (Finlayson et al. 2013). Individuals living in public housing less than one year were excluded.

4.4.2 Data Source

The Population Research Data Repository housed at the Manitoba Centre for Health Policy is a rich collection of anonymized health and social administrative databases linkable at the individual level via a unique scrambled personal health identification number. Previous researchers have identified all residents who applied to and/or who moved into public housing

and linked this information to a comprehensive set of health and socioeconomic indicators and outcomes (Hinds et al., 2016; Martens et al., 2014; Smith et al., 2013).

The Tenant Management System (TMS) was used to indicate residents of Manitoba Housing's rental housing. The TMS contains information on public housing managed by the provincial government (approximately 2,300 buildings and 13,000 units). The number of public housing units has remained fairly constant over time; approximately 59% of the units are located in the Winnipeg health region (Finlayson et al., 2013). Demographic (e.g., sex, birth date, six-digit postal code) and health coverage information (e.g., start and end of coverage dates) was obtained from the Population Registry. The Registry contains information for all Manitoba residents registered with the provincial health plan (excludes military personnel, the RCMP, and new residents) and is updated every six months (June and December). The Social Assistance Management Information Network provides information on households receiving financial support under the provincial Employment and Income Assistance program. Average household income information from the 2006 Canadian Census was used to create an area-level measure of income (i.e., income quintile).

Information on discharges from all acute and chronic care facilities was obtained from the hospital discharge abstracts database. Up to 25 diagnosis codes are recorded using the International Classification of Diseases, 10^{th} revision, Canadian version (i.e., ICD-10-CA). The physician billing claims database captures all fee-for-service physician visits, which comprises the vast majority of visits. The diagnosis deemed most responsible for the visit is recorded using a three-digit International Classification of Diseases, 9^{th} revision, Clinical Modification (i.e., ICD-9-CM) code. Information about visits to adult emergency departments (EDs) in Winnipeg was obtained from the Emergency Department Information System. There was no corresponding

data available on ED visits outside of Winnipeg. Information about prescription drugs dispensed from community pharmacies was obtained from the Drug Program Information Network (DPIN) database.

4.4.3 Study Variables

Demographic variables included sex and age group (18-24, 25-39, 40-64, 65+ years) as of the move-in date. Geographic, residential mobility, and economic variables were defined for the 365 days prior to the move-in date. The six-digit postal code was used to determine residence before a move to public housing. Region of residence was defined as urban or rural (i.e., Winnipeg or non-Winnipeg). Approximately 55% of the Manitoba population resides in Winnipeg. Residential mobility was defined by identifying changes in postal code in the 365 days prior to the move-in date. In Winnipeg, a postal code covers a medium sized apartment or a residential block, while postal code areas are larger outside of the city. Individuals were classified as movers or non-movers depending on whether their postal code changed (DeVerteuil et al., 2007; Lix et al., 2006). The Manitoba Housing move-in and move-out dates were used to determine length of tenancy. The move-out reason indicated that individuals moved out voluntarily or were evicted.

The economic variables were receipt of income assistance (IA) and income quintile. Individuals were classified as recipients of IA if they or a member of their household received any form of IA in the 365 days prior to the move-in date (Heaman et al., 2012). IA is based on financial need as well as other eligibility criteria. Income quintile (IQ) is an area-level measure of income based on the average household income in the dissemination area (DA), the smallest geographic level for which Census data are reported (Roos & Mustard, 1997). The DAs are sorted from poorest to wealthiest and grouped into quintiles. Each quintile represents

approximately 20% of the population. Different household income cut-offs define quintiles for urban and rural areas.

Health status in the 365 days prior to the move-in date was established using diagnosis codes for selected conditions in physician billing claims and hospital discharge abstracts databases (Appendix). These conditions have been used previously to describe public housing applicants and/or residents (Hinds et al., 2016; M. Smith et al., 2013). Mental health conditions included schizophrenia, affective (mood and anxiety) disorders, and substance abuse disorders. Physical health conditions included respiratory illness (e.g., asthma chronic obstructive pulmonary disease, bronchitis, emphysema), diabetes, hypertension, cancer, arthritis, and injuries. Health status in the 365 days prior to the move-in date was summarized using Aggregated Diagnostic Groups (ADGs) (Austin, van Walraven, Wodchis, Newman, & Anderson, 2011; L. L. Roos, Walld, & Witt, 2014). ADGs are groups of ICD-9-CM/ICD-10-CA codes that represent diagnoses that are clinically similar and for which the expected or actual use of healthcare services is similar. The John Hopkins Adjusted Clinical Groups® (ACG®) Case-Mix System version 9 clusters the ICD codes into 32 mutually exclusive ADGs. A higher ADG score indicates a greater level of comorbidity.

To examine trends in healthcare use, the number of general practitioner physician (GP) visits and the number of specialist visits were summarized for twelve 30-day periods before and after the move-in date; these were determined using the date of service and physician type in the physician billings claims database. The number of inpatient hospitalizations in each 30-day period was calculated using the admission and discharge dates recorded in the hospital discharge abstracts database. Pregnancy-related hospitalizations were not included. Hospitalizations within 24 hours and transfers between facilities were considered a single hospitalization (Lix, Quail,

Fadahunsi, & Teare, 2013). Two hospitalization measures were defined. First, hospital stays that spanned more than one 30-day period were counted in each period (i.e., accounts for length of stay). Second, a hospital stay was counted only in the period in which an individual was admitted. The number of different prescription drugs using the fourth-level of the ATC classification system in each 30-day period was determined from the dispensation date in the DPIN database. The fourth-level ATC code denotes the chemical, therapeutic, or pharmacological subgroup and has been used by other researchers to count the number of different drugs (P. Martens et al., 2008). The number of days on each drug was determined from the days supply and used to determine if use spanned more than one period. Prescription drugs spanning more than one period were counted in each period. The number of ED visits in each 30-day period was also calculated. ED visits overlapping more than one period were counted in each period.

4.4.4 Statistical Analysis

Descriptive statistics, including means, standard deviations, and frequencies were used to characterize the cohort. Generalized linear models with generalized estimating equations (GEEs) tested for changes in healthcare use. We adopted an unstructured correlation structure, the least restrictive structure, to account for the within-subject correlation over the 30-day periods. The quasi-likelihood information criterion (QIC) was used to assess model fit (SAS Institute Inc., 2013). Unadjusted and adjusted models were fit to the data. The unadjusted models included period (pre- and post- move-in date), month (30-day intervals), and period by month two-way interaction. The adjusted models included the period, month, and period by month two-way interaction as well as demographic (i.e., sex, age group), geographic (i.e., region of residence), economic (i.e., income quintile, receipt of IA), residential mobility, and health status

characteristics (i.e., physician-diagnosed mental (schizophrenia, mood disorders, substance abuse disorders) and physical health (i.e., injury, diabetes, respiratory illness, arthritis, cancer, hypertension) conditions and ADGs). If the period by month interaction was not statistically significant, the interaction was dropped from the model, and the results for the main effects model were presented.

Hospitalizations, specialist visits, and ED visits were modeled as dichotomous variables (i.e., no hospitalization/visit, hospitalization/visit in the 30-day period). The regression coefficients are presented as odds ratios (ORs) along with their corresponding 95% confidence intervals (95% CIs). A negative binomial distribution, appropriate for counts of relatively rare events that exhibit extra-Poisson variation, was adopted for modeling the number of GP visits. The regression coefficients are presented as incident rate ratios (IRRs) along with their corresponding 95% CIs. The number of prescription drugs was modeled using a normal distribution. All analyses were conducted using SAS version 9.4 (SAS Institute Inc., Cary NC, USA).

4.5 Results

After exclusions, the cohort comprised 1942 (46.4%) of the 4183 adult primary applicants to Manitoba Housing's rental housing and who moved in between January 1, 2009 and December 31, 2010 (Figure 4-1). The largest exclusion (28.9%) was because individuals had resided in public housing in the two years before their 2009/2010 move-in date.

4.5.1 Cohort Sociodemographic and Health Characteristics

The sociodemographic and health characteristics of the cohort are reported in Table 4-1. Almost three-quarters of the cohort were female and the average age at the move-in date was 41.7 years (SD = 18.6). The majority were urban residents (54.5%). An income quintile gradient

showed that as neighbourhood income increased, the percentage of the cohort residing in those areas decreased. More than two-thirds (68.2%) of households received IA. Approximately one-third of the cohort reported an address change in the year prior to the move-in date.

During the observation period (January 1, 2009 to March 31, 2013), one-third of the cohort moved out of public housing. Among the movers, 21.9% were evicted and 78.1% moved out voluntarily. The most common physical and mental health conditions were arthritis (26.3%) and affective disorders (32.9%), respectively. The average number of ADGs was 4.52 (SD = 3.14).

The median length of time between the application date and the approval date was 18 days (Q1 = 8, Q3 = 45) and the median length of time between the approval date and the move-in date was 55 days (Q1= 28, Q3 = 120). In total, the median length of time between the application date and the move-in date was 89 days (Q1 = 47, Q3 = 180).

4.5.2 Healthcare Use

Figures 4-2 and 4-3 show healthcare use in the twelve 30-day periods before and after the public housing move-in date. As presented in Figure 2, in any 30-day period, between 37.0% and 43.0% of the cohort visited a GP. In the month after the move-in date the percentage of the cohort who visited a GP decreased, but then increased close to the pre-move-in date level. The cohort averaged 7.42 GP visits (SD = 7.34, median = 6) in the year before and 7.33 GP visits (SD = 6.95, median = 6) in the year after the move-in date. The percentage of the cohort visiting a specialist physician in a 30-day period ranged between 10.0 and 14.0%; the percentage tended to be lower after the move-in date. On average, the cohort had 2.19 specialist physician visits (SD = 4.11, median = 0) in the year before the move-in date and 1.92 specialist physician visits (SD = 3.87, median = 0) in the year after the move-in date.

The percentage of the cohort hospitalized (accounting for length of stay) increased before the move-in date, peaking three months before at approximately 4.0%, and then decreased after the move-in date and stabilized at around 2.0% at six months. There was a similar pattern in the percentage hospitalized when hospitalizations were only counted in the period in which a person was admitted, except in the two months before the move-in date. The percentage admitted to hospital peaked three months before the move-in date and then decreased, while the percentage hospitalized remained at an elevated level in the three months before the move-in date. In total, 16.9% of the cohort was hospitalized in the year before the move-in date and 13.9% were hospitalized in the year after.

The percentage of Winnipeg residents who visited an emergency department fluctuated between 7.0% and 10.0%, peaking in the three months prior to the move-in date, declining in the three months after the move-in date, but then rebounding after to the pre-move-in date levels. In total, 46.7% and 43.4% of the Winnipeg residents visited an emergency department in the year before and year after the move-in date, respectively. There is no data available on visits to an emergency department outside of Winnipeg.

As shown in Figure 4-3, the mean number of different prescriptions filled in a 30-day period increased over time, from two prescriptions the year before the move-in date to three prescriptions at the end of the first year in public housing. On average, the cohort filled 6.38 (SD = 5.27, median = 5) prescriptions in the year before the move-in date and 6.51 (SD = 5.11, median = 6) in the year after.

The estimates and 95% confidence intervals (CIs) for the period by month interaction are presented in Table 4-2. The period by month interaction was statistically significant for hospitalization (all periods) ($p < 0.01$), GP visits ($p = 0.05$) and prescriptions ($p < 0.01$) in the

adjusted models. The average change in the odds or rate of utilization was smaller in the post-move-in period than in the pre-move-in period.

The period by month interaction was not statistically significant for specialist visits (p = 0.89). However, the period effect was statistically significant (p = 0.02) in the main effects model; specifically, the odds of visiting a specialist in the post- move-in period was lower than the odds of visiting a specialist in the pre- move-in period (OR = 0.91; 95% CI 0.84, 0.99).

The period by month interaction was not statistically significant for ED visits (p = 0.20). The period effect was marginally significant (p = 0.06) in the main effects model; specifically, the odds of visiting an ED in the post- move-in period was lower than the odds of visiting an ED in the pre- move-in period (OR = 0.90; 95% CI 0.80, 1.00).

The absolute estimates and 95% CIs for each period are presented in Table 4.3. The odds of hospitalization in the pre- move-in period changed over time (OR = 1.07; 95% CI 1.04, 1.10), but there was a non-significant change in the odds in the post- move-in period. Similarly, the odds of an ED visit significantly increased over time in the pre-move-in period (OR = 1.02; 95% CI 1.00, 1.04), but the change in the odds was not statistically significant in the post- move-in period. In the pre- move-in period, the GP visit rate increased very slightly (IRR = 1.01, 95% CI 1.01, 1.02), but the change in the GP visit rate was not statistically significant in the post- move-in period. For prescription medications, there was a statistically significance change in both the pre- move-in period (0.06; 95% CI 0.05, 0.07) and post- move-in period (0.02; 95% CI 0.01, 0.03).

4.6 Discussion

This cohort of new public housing residents was primarily comprised of female, urban residents who lived in very low income areas, and received some form of government assistance.

Approximately one-third changed their residence in the year prior to moving into public housing. This is a high level of residential mobility (Lix et al., 2006), but is consistent with other studies of this population (Hinds et al., 2016). On average, the cohort had more than four health conditions requiring medical attention, which is more than reported by other researchers (Bazargan et al., 2005; B. S. Black et al., 1998; Betty Smith Black et al., 1997). Other researchers, however, reported that public housing residents have a high prevalence of chronic physical health (Digenis-Bury et al., 2008) and mental health conditions (Bazargan et al., 2005; Cummings et al., 2013; Pollack et al., 2014; Rabins et al., 1996; Simning, van Wijngaarden, & Conwell, 2011b; Simning, van Wijngaarden, Fisher, Richardson, & Conwell, 2012). The prevalence of respiratory disease (which includes asthma, acute and chronic bronchitis, emphysema, and chronic airway obstruction) in our cohort was double that reported for the general population of Manitoba; although hypertension was approximately 10% lower in our cohort (Fransoo et al., 2013), which may be due to the relative youth of our cohort. The high prevalence of respiratory disorders is consistent with other studies reporting a high prevalence of smoking among public housing residents (Cummings et al., 2013; Manfredi, Lacey, Wamecke, & Buis, 1992; Pollack et al., 2014; Wiggers et al., 2001; Yu et al., 2012). Affective disorders (anxiety and depression) were the most common health conditions among our cohort; higher than that reported for the general population (Fransoo et al., 2013). Almost 8% of our cohort had a physician-diagnosed substance abuse disorder; this is also higher than that reported for the general population (Fransoo et al., 2013), consistent with other work showing a high prevalence of drug and alcohol use among public housing residents (Cummings et al., 2013; Dekeseredy et al., 2003; Wiggers et al., 2001; Williams & Adams-Campbell, 2000). All of these conditions were measured in the year before they moved into public housing. This suggests that public

housing in Manitoba accepts and houses individuals with a high burden of disease - individuals who may have trouble obtaining and maintaining employment.

The cohort had a high use of healthcare services both before and after they moved into public housing; however, given the high burden of disease, the amount of health services use is not surprising. The average number of physician visits, and the percentage who was hospitalized in a year is higher in our cohort than has been reported for the Manitoba population (age and sex adjusted ambulatory physician visit average is between four and five visits; percent hospitalized is between 6 and 7%) (Fransoo et al., 2013). Winnipeg residents in our cohort also had more ED visits in a year than the population of Winnipeg (15%) (Doupe et al., 2017). Additionally, our cohort, on average, filled more prescriptions in a year compared to the Manitoba population (age and sex adjusted average of just under 4 prescriptions) (Fransoo et al., 2013). In any 30-day period, we found that approximately 40% had a GP visit, 12% had a specialist visits, 8% (of Winnipeg residents) visited an ED, and 2.5% were hospitalized. There was also evidence that healthcare use changed when individuals moved into public housing, but the direction of the change varied by the type of health service. We hypothesized that healthcare use may increase prior to tenancy in public housing due to a health event that prompts an application to public housing. Healthcare use did increase up to approximately three months prior to the move-in date; then within a few months after the move-in date, the percentage of the cohort using all forms of health service decreased, except for those using prescription medications. There was evidence that use of healthcare changed in the pre- move-in period and not in the post-move-in period for hospitalization, GP visits, and ED visits; while the use of prescription drugs changed in both periods. There was no change in the use of specialists over the two time periods.

Approximately 50% of people applied to public housing three months before their move-in date. Further research is needed to determine whether there is an association between application approval (i.e., approved/not approved, length of time to be approved) and health, and between application reason (i.e., health/non-health) and length of time to be housed.

Prescription use steadily increased over the two-year time period. Specialist visits and hospitalizations were maintained at a level lower in the post-move-in period compared to the pre-move-in date period. The percentage of the cohort visiting GPs and emergency rooms fluctuated over the first year in public housing at levels similar to the year before the move-in date. Our results are consistent with Smith, Alexander, and Easterlow (1997). They found that healthcare use changed for individuals who moved into medical priority public housing (a practice in Britain of prioritizing individuals with health or mobility problems to receive social housing). Most reported it decreased; specifically, one in five people visited their family doctor less and had fewer outpatient visits, one in four people had fewer consultant/specialist visits, and one in three people spent less time in hospital.

Wood et al. (2016) also linked healthcare use databases with public housing data to examine the impact of moving into public housing among the homeless. Access and frequency of some forms of healthcare use in the study population's first year in public housing decreased compared to the year before they moved in. Specifically, there was a significant decrease in access to emergency departments, overnight hospital stays, admissions to the ICU, receipt of psychiatric care, receipt of mental health services, and use of three prescriptions (namely, Methadone, Subutex, Suboxone). However, when healthcare use in the three years before the public housing move-in date was compared with healthcare use in the year after the move, some changes in the magnitude of healthcare use were found. Specifically, overnight hospital stays and

use of mental healthcare were more common after the move-in date. Receipt of psychiatric care was reduced after the move-in date for individuals who were part of support programs, but more for individuals receiving treatment as usual. Therefore, there was evidence that use of healthcare increased over the three years prior to the move-in date. Wood et al. (2016) also examined frequency/duration of use of healthcare in the year before and year after the move-in date. Among those who visited emergency departments, little difference in the mean number of visits was found; however, there was a reduction in the mean number of days in hospital, ICU days, days admitted for psychiatric care, mean number of hours of receipt of mental health services and mean number of prescriptions in the year after the move-in date compared with the year before. Interestingly, the decrease in healthcare use was most pronounced for individuals living in public housing between one and four years. A reduction in prescriptions for opioid dependence occurred for individuals residing less than one year.

4.6.1 Study Strengths

Our study has a number of strengths. We linked public housing data to health data at an individual-level to comprehensively examine healthcare before and after the public housing move-in date. Wood et al. (2016) compared healthcare use in two periods (pre and post-move-in date). We divided these two periods into twelve 30-day intervals. These shorter units of time allowed us to examine trends, providing evidence there may be factors precipitating an application to public housing as well as evidence of a transition or adjustment period to public housing.

4.6.2 Study Limitations and Future Directions

Our cohort was limited to residents of public housing, housing that is directly managed by the province. Approximately 63% of social housing units in the province are not directly

managed by government, but are operated by cooperatives, non-profit groups, and property management agencies. Residents of these forms of social housing were not included as there was no individual-level administrative data available. Also, we excluded individuals who resided in public housing for less than a year and this may have resulted in some selection bias.

Measurement error maybe associated with some of the covariates. For example, the diagnoses of the health conditions are based on physician visits and hospitalizations. Only one diagnosis code is recorded for each physician visit. Consequently, the number of people with any of the health conditions may be underestimated. Residential mobility may have been underestimated if address changes were not reported to the province. However, given the high level of healthcare utilization by the cohort, and that fact that healthcare providers and hospitals require patients to have up-to-date information on their health card, any underestimation in residential mobility is likely minimal.

We did not include a comparison group; consequently we cannot determine whether changes in healthcare use were just reflective of changes in use by the larger population. A future study using the administrative data could include such a group. We were unable to determine what contributed to changes in healthcare use. Potential contributing factors to decreased use include better access to informal caregivers (May, 2007; S. J. Smith et al., 1997), better housing (Fertig & Reingold, 2007), improved access to social services, including family resource centres (Larios, Lyle, Paille, & Smith, 2013), more income to spend on nutritious food and recreational activities (income effect) (Fertig & Reingold, 2007), and increased access to other services (Apparicio & Seguin, 2010). A future qualitative research study might shed light on the reasons for changes in use. While the drop in healthcare use may reflect decreased access to health services, this is unlikely as others have found that health services are located close to public

housing (Apparicio & Seguin, 2010; Cooper et al., 2012). A future study is warranted to determine whether this is true in Winnipeg and in Manitoba. Others have found that residing in a socioeconomically disadvantaged neighbourhood is associated with decreased healthcare access, even after controlling for healthcare supply and individual-level characteristics (Kirby & Kaneda, 2005). The public housing application asks individuals where they want live, but it is not known how closely placements match preferences. A future study could determine the distance individuals move when placed in public housing, describe residential mobility patterns (i.e., are individuals placed in the same neighbourhood as on their application), and determine whether distance to healthcare services (i.e., hospitals, EDs, primary healthcare provider) changes after a move and whether this varies by health region. Additionally, to move within Manitoba Housing, individuals have to reapply; thus, it is possible to examine residential mobility patterns of public housing residents, and determine how this is related to their pre-public housing location of residence and access to healthcare. Housing administrators would likely find it useful to know where people (with health conditions) are being housed in relation to their healthcare providers and their prior social network. Additionally, since Wood et al. (2016) found varying the length of the pre and post move-in periods affected the findings, a follow-up study could examine healthcare trends over longer periods. Lastly, further research could examine changes in healthcare use for mental health, physical health, and preventive health (i.e., medical screening) reasons as a result of public housing residency.

4.7 Conclusion

In summary, the use of several types of health services (i.e., specialist visits, hospitalizations) declined after people moved into public housing. However, for some forms of health services (GP visits, emergency department visits), the decrease in use was only observed

for the first few months after the move-in date; percentages rebounded shortly thereafter. This rebounding effect could be further examined to understand why this occurred.

In general, since public housing residents are high users of health services and tend to experience a high burden of disease, a need exists to strategically locate health and social services in public housing developments, preferably using an integrative, community/client-centred approach, such that a range of services exists in each location (e.g., Community Health Centres or ACCESS Centres) tailored to the community's needs (Larios et al., 2013). As May (2007) recommends, housing policy needs to be linked with social policy for service integration.

Disclaimer

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Ethics Approval

Ethics approval was obtained from the University of Manitoba Health Research Ethics Board. Data access was approved by the Manitoba Health Information Privacy Committee.

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Authors' Contributions

AMH, LML, BB, JD, and LR contributed to the study conception, design, interpretation of the data, drafting and critical revision of the manuscript. AMH contributed to the data analysis, interpretation of the data, and writing and revision of the manuscript. All authors participated in editing and revising the manuscript. All authors read and approved the final manuscript.

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Table 4-1. Socio-Demographic and Health Characteristics of the Cohort in the 365 Days Prior to the Public Housing Move-in Date (N = 1942).

Variables	Categories	N	%
Sex	Males	517	26.6
	Females	1425	73.4
Age (years) at	18 – 24	385	19.8
Move-in Date	25 – 39	678	34.9
	40 – 64	621	32.0
	65+	258	13.3
Region	Winnipeg	1058	54.5
	Non-Winnipeg	884	45.5
Income Quintile	Q1 (poorest)	832	42.8
	Q2	478	24.6
	Q3	319	16.4
	Q4	197	10.1
	Q5 (affluent)	93	4.8
	NF*	23	1.2
Income Assistance	Yes	1323	68.1
	No	619	31.9
Change in Postal	Yes	657	33.8
Code	No	1285	66.2
Moved-Out Status	Moved out voluntarily	505	26.0
	Evicted	142	7.3
	Did not move out	1295	66.7
Time in Public	Moved	734.1 (256.5)	
Housing (days)†	Moved out voluntarily	726.2 (255.0)	
	Evicted	762.5 (260.5)	
	Did not move out	1175.3 (210.9)	
Physical Disorders	Arthritis	459	26.3
	Injury	425	21.9
	Respiratory Disease	355	18.3
	Hypertension	286	14.7
	Diabetes	176	9.1
	Ischemic Heart Disease	37	1.9
	Cancer	36	1.9
	Inflammatory Bowel Disease	11	0.6
Mental Disorders	Affective Disorders	638	32.9
	Substance Abuse Disorders	145	7.5
	Schizophrenia	61	3.1

Notes. *NF = Not Found. †Means (SD)

Table 4-2. Unadjusted and Adjusted Estimates and 95% Confidence Intervals (CIs) of the Period (Post-move-in Relative to Pre-move-in) by Month Interaction for Healthcare Use.

Healthcare Use	Model	Estimate	95% CI
Hospitalization (all periods)	Unadjusted	**0.93**	**0.89,0.97**
	Adjusted	**0.92**	**0.88,0.96**
Hospitalization (admission period)	Unadjusted	0.97	0.93,1.01
	Adjusted	0.97	0.93,1.02
GP Visits	Unadjusted	**0.99**	**0.98,1.00**
	Adjusted	**0.99**	**0.98,1.00**
Specialist Visits	Unadjusted	1.00	1.00,1.02
	Adjusted	1.00	0.98,1.02
Prescriptions	Unadjusted	**-0.03**	**-0.04,-0.02**
	Adjusted	**-0.04**	**-0.05,-0.03**
ED Visits*	Unadjusted	0.98	0.95,1.01
	Adjusted	0.98	0.95,1.10

Note. Bold values indicate statistically significant findings; Covariates in adjusted models = sex, age group, region of residence, income quintile, residential mobility, receipt of IA, physician-diagnosed mental and physical health conditions (i.e., schizophrenia, mood disorders, substance abuse disorders, injury, diabetes, respiratory illness, arthritis, cancer, hypertension), ADGs

*Winnipeg residents only (N = 960)

Table 4-3. Unadjusted and Adjusted Estimates and 95% Confidence Intervals (CIs) for the Average Rate of Change in Each Period for Healthcare Use.

Healthcare Use	Period	Unadjusted		Adjusted	
		Estimate	95% CI	Estimate	95% CI
Hospitalizations (OR)	Pre	**1.06**	**1.03,1.09**	**1.07**	**1.04,1.10**
(all periods)	Post	0.98	0.95,1.01	0.98	0.95,1.01
Hospitalizations (OR)	Pre	**1.04**	**1.01,1.07**	**1.04**	**1.01,1.07**
(admission period only)	Post	1.01	0.98,1.04	1.01	0.98,1.05
GP Visits (IRR)	Pre	**1.01**	**1.01,1.02**	**1.01**	**1.01,1.02**
	Post	1.00	1.00,1.01	1.00	1.00,1.01
Specialist Visits (OR)	Pre	1.00	1.00,1.02	1.00	0.99,1.02
	Post	1.00	0.99,1.01	1.00	0.99,1.01
Prescriptions (mean)	Pre	**0.05**	**0.04,0.06**	**0.06**	**0.05,0.07**
	Post	**0.02**	**0.01,0.03**	**0.02**	**0.01,0.03**
ED Visits (OR)	Pre	**1.02**	**1.01,1.04**	**1.02**	**1.00,1.04**
	Post	1.01	0.99,1.02	1.00	0.99,1.02

Note. Bold values indicate statistically significant findings; Covariates in adjusted models = sex, age group, region of residence, income quintile, residential mobility, receipt of IA, physician-diagnosed mental and physical health conditions (i.e., schizophrenia, mood disorders, substance abuse disorders, injury, diabetes, respiratory illness, arthritis, cancer, hypertension), ADGs; [*]Winnipeg residents only (N = 960).

Figure 4-1. Flow chart for the construction of the study cohort.

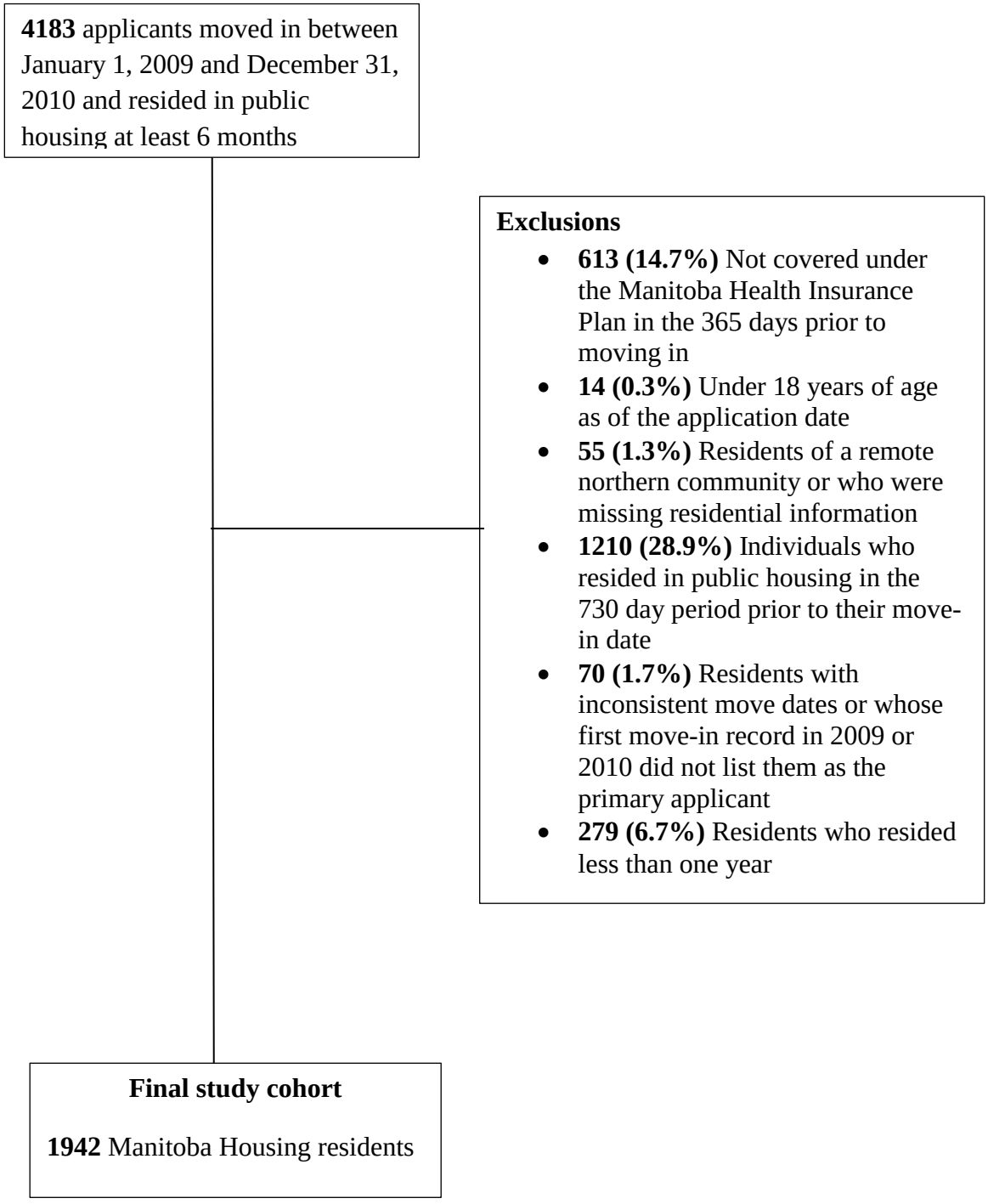


Figure 4-2. Percentage of the study cohort who were hospitalized, visited an emergency department (Winnipeg residents), and saw a GP or a specialist in the year before and the year after the public housing move-in date.

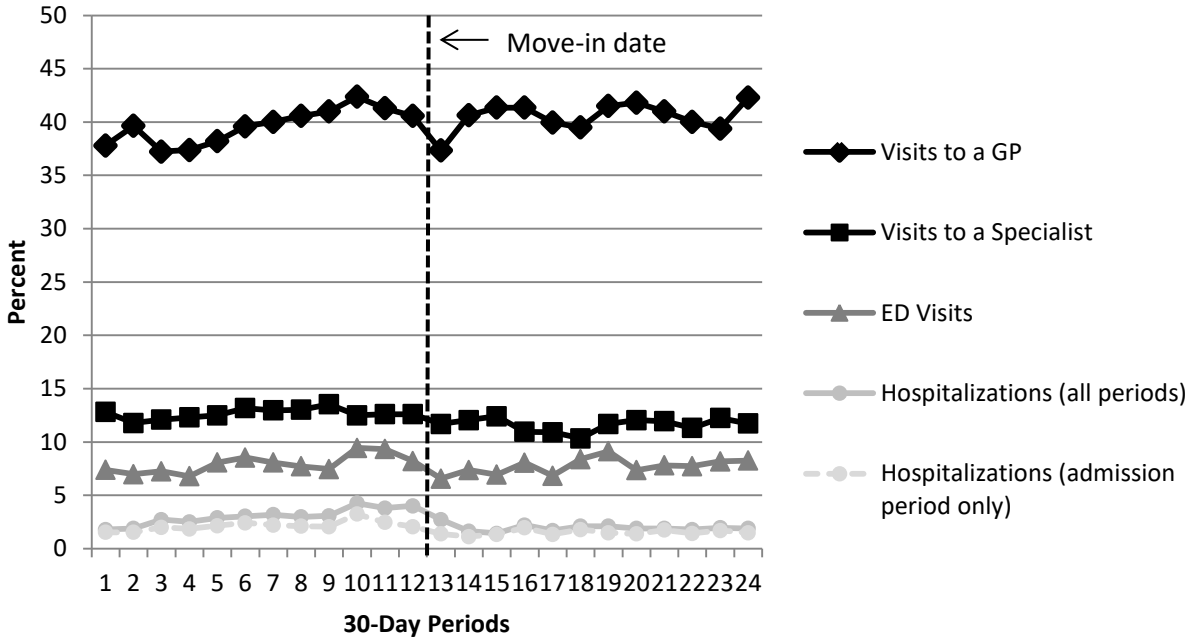
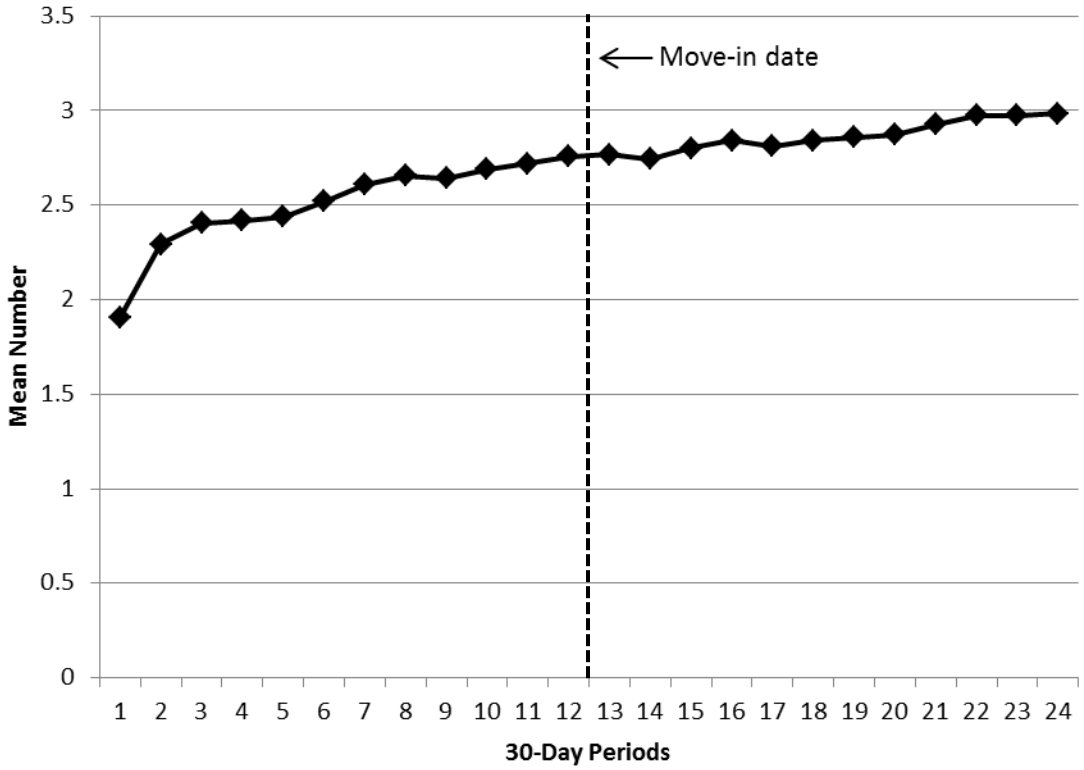


Figure 4-3. Mean number of prescriptions filled by the study cohort in the year before and the year after the public housing move-in date.



Appendix A. Supplementary Table

Table1. ICD Codes Used to Define Physical and Mental Disorders.

Condition	ICD-9-CM	ICD-10-CA
Physical		
Respiratory Illness	466, 490 – 493, 496	J20, J21, J40 – J45
Diabetes	250	E10 – E14
Hypertension	401 – 405	I10 – I15
Cancer	14 – 20	C00 – C97
Arthritis	274, 446, 710 –721, 725 –729, 739	M00 – M03, M05 – M07, M10 – M25, M30 – M36, M65 – M79
Injury	80 – 99	S00 – S99, T00 – T98
Mental Disorder		
Schizophrenia	295	F20, F21, F25, F232
Affective Disorder	296, 300, 309, 311	F31 – F33, F40 – F42, F44, F48, F99, F341, F380, F381, F410, F411, F412, F413, F418, F419, F431, F432, F438, F450, F451, F452, F530, F680, F930
Substance Abuse Disorder	291, 292, 303 – 305	F10 – F19, F55

CHAPTER 5 : PUBLIC HOUSING AND HEALTHCARE USE: AN INVESTIGATION USING LINKED ADMINISTRATIVE DATA

5.1 Chapter Overview

This study compared healthcare use of a cohort of individuals who moved into public housing in 2012 and 2013 with a cohort from the general population matched one-to-one on the basis of sex, age, receipt of income assistance, and health region of residence. Healthcare use was measured in the year before and year after the move-in date. The matched cohort was randomly assigned a move-in date in 2012 or 2013. A higher percent of the public housing cohort had physical and mental health conditions compared to the matched cohort. For most types of healthcare services, use was higher in the pre-move-in date period compared to the post-move-in date period and use was higher among the public housing cohort than the matched cohort. The time period by cohort interaction was only significant for inpatient days; therefore, most changes in healthcare use observed in the public housing cohort were mirrored by the matched cohort.

Publication Details

To be submitted to *SSM – Population Health*

5.2 Abstract

*Introduction***:** Moving to public housing may affect health and, correspondingly, healthcare use. We tested for changes over time in healthcare use among public housing residents and compared utilization to a general population cohort who did not move into public housing.

*Method***:** Applicants who moved into public housing in 2012 and 2013 were matched one to one on sex, age, region, and receipt of income assistance to individuals from the general population. The numbers of healthcare contacts in the years before and after the move-in date were measured. Generalized linear models with generalized estimating equations tested for differences in utilization over time (pre- versus post- move-in) after adjusting for economic, residential mobility, and health status characteristics. The data were modeling using Poisson (rate ratio, RR), negative binomial (incident rate ratio, IRR), and binomial (odds ratio, OR) distributions, depending on the measure.

*Results***:** There were 2619 residents in the public housing cohort; 99.7% were matched to the general population. Approximately 73% were female, 60% lived in a rural location, and 65% received income assistance. The cohort by time period interaction was only statistically significant for inpatient days ($p = 0.0018$). GP visits (IRR = 1.04, 95% CI 1.01-1.06) and prescriptions (IRR = 1.04, 95% CI 1.02-1.05) increased over time, while emergency department visits (RR = 0.90, 95% CI 0.82-1.00) and hospitalizations (OR = 0.95, 95% CI 0.93-0.96) decreased for both cohorts. The public housing cohort had a significantly higher rate of GP visits (IRR = 1.08, 95% CI 1.04-1.13), emergency department visits (RR = 1.18, 95% CI 1.01-1.37), and prescriptions (IRR = 1.09, 95% CI 1.05-1.13), and were more likely to be hospitalized (OR =1.39, 95% CI 1.21-1.61) compared to the matched cohort.

Discussion: There is little evidence that public housing functions as an intervention in the use of healthcare services. Due to the high burden of disease, healthcare services should be strategically located close to public housing. Since providing housing does not address all of the challenges low income individuals face, efforts should be made to address the other social determinants of health.

5.3 Introduction

Public housing is a form of long-term subsidized housing owned and/or managed by government (municipal, provincial/state, or federal). To be eligible for public housing prospective tenants must meet certain requirements with household income not exceeding the program limit. Rent is calculated as a percentage of before-tax household income (typically less than 30%) (Canada Mortgage and Housing Corporation, 2014).

Little research has been conducted to investigate whether public housing functions like an intervention, since it is not designed/implemented to target specific outcomes and often researchers do not have access to longitudinal population-based data (Dockery, Ong, Whelan, & Wood, 2008). However, there is some evidence that residence in public housing has a positive effect on educational achievement (Aratani, 2010; Currie & Yelowitz, 2000) and personal finances (Aratani, 2010). For example, Newman and Harkness (2002) found that individuals who had resided in public housing when they were between the ages of 10 and 16 years old were more likely to be working, had higher annual incomes, and used welfare less when they were in the 20s than individuals who were eligible for federally assisted housing but were not assisted. Dujardin and Goffette-Nagot (2009) did not find a relationship between residence in public housing in France and the probability of being unemployed. Goffette-Nagot and Sidibe (2016) (2016) determined that "a spell in public housing" facilitated future homeownership attainment for some households (when compared to private renting) (people were able to accumulate enough wealth for a down payment on a home).

There are two studies that examined changes in healthcare use when people moved into public housing. In Smith, Alexander, and Easterlow's (1997) study, among individuals who identified that moving into medical priority public housing (a practice in England of giving

housing priority to those with medical conditions) affected their healthcare use, most said it decreased; specifically, one in five people visited their family doctor less and had fewer outpatient visits, one in four people had fewer consultant/specialist visits, and one in three people spent less time in hospital. Wood et al. (2016) linked health service use databases to public housing data to compare healthcare use in the year before with the year after the move-in date among formally homeless individuals. Access and frequency of some forms of healthcare use decreased between these two periods. Among those who visited emergency departments, there was little difference in the mean number of visits was found; however, there was a reduction in the mean number of days in hospital, ICU days, days admitted for psychiatric care, mean number of hours of receipt of mental health services, and mean number of prescriptions. Additionally, many studies have investigated changes in healthcare use when homeless individuals receiving any form of housing (often with supports). There is fairly strong evidence that receipt of housing among this population is associated with decreased healthcare use, particularly acute care (Brown et al., 2015; Kushel, Perry, Bangsberg, Clark, & Moss, 2002; Larimer et al., 2009; Martinez & Burt, 2006; Sadowski & Buchanan, 2009; Srebnik, Connor, & Sylla, 2013; Wright, Vartanian, Li, Royal, & Matson, 2016), though this is not always the case (Hwang, Weaver, Aubry, & Hoch, 2011; Kessell, Bhatia, Bamberger, & Kushel, 2006) since individuals who lack housing stability may attend to their basic needs, such as obtaining food and shelter, before accessing healthcare (Gelberg, Gallagher, Andersen, & Koegel, 1997; Ma, Gee, & Kushel, 2008; Reid, Vittinghoff, & Kushel, 2008).

Several studies examined changes in healthcare access when people moved out of public housing; namely, in Atlanta, Georgia, Cooper et al. (2012) found that the spatial access to safety-

net primary care clinics decreased and Cummings et al. (2016) observed that individuals tended to move into census tracts with significantly fewer primary care physicians.

To our knowledge, no one has investigated changes in healthcare use among a population of residents new to public housing. The purpose of our research was to examine the association between public housing residence and healthcare use. The specific objectives were to determine whether use of different types of healthcare services changed over time among public housing residents and to test for differences in use with individuals from the general population. We hypothesized that public housing residents would be higher users of healthcare services than the general population, since previous research has shown that public housing residents are in poorer health than the general population. We also hypothesized that healthcare use, particularly use of acute care services (i.e., hospitalizations and emergency department visits) and general practitioner/family physician visits, would decrease when people moved into public housing (as suggested by previous research), but would remain above the general population level. Since pharmaceutical use tends to increase over time, we did not expect that it would decrease when people moved into public housing. We focused on the year before and year after people moved into public housing in order to assess the immediate (i.e., short-term) impact of public housing on healthcare use (i.e., does public housing function as an intervention?) (Srebnik et al., 2013).

5.4 Methods

5.4.1 Study Cohorts

Manitoba is a Canadian province with an ethnically diverse population of 1.3 million. The public housing cohort included all adults (18+ years) who moved into Manitoba Housing between January 1, 2012 and December 31, 2013 who were listed as the primary applicant and resided at least one year. The Manitoba Housing move-in and move-out dates were used to

determine tenancy length. All cohort members were registered with the Manitoba Health Services Insurance Plan in the year prior to and in the year following their move-in date. Applicants residing in public housing within two years of their 2012/2013 move-in date were excluded. Residents of Churchill, a remote northern community, were also excluded because it was not possible to identify those residing in subsidized units from those residing in the private market units (Finlayson et al. 2013).

A matched cohort from the general population was created. The general population did not include individuals who applied to or were residents of public housing between January 1, 2010 and December 31, 2014. Using a uniform distribution, a 'move-in' date between January 1, 2012 and December 31, 2013 was randomly assigned to the general population. To be included in the cohort, individuals had to be covered under the Manitoba Health Services Insurance Plan in the year before and after the 'move-in' date and be 18 years or older. Residents of the northern community of Churchill were excluded. Individuals who had a residential start date in the year after the 'move-in' date were also excluded to match the requirement that the public housing cohort be residents of public housing for at least one year. One-to-one matching to the public housing cohort was based on age at the move-in date, sex, receipt of income assistance in the year prior to the move-in date, and health region of residence at or before the move-in date.

5.4.2 Data Source

The Population Research Data Repository housed at the Manitoba Centre for Health Policy is a rich collection of anonymized health and social administrative databases linkable at the individual level via a unique scrambled personal health identification number. Previous researchers have identified all residents who applied to and/or who moved into public housing

and linked this information to a comprehensive set of health and socioeconomic indicators and outcomes (Hinds et al., 2016; Martens et al., 2014; Smith et al., 2013).

The Tenant Management System (TMS) was used to identify applicants to and residents of Manitoba Housing's rental housing. The TMS contains information on public housing managed by the provincial government (approximately 2,300 buildings and 13,000 units) (Finlayson et al., 2013). More than 30,000 individuals reside in public housing in a year, with approximately half the population under the age of 20 years (Finlayson et al., 2013). The TMS does not capture social housing managed by co-operatives and non-profit groups.

Demographic (e.g., sex, birth date, six-digit postal code) and health coverage information (e.g., start and end of coverage dates) was obtained from the Population Registry. The Registry contains this information for all Manitoba residents registered with the provincial health plan (excludes military personnel, the RCMP, and new residents) and is updated every six months (June and December). Information on households receiving financial support under the provincial Employment and Income Assistance program was obtained from the Social Assistance Management Information Network. Canadian Census data was used to create a dissemination area (DA) level measure of income (i.e., income quintile).

Information on discharges from all acute and chronic care facilities was obtained from the hospital discharge abstracts database which includes up to 25 diagnostic codes recorded using the International Classification of Diseases (ICD-10-CA) coding system. The physician billing claims data was used to obtain information about ambulatory physician visits. This database captures the majority of physician visits for all Manitobans, as most physicians are reimbursed on a fee-for-service basis. The diagnosis deemed most responsible for the visit is recorded using a three-digit ICD-9-CM code. Information on visits to the adult emergency

departments (EDs) in Winnipeg, the capital of Manitoba, was obtained from the Emergency Department Information System. There is no corresponding data available on ED visits outside of Winnipeg. Information about prescription drugs dispensed from community pharmacies was obtained from the Drug Program Information Network (DPIN) database.

5.4.3 Study Variables

5.4.3.1 Exposure Variable

The exposure variable was time in public housing. The public housing cohort was exposed in the post- move-in period (year after the move-in date), while the general population matched cohort was not exposed to public housing.

5.4.3.2 Outcome Variables

Healthcare use was measured in the 365 days before and 365 days after the move-in date to assess the short-term impact of moving into public housing. The number of general practitioner (GP) visits and the number of specialist visits were determined using the date of service and physician type in the physician billings claims database. Specialists included psychiatrists, pediatricians, obstetricians and gynecologists, medical specialists, general surgeons, and surgical specialists.

The number of inpatient hospitalizations was determined using the admission and discharge dates recorded in the hospital discharge abstracts database. Hospitalizations within 24 hours and transfers between facilities were considered a single hospitalization (Lix, Quail, Fadahunsi, & Teare, 2013). Hospital stays that spanned both periods were counted in each period. Length of hospital stay was based on the admission and discharge dates. The number of different prescription drugs using the fourth-level of the Anatomical Therapeutic Chemical Classification System was determined from the dispensation date in the DPIN database.

Prescription drug use that spanned both periods (as determined by the days supply) was counted in each period. The number of ED visits was also calculated. The length of the ED visit was determined using the admission and discharge dates. ED visits that spanned both periods were counted in each period.

5.4.3.3 Covariates

Our choice of covariates was guided by the Behavioral Model for Vulnerable Populations (Bazargan et al., 2005; Gelberg, Andersen, & Leake, 2000), an update of Andersen and Newman's Behavioral Model of Health Service Use (Andersen, 1995), as well as other studies that examined determinants of healthcare use among differentially housed individuals (Duchon, Weitzman, & Shinn, 1999; Kushel et al., 2002; O'Toole, Gibbon, Hanusa, & Fine, 1999). The Behavioral Model for Vulnerable Populations has been used as the guiding framework for two other studies on the determinants of healthcare use (i.e., alternative healthcare, vision care) of public housing residents (Baker, Bazargan, Bazargan-Hejazi, & Calderone, 2005; Bazargan et al., 2005). The predisposing factors in our study included demographic variables, namely sex and age group (18-24, 25-39, 40-64, 65+ years) at the move-in date, as well as residential mobility in the 365 days prior to the move-in date. Residential mobility was determined from changes in the six-digit postal code. In Winnipeg, a postal code covers a medium-sized apartment or a residential block, while postal code areas are larger outside of the city. Individuals were classified as movers or non-movers depending on whether their postal code changed (DeVerteuil et al., 2007; Lix et al., 2006).

The enabling factors included geographic and economic characteristics, which were defined in the 365 days prior to the move-in date. Location of residence prior to the move-in date was determined from the six-digit postal code. Region of residence was assigned as urban or

rural (i.e., Winnipeg or non-Winnipeg). Approximately 55% of the provincial population resides in Winnipeg; the remainder of individuals are scatted across northern (remote) and southern regions that are sparsely populated, particular in the north. The economic variables were receipt of income assistance (IA) and income quintile. Individuals were classified as recipients of IA if they or a member of their household received any form of IA at least once in the 365 days prior to the move-in date (Heaman et al., 2012). Receipt of IA is based on financial need as well as other eligibility criteria. Income quintile (IQ) is an area-level measure of income based on the average household income in the dissemination area (DA), the smallest geographic level for which Census data are reported (Roos & Mustard, 1997). The DAs are sorted from poorest to wealthiest and grouped into quintiles. Each quintile represents approximately 20% of the population. Different cut-offs are used for urban and rural areas.

The need factors included different measures of health status. Health status was measured in the 365 days prior to the move-in date was determined by the presence of International Classification of Diseases (ICD) codes for selected conditions in physician billing claims and hospital discharge abstracts (Appendix). Mental illness (de Boer, Wijker, & de Haes, 1997; Kushel et al., 2002), substance abuse (Kushel et al., 2002), and chronic physical illnesses (de Boer et al., 1997; Duchon et al., 1999; Kushel et al., 2002; O'Toole et al., 1999) have been associated with healthcare use in other studies. The mental health conditions included schizophrenia, affective (mood and anxiety) disorders, and substance abuse disorders. The physical health conditions included respiratory illness (e.g., asthma chronic obstructive pulmonary disease, bronchitis, emphysema), diabetes, hypertension, cancer, arthritis, and injuries. Health status in the 365 days prior to the move-in date was also assessed using Aggregated Diagnostic Groups (ADGs) (Austin, van Walraven, Wodchis, Newman, &

Anderson, 2011; Roos, Walld, & Witt, 2014). ADGs are groups of ICD-9-CM/ICD-10-CA codes that represent diagnoses that are clinically similar and for which the expected or actual use of healthcare services is similar. The John Hopkins Adjusted Clinical Groups® (ACG®) Case-Mix System version 9 clusters the ICD codes into 32 mutually exclusive ADGs. A higher ADG score indicates a greater level of comorbidity.

5.4.5 Statistical Analysis

Descriptive statistics, including means, standard deviations, and frequency distributions were used to characterize the cohorts. A chi-square test of homogeneity was used to test for differences between the two cohorts in the frequency distribution of the categorical variables.

Generalized estimating equations (GEE) were used to determine if there was a cohort (i.e., public housing versus general population) by time period (i.e., before versus after the move-in date) two-way interaction for each of the healthcare use measures. If the interaction was not statistically significant the interaction was dropped from the model and the main effects model was interpreted. We adopted an unstructured correlation structure, the least restrictive structure, to account for the within-subject correlation over the two periods. The QIC was used to assess model fit (SAS Institute Inc., 2013). The economic, residential mobility, and health status variables were confounding covariates in the adjusted models. The unadjusted models did not include these confounding covariates.

Inpatient hospitalization was modeled as a dichotomous variable (i.e., no hospitalization, hospitalization). The regression coefficients are presented as odds ratios (ORs) along with the corresponding 95% confidence intervals (95% CIs). GP visits, specialist visits, ED visits, inpatient days, and prescription drug use were modeled as count variables. ED visits were modeled using the Poisson distribution and the rate ratios (RR) and 95% confidence intervals

(CIs) are presented. GP visits, specialist visits, inpatient days, and prescription drug use were modeled using a negative binomial distribution and incident rate ratios (IRRs) and 95% confidence intervals are presented. The models for inpatient days included individuals who had at least one hospitalization during the two years. A negative binomial distribution is appropriate for counts of relatively rare events that exhibit extra-Poisson variation. The model distribution (i.e., negative binomial, Poisson) was chosen based on the quasi-likelihood information criterion (QIC) statistic. All analyses were conducted using SAS version 9.4 (SAS Institute Inc., Cary NC, USA).

5.5 Results

A total of 2619 individuals (52.3%) were retained in the public housing cohort (Figure 1). Almost all individuals, namely 2612 (99.7%), were matched one-to-one to individuals from the general population.

5.5.1 Socioeconomic and Health Characteristics

As expected (Table 5-1) based on the matching methodology, the frequency distributions of sex, age, health region of residence, and receipt of income assistance were identical for the public housing and matched cohorts. Almost three-quarters of the cohorts were female, the majority resided outside of Winnipeg, and almost two-thirds received income assistance in the year before the move-in date. The public housing cohort was more likely to reside in lower income areas and be residentially mobile in the year before the move-in date compared to the matched cohort. Affective disorders were the most common health condition for both cohorts. The public housing cohort was significantly more likely to have arthritis, an injury, respiratory disease, hypertension, diabetes, and ischemic heart disease compared to the matched cohort. The two cohorts did not differ with respect to diagnoses of cancer and inflammatory bowel disease.

The public housing cohort was also significantly more likely to have an affective disorder and a substance abuse disorder compared to the matched cohort. The cohorts differed significantly on the distribution of the ADG categories, indicating that the public housing cohort was more likely to have co-occurring health conditions.

5.5.2 Healthcare Utilization

A summary of healthcare use in the 365 days before and after the move-in date is presented in Table 5-2. In general, a higher percentage of the public housing cohort used healthcare compared to the matched cohort and use tended to be higher in the year before the move-in date compared to the year after. However, visits to the ED increased over time for both cohorts. The number of prescriptions increased slightly over time for the public housing cohort, but decreased slightly for the matched cohort.

The results from the models are presented in Table 5-3. For hospitalizations, the adjusted model with the two-way interaction was not statistically significant ($p = 0.33$). Both main effects were significant. The public housing cohort had a higher odds (OR = 1.39; 95% CI 1.21, 1.61) of being hospitalized than the matched cohort. The odds of hospitalization were 21% lower in the second time period (year after the move-in date) than the first (year before the move-in date) (OR = 0.79; 95% CI 0.70, 0.89). The odds of being hospitalized in the post-move-in period relative to the pre-move-in period was 0.75 (95% CI 0.65, 0.88) for the public housing cohort and 0.85 (95% CI 0.70, 1.02) for the matched cohort.

In the year before the move-in date, 427 (67.9%) individuals from the public housing cohort were hospitalized; the average length of stay was 15.8 days (SD = 38.6, median = 2) and 265 (61.2%) individuals from the matched cohort were hospitalized; the average length of stay was 7.6 days (SD = 23.1, median = 1). In the year after the move-in date, 347 (55.17%)

individuals from the public housing cohort were hospitalized; the average length of stay was 7.7 days (SD = 20.3, median = 1), while 232 (53.58%) individuals from the matched cohort were hospitalized; the average length of stay was 7.9 days (SD = 23.2, median = 1). The cohort by time period interaction was statistically significant ($p < 0.01$). For the public housing cohort, the rate of inpatient days was significantly lower in the post-move-in period compared to the pre-move-in period (IRR = 0.60; 95% CI 0.46, 0.79). There was no difference in the rate of inpatient days between the two periods for the matched cohort (IRR = 1.25; 95% CI 0.87, 1.82). The public housing cohort had a significantly higher rate of inpatient days in the pre-move-in date period (IRR = 1.64; 95% 1.12, 2.41) compared to the matched cohort. In the post-move-in date period, there was no difference between the cohorts (IRR = 0.79; 95% 0.55, 1.12).

The cohort by period two-way interaction for GP visits ($p = 0.78$) and specialist visits ($p = 0.26$) was not statistically significant and was removed. Compared to the matched cohort, the public housing cohort has an incident rate 1.08 times greater for GP visits (95% CI 1.04, 1.13). The rates did not differ between the cohorts for specialist visits (IRR = 0.98; 95% CI 0.88, 1.09). The rate of GP visits during the year in housing was significantly higher than the year before the move-in date (IRR = 1.04; 95% CI 1.01, 1.06). The incident rate for GP visits in the year after the move-in date relative to the year before the move-in date was not statistically significant (IRR = 1.03; 95% CI 1.00, 1.07) for the public housing cohort, but was statistically significant (IRR = 1.04; 95% CI 1.01, 1.08) for the matched cohort. There was no time main effect for specialist visits (IRR =1.00; 95% CI 0.94, 1.06). The incident rate for specialist visits in the year after the move-in date relative to the year before was 0.96 (95% CI 0.88, 1.05) for the public housing cohort and 1.03 (95% CI 0.95, 1.12) for the matched cohort.

The period by cohort interaction was not statistically significant for prescription drug use ($p = 0.10$) and was removed from the model. The public housing cohort filled prescriptions at a rate significantly higher than the matched cohort (IRR = 1.09; 95% CI 1.05, 1.13) and the rate at which prescriptions were filled increased slightly over time (IRR = 1.04; 95% CI 1.02, 1.05). The incident rate for prescriptions in the year after the move-in date relative to the year before was 1.05 (95% CI 1.03, 1.07) for the public housing cohort. The incident rate in the year after the move-in date relative to the year before the move-in date was not statistically significant (IRR = 1.02; 95% CI 1.00, 1.04) for the matched cohort.

For ED visits, the cohort by time period interaction was not statistically significant ($p = 0.53$), but both main effects were significant. The public housing cohort had a rate of ED visits 1.18 times higher than the matched cohort (95% CI 1.01, 1.37**)**. The rate of ED visits in the post-move-in date period was significantly lower than the rate in the pre-move-in date period (RR = 0.90; 95% CI 0.82, 1.00). The rate for ED visits in the year after the move-in date relative to the year before the move-in date was 0.92 (95% CI 0.81, 1.05) for the public housing cohort and 0.87 (95% CI 0.74, 1.01) for the matched cohort.

5.6 Discussion

We identified a cohort of individuals who moved into public housing for the first time within a two year period and successfully matched them to a cohort similar in terms of their socioeconomic characteristics but did not apply or move into public housing during the same period. The socioeconomic and health characteristics of the public housing cohort are consistent with other studies (Aratani, 2010; Finlayson et al., 2013; Hinds et al., 2016).

Research has shown that applicants to and residents of public housing use healthcare services frequently (B. S. Black et al., 1998; Betty Smith Black, Rabins, German, McGuire, &

Roca, 1997; Carder, Luhr, & Kohon, 2016; Hinds et al., 2016; M. Smith et al., 2013); though, this is not always a consistent finding (Digenis-Bury, Brooks, Chen, Ostrem, & Horsburgh, 2008). We examined healthcare use over time (i.e., year before and year after the move-in date) for both cohorts. In both time periods, compared to the matched cohort, the public housing cohort had a higher percentage that used healthcare and had higher average use. The public housing cohort had a significantly higher rate of physician and GP visits compared to the matched cohort, but there was no difference in rates for specialist visits. The public housing cohort was significantly more likely to be hospitalized compared to the matched cohort and the likelihood of having a hospitalization was lower in the post-move-in date period compared to the pre-move-in date period. There was a significant interaction between time period and cohort for inpatient days, indicating that the rate of inpatient days decreased more for the public housing cohort over time compared to the matched cohort.

A higher percentage of the public housing cohort visited an ED in each year compared to the matched cohort; the difference in rate of ED visits between the cohorts was significant. The public housing cohort on average filled more than seven prescriptions in both time periods, while the matched cohort averaged five. The public housing cohort filled prescriptions at a statistically higher rate than the matched cohort and the rate prescriptions were filled increased over time.

Occasionally public housing is identified as contributing to poor health; however this research and others have shown that individuals are often in poor health prior to applying (Carder et al., 2016; Hinds et al., 2016) and moving into public housing (Hinds et al., 2017 accepted). Given that public housing residents tend to be in poorer health, it is not surprising that we found they were significantly more likely to use all forms of healthcare (except specialist visits). It is a good thing that clinics are often strategically located within public housing or

nearby (gateway effect) (Apparicio & Seguin, 2006; Cooper et al., 2012; Culhane-Pera, Ellmore, & Wessel, 2007; Fertig & Reingold, 2007), so residents may experience improved access to healthcare providers (e.g., family physicians and nurse practitioners) when they move into public housing. Culhane-Pera et al (2007) note that "High quality health services for residents of public housing can have a positive effect on the health of the residents, which ultimately can lead to positive employment outcomes for a resident, which can improve socio-economic status, which ultimately can further improve health" (p. 736).

Since the time period by cohort interaction was not statistically significant for most of the healthcare measures, there is little evidence that residence in public housing affected healthcare use (in the short term). This suggests that public housing does not function like an intervention to influence use of healthcare services. This may not be surprising given that public housing residents tend to have a high burden of co-occurring chronic physical and mental health conditions. Since chronic conditions tend to require ongoing care and monitoring, it seems reasonable that healthcare use may not change much over a short period of time (i.e., a two year timespan). Additionally, public housing residents may still struggle to meet their basic needs (e.g., safety, poverty, food), which may negatively affect their health and healthcare use (Battaglia et al., 2012). Therefore, it would be useful to address other social determinants that may affect their health, such as income, early child development, education, (un)employment, food security, and social exclusion. Policies and programs to improve the health and wellness of public housing residents are important public health measures.

Another benefit to residing in public housing is the better access to informal caregivers (Smith et al., 1997). May (2007) reported that public housing may help residents develop social networks that supplement their lack of connectivity to formal services (i.e. child care, shared

meals, word of mouth about employment). This connectivity between neighbours (network effect) (Fertig & Reingold, 2007) may be facilitated by family resource centres and tenant associations. In addition to helping residents address their needs (e.g., access to computers and phone, food bank, breakfast programs, clothing depot, laundry facilities, assistance with income tax, counseling, day care, connect to social assistance programs) and support the development of life skills (e.g., cooking classes, wellness groups), family resource centres provide meeting places for residents to gather, develop relationships with their neighbours, and share information (Larios, Lyle, Paille, & Smith, 2013). Tenant associations provide opportunities to organize community activities, voice concerns, and represent residents (Larios et al., 2013). Consequently, these opportunities to gather and actively participate in their community may improve residents' well-being, increase their sense of community and connectedness, and decrease their social isolation (Fertig & Reingold, 2007).

5.6.1 Study Strengths

Our ability to link several longitudinal, population-based, health and social administrative databases at an individual-level is one of the study strengths. Because of this, we were able identify a cohort of individuals who moved into public housing for the first time in 2012 or 2013 and match them one-to-one on the basis of several socioeconomic characteristics to a cohort from the general population who did not apply or move into public housing during the study period. We were able to test for changes in use of several different types of health services over time in both cohorts, while adjusting for differences in socioeconomic and health status characteristics.

5.6.2 Study Limitations & Future Directions

There are also a number of limitations. Firstly, our cohort only included residents of public housing, which is directly managed by the province. Other forms of social housing were not included, including housing operated by cooperatives, non-profit groups, and property management agencies, because of the lack of individual-level administrative data from these housing projects. The general population matched cohort did not move, which is a potential limitation. Moving may be a disruptor, and the general population matched cohort may or may not have experienced it (we tried to limit this in the post-period by excluding people who had a residential start date during this period); this is a potential confounder in the analysis. A future study should compare people who move into public housing with people who move, but not into public housing.

There may be measurement error in the covariates. For example, the diagnoses of the health conditions are based on physician visits and hospitalizations in the 365 days prior to the move-in date. Only one diagnosis code is recorded for each physician visit. Consequently, the number of people with any of the health conditions may be underestimated; however, this should have affected both cohorts similarly. Residential mobility may have been underestimated if address changes were not reported to Manitoba Health; however, this is likely minimal given the high use of healthcare services and that healthcare providers usually require accurate information on a person's health card.

Wood et al. (2016) compared healthcare use before and after homeless individuals moved into public housing. Some of their results changed when they used a three-year pre-move-in date period compared to a one-year pre-move-in date period. A future study could therefore assess how the length of the pre and post-move-in date periods affect the findings (e.g., at least one

year, at least two years, etc.). Additionally, it would be interesting to add a third comparison group, one that applied to public housing but did not move into this type of housing. This group could be identified in administrative data, given that public housing application cancelation date and the cancelation reasons are provided. It would also be worthwhile to compare healthcare use before and after individuals move out of public housing, as well as to use GIS techniques to examine and compare distances to healthcare services in prior to the move-in date, during public housing tenancy, and after moving out. Lastly, a future study could test for changes in mental health, physical health (e.g., Martinez & Bart, 2006), and preventive health service use (i.e., medical screening).

5.7 Summary

In summary, residents of public housing tend to be higher users of healthcare services compared to individuals who are similar in terms of their socioeconomic characteristics over a two-year period proximal to their move date. In general, changes in healthcare use over time were similar in the two cohorts. Because the interaction between time period and cohort was only significant for inpatient days, there is little evidence to support the idea that public housing functions as an intervention in the realm of healthcare use.

Disclaimer

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Ethics Approval

Ethics approval was obtained from the University of Manitoba Health Research Ethics Board. Data access was approved by the Manitoba Health Information Privacy Committee.

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Authors' Contributions

AMH, LML, BB, JD, and LR contributed to the study conception, design, interpretation of the data, drafting and critical revision of the manuscript. AMH contributed to the data analysis, interpretation of the data, and writing and revision of the manuscript. All authors participated in editing and revising the manuscript. All authors read and approved the final manuscript.

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Table 5-1. Socio-Demographic and Health Characteristics of the Public Housing and Matched Cohorts in the 365 Days Prior to the Public Housing Move-in Date.

Variables	Categories	Public Housing Cohort (n = 2612)	Matched General Population Cohort (n = 2612)
Sex	Males	27.1	27.1
	Females	72.9	72.9
Age (years) at Move-in Date	18 – 24	15.9	15.9
	25 – 39	32.2	32.2
	40 – 64	37.4	37.4
	65+	14.4	14.4
Region	Winnipeg	40.2	40.2
	Non-Winnipeg	59.8	59.8
Income Assistance	Yes	65.1	65.1
Income Quintile†	Q1 (poorest)	43.0	32.0
	Q2	22.0	21.8
	Q3	15.6	19.6
	Q4	11.6	13.5
	Q5 (most affluent)	6.4	11.1
	NF*	1.4	2.0
Change in Postal Code†	Yes	25.8	15.5
Physical Health Conditions	Arthritis‡	24.2	20.7
	Injury†	21.6	16.9
	Respiratory Disease†	18.5	14.4
	Hypertension‡	18.3	15.2
	Diabetes†	14.6	9.8
	Ischemic Heart Disease‡	1.9	1.0
	Cancer	3.0	2.9
	Inflammatory Bowel Disease	0.5	0.7
Mental Health Conditions	Affective Disorders†	30.1	24.8
	Substance Abuse Disorders‡	6.1	4.1
	Schizophrenia	2.1	2.6
ADGs†	Low	17.4	24.5
	Medium	25.3	28.9
	High	57.4	46.6

Note. ADGs = Aggregated Diagnostic Groups; *NF = Not Found; ‡$p < 0.01$ †$p < 0.0001$

Table 5-2. Healthcare Utilization Characteristics of the Public Housing and Matched Cohorts in the Year Before and After the Move-in Date.

Healthcare Utilization	Public Housing Cohort (n = 2612)		Matched General Population Cohort (n = 2612)	
	Year Before	Year in Housing	Year Before	Year in Housing
Hospitalization (%)				
Yes	16.4	13.3	10.2	8.9
No	83.7	86.7	89.9	91.1
Median # of Inpatient Days* (IQR)	6 (20)	6 (14)	4 (9)	4 (9)
Mean # of Physician Visits (SD)	8.7 (7.8)	8.2 (7.5)	7.1 (7.4)	6.8 (7.1)
Mean # of GP Visits (SD)	7.0 (6.8)	6.6 (6.4)	5.6 (6.2)	5.3 (5.9)
Mean # of Specialist Visits (SD)	1.8 (3.4)	1.6 (3.1)	1.5 (3.3)	1.4 (3.2)
Mean # of Prescriptions (SD)	7.1 (5.8)	7.2 (5.7)	5.7 (5.2)	5.6 (5.2)
Number of ED Visits (%)				
0	75.3	66.0	83.4	75.2
1	12.1	13.3	8.7	11.8
2+	12.6	20.8	8.0	13.0

Note. GP = general practitioner; ED = emergency department; *Calculated for those who were hospitalized.

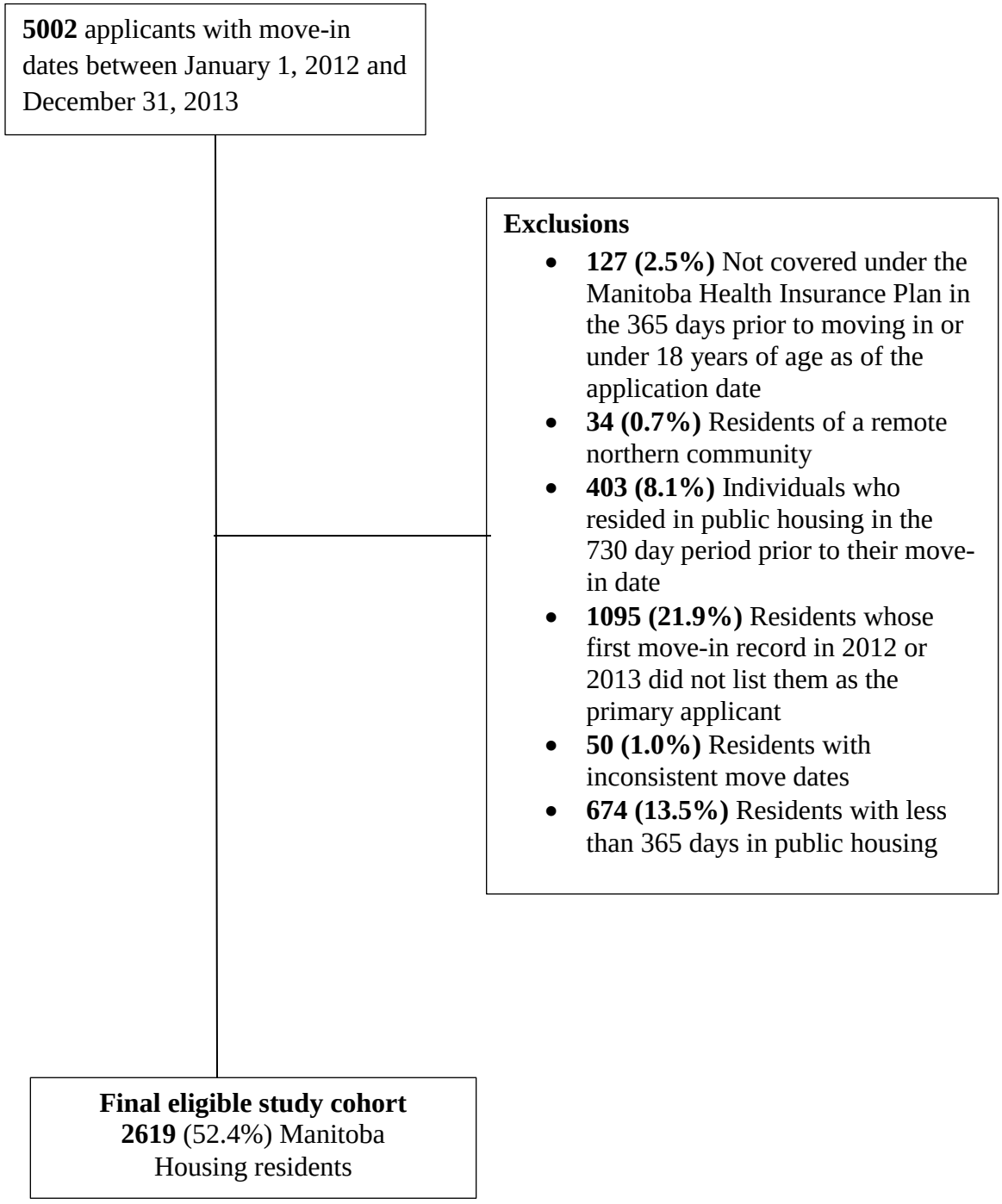
Table 5-3. Unadjusted and Adjusted Estimates and 95% Confidence Intervals (CIs) of the Cohort by Time Period Interaction, and the Main Effects of Cohort and Time Period for Healthcare Use.

Model	Effect	Category	Estimate	Significance 95% CI	QIC
		Hospitalization			
Adjusted Model	Time period	Year in Housing	**0.79**	**0.70, 0.89**	6711.98
		Year Before	Ref	-	
	Cohort	Public Housing	**1.39**	**1.21, 1.61**	
		Matched	Ref	-	
Unadjusted Model	Time period	Year in Housing	**0.82**	**0.74, 0.90**	7661.38
		Year Before	Ref	-	
	Cohort	Public Housing	**1.66**	**1.45, 1.89**	
		Matched	Ref	-	
		GP Visits			
Adjusted Model	Time period	Year in Housing	**1.04**	**1.01, 1.06**	-120990.85
		Year Before	Ref	-	
	Cohort	Public Housing	**1.08**	**1.04, 1.13**	
		Matched	Ref	-	
Unadjusted Model	Time period	Year in Housing	**0.95**	**0.93, 0.97**	-129531.57
		Year Before	Ref	-	
	Cohort	Public Housing	**1.25**	**1.18, 1.31**	
		Matched	Ref	-	
		Specialist Visits			
Adjusted Model	Time period	Year in Housing	1.00	0.94, 1.06	-3265.49
		Year Before	Ref	-	
	Cohort	Public Housing	0.98	0.88, 1.09	
		Matched	Ref	-	
Unadjusted Model	Time period	Year in Housing	**0.91**	**0.87, 0.96**	-3078.40
		Year Before	Ref	-	
	Cohort	Public Housing	**1.11**	**1.01, 1.23**	
		Matched	Ref	-	
		Prescriptions			
Adjusted Model	Time period	Year in Housing	**1.04**	**1.02, 1.05**	-132628.77
		Year Before	Ref	-	
	Cohort	Public Housing	**1.09**	**1.05, 1.13**	
		Matched	Ref	-	
Unadjusted Model	Time period	Year in Housing	1.00	0.99, 1.02	-155558.88
		Year Before	Ref	-	
	Cohort	Public Housing	**1.27**	**1.21, 1.33**	
		Matched	Ref	-	
		ED Visits			
Adjusted Model	Time period	Year in Housing	**0.90**	**0.82, 1.00**	3998.54
		Year Before	Ref	-	
	Cohort	Public Housing	**1.18**	**1.01, 1.37**	
		Matched	Ref	-	

Unadjusted Model	Time period	Year in Housing	**0.90**	**0.82, 1.00**	3180.39
		Year Before	Ref	-	
	Cohort	Public Housing	**1.59**	**1.36, 1.86**	
		Matched	Ref	-	

Note. Covariates = residential mobility, income quintile, injury, diabetes, arthritis, hypertension, respiratory disease, cancer, affective disorders, schizophrenia, substance abuse disorders, ADG

Figure 5-1. Flow chart for construction of the public housing cohort.



Appendix A. Supplementary Table

Table 1. ICD Codes Used to Define Physical and Mental Disorders.

Condition	ICD-9-CM	ICD-10-CA
Physical		
Respiratory Illness	466, 490 – 493, 496	J20, J21, J40 – J45
Diabetes	250	E10 – E14
Hypertension	401 – 405	I10 – I15
Cancer	14 – 20	C00 – C97
Arthritis	274, 446, 710 –721, 725 –729, 739	M00 – M03, M05 – M07, M10 – M25, M30 – M36, M65 – M79
Injury	80 – 99	S00 – S99, T00 – T98
Mental Disorder		
Schizophrenia	295	F20, F21, F25, F232
Affective Disorder	296, 300, 309, 311	F31 – F33, F40 – F42, F44, F48, F99, F341, F380, F381, F410, F411, F412, F413, F418, F419, F431, F432, F438, F450, F451, F452, F530, F680, F930
Substance Abuse Disorder	291, 292, 303 – 305	F10 – F19, F55

CHAPTER 6 : SUMMARY

6.1 Summary of Findings

Numerous studies on individuals' health, housing, and education after they move out of public housing have been undertaken (Clampet-Lundquist, Edin, Kling, & Duncan, 2011;Clampet-Lundquist, 2007; Leventhal & Brooks-gunn, 2003); many of these were conducted in the US, when public housing tenants moved to mixed-income communities. However, far fewer studies about health and housing outcomes when individuals move into public housing exist. Goffette-Nagot and Sidibe (2016) wrote, "Although public housing is a policy designed to improve the housing conditions of low-income households, there are very few research [studies] on its effects on tenants' outcomes" (Goffette-Nagot & Sidibe, 2016, p.20). The purpose of this research was to use linkable population-based administrative databases to examine housing and health outcomes of applicants to and residents of public housing in Manitoba. This was accomplished by completing four related studies.

Research has shown residents of public housing, on average, tend to be in poorer health than the general population; however, little was known about their health prior to moving in. As not all individuals with low incomes apply to public housing, research was needed to explore whether being in poorer health contributes to the decision to apply. In our first study (Chapter 2), we identified a cohort of individuals who applied to public housing in 2005 and 2006 and matched them to a cohort from the general population similar in socioeconomic characteristics but did not apply for public housing. We found that public housing applicants were more likely to be female, resided in low income areas, were recipients of income assistance, and about one-third were residentially mobile in the year prior to their application date. Individuals in the public housing applicant cohort were more likely to have physical and mental health conditions and

were higher users of health services than the matched cohort. Economic (i.e., area-level income, single parent and general assistance), residential mobility, and health status (i.e., presence of respiratory illness, diabetes, cancer, schizophrenia, affective disorders, substance abuse disorders, and resource utilization bands) measures were significantly associated with applications to public housing. These findings were replicated in a cohort who applied to public housing in 2011 and 2012. These results imply that health status is factor contributing to an individual's decision to apply for public housing.

Research has shown that socioeconomic characteristics are associated with moving out of public housing. Few studies had considered the relationship between moving out of public housing and health status and whether the factors associated with moving out vary by move-out reason. In the second study (Chapter 3), we identified a cohort of public housing residents who moved into public housing in 2007 and 2008 and followed them for seven years (March 31, 2013). Voluntary movers (i.e., were not evicted) (48.6%) resided an average of 1.9 years, and evicted movers (14.2%) resided an average of 1.8 years. We found that individuals evicted from public housing tended to be younger, were more likely to be recipients of income assistance, and were more residentially mobile in the year before they moved into public housing compared to those who did not move during the observation period. Meanwhile, voluntary movers were more likely to be young, but were less likely to be recipients of income assistance compared to individuals who did not move. Evicted movers were more likely to have a physician-diagnosed substance abuse disorder or to have sustained an injury, and had more GP visits, and poorer continuity of care than individuals who did not move. We found that socioeconomic characteristics (and not health characteristics) were associated with moving out voluntarily, while socioeconomic, health status, and health service use characteristics were associated with

being evicted. This study is useful for understanding tenancy behavior and identifying individuals that may experience housing challenges.

In Chapters 4 and 5, we sought to describe patterns in healthcare use over time and to determine whether healthcare use changed when individuals moved into public housing. In Chapter 4, we identified a cohort of individuals who moved into public housing in 2009 and 2010 and examined their healthcare use in twelve 30-day periods before and after the move-in date. Healthcare use tended to increase in the two to three months prior to the move-in date and was lower in the two to three months after the move-in date. Visits to specialist physicians and hospitalizations were significantly lower in the year after the move-in date compared to the year before the move-in date, while prescriptions use was significantly higher in the year following the move-in date. Therefore, there is evidence that residency in public housing coincides with a decrease in healthcare use, at least temporarily.

In Chapter 5, we identified a cohort of individuals who moved into public housing in 2012 and 2013 and examined their healthcare use in the years before and after the move-in date. We compared their healthcare use to a cohort from the general population matched one-to-one on the basis of age, sex, health region, and receipt of income assistance. The public housing cohort was more likely to reside in lower income areas, be residentially mobile, and have physical and mental health conditions compared to the matched cohort. The public housing cohort was also more likely to be hospitalized, and had higher rates of physician visits, GP visits, ED visits, and prescription use compared to the matched cohort. Rates of healthcare use were higher in the year before the move-in date compared to the year after the move-in date. Compared with individuals with similar sociodemographic characteristics and controlling for differences in health characteristics, residents of public housing are more frequent users of healthcare services. Since

the time period by cohort interactions were not statistically significant for all healthcare variables, except inpatient days, there is insufficient evidence to conclude that residence in public housing affects healthcare use.

6.2 Policy Importance

Overall, the results unequivocally demonstrate that poor health often precedes public housing tenancy and indicates new residents may require supports in order to have successful tenancies. Additionally, this research intimates Manitoba Housing may be achieving one of its mandates - to provide affordable housing for individuals with low to moderate incomes and those with specialized needs (Manitoba Government, 2016). Therefore, this research supports the idea that public housing serves the public good, since it appears to be providing a safety net for individuals who may not be able to afford to rent in the private market. As Baker, Bazargan, Bazargan-Hejazi, and Calderone (2005) note, public housing is an important resource for low income families. One advantage of residing in public housing (over other forms of housing) is the availability of services located in or nearby by public housing developments that support residents (e.g., family resource centres, Boys and Girls Clubs, etc.). There are also opportunities for residents to increase their own capacity (e.g., training, leadership opportunities in organizing community events and sitting on tenant associations, etc.). Manitoba Housing recognizes that housing and health (and other outcomes) are linked and engages in community development activities to promote social inclusion and support residents' "efforts to increase economic and social independence, personal accountability, [and] individual choice" (Manitoba Government, 2016).

Given that public housing residents tend to have a high burden of disease, it is prudent to locate health services in or close to public housing developments. To ensure services are

accessible, residents should be consulted about barriers in accessing them. Since residence in public housing may represent an improved housing situation, policies/programs addressing other social determinants of health should be implemented (or continued or expanded). The most effective programs in public housing aimed to address health and wellness involve community engagement (Andrews et al., 2012; Andrews, Bentley, Crawford, Pretlow, & Tingen, 2007; Andrews, Felton, Wewers, Waller, & Tingen, 2007; Brown et al., 2011; Cooper, 2012; El-Askari et al., 1998; Keith, 2009; Kramer, 1967; Krieger, Rabkin, Sharify, & Song, 2009; McConnell, Dwyer, & Leeming, 1996; Rorie et al., 2011; Wolff et al., 2004; Wolff, Young, & Maurana, 2001; Woodall, Raine, South, & Warwick-booth, 2010; Yoo, Butler, Elias, & Goodman, 2009); therefore, residents should participate in the design, implementation, and evaluation of any initiative in public housing. Additionally, the government should continue to finance repairs and upgrades to the existing public housing stock so it is a safe and pleasant place to live.

Housing individuals may not be sufficient to guarantee they will have positive outcomes (i.e., successful tenancy, improved health, etc.) since they are still living in poverty. While providing individuals with a minimum level of income would be ideal, ensuring they receive income assistance and other benefits they are eligible for is a feasible goal. In the fourth study, we found that residence in public housing coincided with an increase in the percentage of households receiving income assistance monthly, as well there was an improvement in the consistency in which they received income assistance (result not presented in Chapter 5). Over time, the percentage of the matched cohort receiving income assistance decreased. These results support the notion that public housing may also help stabilize individuals' financial situation and connects them to resources. Since a substantial proportion of public housing residents (approximately 35%) did not receive income assistance, efforts could be made to contact them to

determine if they are eligible and assist them in applying. This would require coordination between the departments that provide housing and income assistance.

In an era when many jurisdictions are dismantling public housing, it is worthwhile to demonstrate the value of public housing. In summary, public housing is a safety net; providing low income housing to the more vulnerable, when they are the most vulnerable, and for the most part, keeps them stably housed. Interestingly, Harris (1999) argues in his review of the history of housing policy in Canada and US, that housing policy has never been part of social policy in either country. He writes: "Few Canadians, and no governments, have ever been convinced to subsidise social housing on the basis of need alone. Job-creation and economic growth, more than homelessness, are the issues which may mobilise public opinion again" (Harris, 1999, p. 1174). Our studies are a step in filling the research gap on the health and healthcare use of public housing applicants and residents in Canada, and help to demonstrate the need for this type of subsidized housing.

6.3 Future Directions

Due to the availability of numerous linkable population-based databases in Manitoba, there are many possible avenues for future inquiry. Other outcomes could be examined, including access and use of preventive healthcare (e.g., cancer screening), educational achievement (Roos, Walld, & Witt, 2014), and involvement in the justice system. In Manitoba, we have the ability to link public housing records to public school (kindergarten to grade 12), college, and university records.

While our studies focused on the characteristics of the primary applicant to public housing, characteristics of both the household and the building/project could be examined for their influence on the outcomes for the primary applicant. These include characteristics of

dependents (Dujardin & Goffette-Nagot, 2009) and family composition. For example, family units can be identified using birth records and the family registration number which is part of the personal health identification number in the Registry; therefore, the number of children and the sex-age distribution of an applicant's children can be determined. However, father-offspring relationships are less accurately specified in the data, particularly in more recent years, than mother-offspring relationships because marriages have to reported to the provincial health ministry for fathers to be connected to a household (Bolton et al., 2013; Lix et al., 2017; Roos, Walld, Burchill, Roos, & Nickel, 2017; Yang et al., 2016). Additionally, it is becoming more common for unmarried couples to have children. These challenges may be partly overcome by linking administrative date to survey data which includes information about partner status (Roos et al., 2017).

While the Population Research Data Repository housed at the Manitoba Centre for Health Policy does not contain information about individuals residing in other forms of social housing (e.g., housing managed by cooperatives non-profits), there is data on low-income individuals receiving rental support to live in private housing. Future studies could compare housing and health outcomes of public housing residents with individuals who receive rental assistance. Dunn (2000) noted the need for studies that examine the range of housing situations in Canada.

Because of the longitudinal nature of the data available in the Population Data Research Repository, one could investigate what happens to people when they move out of public housing. Additionally, researchers could examine the effect of residing in public housing over the life course; that is, does the number (i.e., single stayers versus returners), length (i.e., short versus long), and timing of tenancies (i.e., life stages; early childhood, adolescence, adulthood) impact

health, education, justice, and housing? Dunn (2000, 2004) and Dunn, Hayes, Hulchanski, Hwang, and Potvin (2004) noted that a life course approach to examine the relationship between housing and health is a research priority.

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APPENDIX. UNIVERSITY OF MANITOBA HEALTH RESEARCH BOARD ETHICS APPROVAL AND DATA ACCESS APPROVALS

P126-770 Bannatyne Avenue
Winnipeg, Manitoba
Canada R3E 0W3
Telephone 204-789-3255
Fax 204-789-3414

UNIVERSITY OF MANITOBA | BANNATYNE CAMPUS
Research Ethics Board

HEALTH RESEARCH ETHICS BOARD (HREB)

CERTIFICATE OF FINAL APPROVAL FOR NEW STUDIES

Delegated Review

PRINCIPAL INVESTIGATOR:	INSTITUTION/DEPARTMENT:	ETHICS #:
Ms. Aynslie Hinds	U of M/Community Health Sciences	H2014:381
APPROVAL DATE: November 6, 2014	**EXPIRY DATE:** November 6, 2015	
STUDENT PRINCIPAL INVESTIGATOR SUPERVISOR (If applicable): Dr. Lisa Lix		

PROTOCOL NUMBER:	PROJECT OR PROTOCOL TITLE;
N/A	Public Housing, Health and Residential Mobility: A Population-Based Analysis
SPONSORING AGENCIES AND/OR COORDINATING GROUPS: U of M Start Up Funds (and pending Evelyn Shapiro Award for Health Service Research)	

Submission Date of Investigator Documents:	HREB Receipt Date of Documents:
October 28, 2014	October 29, 2014

THE FOLLOWING ARE APPROVED FOR USE:

Document Name	Version(if applicable)	Date
Protocol: Proposal		October 28, 2014
Consent and Assent Form(s):		
Other: Data Extraction Form		October 28, 2014

CERTIFICATION

The above named research study/project has been reviewed in a ***delegated manner*** by the University of Manitoba (UM) Health Research Board (HREB) and was found to be acceptable on ethical grounds for research involving human participants. The study/project and documents listed above was granted final approval by the Chair or Acting Chair, UM HREB.

HREB ATTESTATION

The University of Manitoba (UM) Research Board (HREB) is organized and operates according to Health Canada/ICH Good Clinical Practices, Tri-Council Policy Statement 2, and the applicable laws and regulations of Manitoba. In respect to clinical trials, the HREB complies with the membership requirements for Research Ethics Boards defined in Division 5 of the Food and Drug Regulations of Canada and carries out its functions in a manner consistent with Good Clinical Practices.

QUALITY ASSURANCE

The University of Manitoba Research Quality Management Office may request to review research documentation from this research study/project to demonstrate compliance with this approved protocol and the University of Manitoba Policy on the Ethics of Research Involving Humans.

CONDITIONS OF APPROVAL:

1. The study is acceptable on scientific and ethical grounds for the ethics of human use only. ***For logistics of performing the study, approval must be sought from the relevant institution(s).***
2. This research study/project is to be conducted by the local principal investigator listed on this certificate of approval.
3. The principal investigator has the responsibility for any other administrative or regulatory approvals that may pertain to the research study/project, and for ensuring that the authorized research is carried out according to governing law.
4. **This approval is valid until the expiry date noted on this certificate of approval. A Bannatyne Campus Annual Study Status Report** must be submitted to the HREB within 15-30 days of this expiry date.
5. Any changes of the protocol (including recruitment procedures, etc.), informed consent form(s) or documents must be reported to the HREB for consideration in advance of implementation of such changes on the **Bannatyne Campus Research Amendment Form.**
6. Adverse events and unanticipated problems must be reported to the HREB as per Bannatyne Campus Research Boards Standard Operating procedures.
7. The UM HREB must be notified regarding discontinuation or study/project closure on the **Bannatyne Campus Final Study Status Report**.

Sincerely,

[redacted]

John Arnett, PhD. C. Psych.
Chair, Health Research Ethics Board
Bannatyne Campus

Manitoba
Health, Healthy Living and Seniors
Health Information Management
4040-300 Carlton Street, Winnipeg, Manitoba, Canada R3B 3M9
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December 23, 2014

Aynslie Hinds
Community Health Sciences
University of Manitoba,
S113-750 Bannatyne Avenue
Winnipeg, MB R3E 0W3
[redacted]

HIPC No. 2014/2015–29
File number to be quoted on correspondence

Dear Aynslie Hinds,

RE: Public Housing, Health, and Residential Mobility: A Population-Based Analysis

Thank you for submitting the requested documentation and providing clarification for the above named project. The Health Information Privacy Committee has now ***approved*** your request for data for this project.

Any significant changes to the proposed study design should be reported to the Chair/HIPC for consideration in advance of their implementation. Also, please be reminded that any manuscripts and presentation materials resulting from this study must be submitted to Manitoba Health, Healthy Living and Seniors for review. Specifically, manuscripts must be submitted at least **30** calendar days prior to publication and presentation materials must be submitted at least **10** calendar days prior to presentation.

Please note that a Researcher Agreement will need to be completed before work on this project can commence. This will be initiated by **MCHP**. If you have any questions or concerns, please do not hesitate to contact Marc Silva, Acting Committee Coordinator at (204)786-7229.

Yours truly,

[redacted]
Dr. Biehl, MD, FRCP
Chair, Health Information Privacy Committee

c.c. D. Malazdrewicz

UNIVERSITY OF MANITOBA | Faculty of Health Sciences

College of Medicine
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[redacted]

November 5, 2014

Jeff Parr
Deputy Minister
Housing and Community Development
352 Legislative Building
450 Broadway
Winnipeg, MB R3C 0V8

Dear Mr. Parr:

Re Project entitled, Public Housing, Health, and Residential Mobility: A Population-Based Approach

According to the literature, public housing residents are in poorer health and have different patterns of health service use compared to the general population. However, living in public housing may have a positive impact on health, because it provides stability and improved access to community resources. Thus, the health and health service use of residents may or may not change as a result of residing in public housing. Little is known about how residing in public housing, particularly the effect of varying lengths of tenancy, impacts the health, health service use, and residential stability of residents within a Canadian context. Most research on public housing residents has involved cross-sectional survey data from the United States. Population-based, longitudinal studies about public housing residents can inform planning for the distribution and types of health services to best serve this population.

The purpose of the research is to examine the associations amongst public housing and sociodemographic characteristics, health status, health service use, and housing stability. The specific objectives are to:
1. Identify predictors of an application for public housing.
2. Identify predictors of duration of public housing residency.
3. Characterize the health service use trajectories of public housing tenants and test their association with housing stability.
4. Test for differences in health service use between public housing tenants and non-public housing tenants over time.

This research may inform policies around public housing investments, including the location and types of supports and services that could be allocated to improve the health and wellness of public housing residents. Additionally, the findings may provide insight into who would benefit from public housing as well as the types of supports to assist individuals from needing public housing.

This project is being lead by Aynslie Hinds from the Department of Community Health Sciences, University of Manitoba. This project is my dissertation research. My advisor is Dr. Lisa Lix, Professor, Department of Community Health Sciences, University of Manitoba.

This project has been submitted for approval to the University of Manitoba Health Research Ethics Board (HREB), Manitoba Health Information Privacy Committee (HIPC) (subject to approval by all data trustees). Copies of these approvals will be on file in our office. If you require a copy, please let us know.

As required in the Data Sharing Agreement, I seek permission for the use of the Tenant Management System data housed in the Population Health Research Data Repository at the Manitoba Centre for Health Policy.

This project, as most projects undertaken by university researchers, assumes the right to publish results obtained as part of the research, subject to established safeguards for the protection of privacy or confidentiality of personal data.

In compliance with the Manitoba Personal Health Information Act (PHIA) section 24(4) we agree:

- not to publish the personal health information and/or personal information requested in a form that could reasonably be expected to identify the individuals concerned;
- to use the personal health information and/or personal information requested solely for the purposes of this approved research project; and
- to ensure that the research project contains reasonable safeguards to protect the confidentiality and security of the personal health information and/or personal information and procedures to remove all identifying information at the earliest opportunity consistent with the purposes of the project.

The above conditions specified in the PHIA with respect to personal health information will also be adhered to with respect to personal information in your datasets. As required, access to data is only permitted upon approval of the specific project from you or your appointee. Craig Marchinko has reviewed and approved this project and I now formally seek your approval for use of Tenant Management System data for the project "Public Housing, Health, and Residential Mobility: A Population-Based Analysis" (Project Synopsis attached). If you are in agreement with this request, I would be most appreciative if you would sign and date below indicating your approval, and return a copy to me at your earliest convenience.

Thank you for your consideration of my request.

Yours sincerely

[redacted]

Aynslie Hinds
PhD Student
Department of Community Health Sciences
University of Manitoba

cc: Craig Marchinko, Executive Director, Strategic Initiatives Manitoba Housing and Renewal Corporation
Deborah Malazdrewicz, Executive Director, Health Information Management, Manitoba Health, Healthy Living and Seniors
Marc Silva, HIPC Coordinator, Manitoba Health, Healthy Living and Seniors
Jo-Anne Baribeau, Repository Access Coordinator, MCHP
Lisa Lix, Professor, Department of Community Health Sciences

Enclosed: Project Synopsis

I approve the access and use of the Tenant Management System located in the Population Health Research Data Repository at MHHLS/MCHP for the project entitled, "Public Housing, Health, and Residential Mobility: A Population-Based Analysis".

[redacted] DEC 16 2014

Jeff Parr — Date
Deputy Minister, Housing and Community Development

Enclosed: Project Synopsis

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[redacted]

November 4, 2014

Mr. Hugh Eliasson
Dept. Jobs and the Economy
Deputy Minister
311 Legislative Building
450 Broadway
Winnipeg, MB R3C 0V8

Dear Mr. Eliasson:

RE: Public Housing, Health, and Residential Mobility: A Population-Based Analysis

According to the literature, public housing residents are in poorer health and have different patterns of health service use compared to the general population. However, living in public housing may have a positive impact on health, because it provides stability and improved access to community resources. Thus, the health and health service use of residents may or may not change as a result of residing in public housing. Little is known about how residing in public housing, particularly the effect of varying lengths of tenancy, impacts the health, health service use, and residential stability of residents within a Canadian context. Most research on public housing residents has involved cross-sectional survey data from the United States. Population-based, longitudinal studies about public housing residents can inform planning for the distribution and types of health services to best serve this population.

The purpose of the research is to examine the associations amongst public housing and sociodemographic characteristics, health status, health service use, and housing stability. The specific objectives are to:
1. Identify predictors of an application for public housing.
2. Identify predictors of duration of public housing residency.
3. Characterize the health service use trajectories of public housing tenants and test their association with housing stability.
4. Test for differences in health service use between public housing tenants and non-public housing tenants over time.

Receipt of and length of time on income assistance will be examined to determine if these economic factors are associated with whether someone applies to public housing and how long they reside in public housing. The association between these economic factors and health service use may also be examined. Lastly, these factors may be used to create a comparison group that does not reside in public housing. These variables are the only individual-level income information available on the population.

This research may inform policies around public housing investments, including the location and types of supports and services that could be allocated to improve the health and wellness of public housing residents. Additionally, the findings may provide insight into who would benefit from public housing as well as the types of supports to assist individuals from needing public housing.

This project is being lead by Aynslie Hinds from the Department of Community Health Sciences, University of Manitoba.This project is my dissertation research. My advisor is Dr. Lisa Lix, Professor, Department of Community Health Sciences, University of Manitoba.

This project has been submitted for approval to the University of Manitoba Health Research Ethics Board (HREB) and the Manitoba Health Information Privacy Committee (HIPC). Copies of these approvals will be on file at the Manitoba Centre for Health Policy (MCHP). If you require a copy, please let me know. As well, all of the data analyses will be conducted within MCHP's secure environment.

As required, I seek your permission for the access and use of the Employment and Income Assistance data in the Social Assistance Management Information Network database housed in the Manitoba Population Health Research Data Repository at MCHP. For use of your data, you or your designate will receive early drafts of papers at which time I welcome your input in ensuring that aspects of your program are accurately represented and confidentiality is maintained. If it is of interest, I will be happy to provide you with briefings on the outcomes of this project prior to its public release.

This project, as most projects publicly funded and undertaken by university researchers, assumes the right to publish results obtained as part of the research, subject to established safeguards for the protection of privacy or confidentiality of personal data.

In compliance with the Manitoba Personal Health Information Act (PHIA) section 24(4) I agree:

- not to publish the personal health information and/or personal information requested in a form that could reasonably be expected to identify the individuals concerned;
- to use the personal health information and/or personal information requested solely for the purposes of this approved research project; and
- to ensure that the research project contains reasonable safeguards to protect the confidentiality and security of the personal health information and/or personal information and procedures to remove all identifying information at the earliest opportunity consistent with the purposes of the project.

The above conditions specified in the PHIA with respect to personal health information will also be adhered to with respect to personal information in the Jobs and the Economy dataset. As required, access to data is only permitted upon approval of the specific project from you or your appointee. Catherine Gates has reviewed and approved this project and I now officially seek your approval for use of the Employment and Income Assistance data for the project "Public Housing, Health, and Residential Mobility: A Population-Based Analysis" (Project Synopsis attached).

If you are in agreement with this request, I would be most appreciative if you would email the research liaison at Manitoba Jobs and the Economy indicating your approval who will then notify the Repository Access Coordinator at MCHP.

I look forward to working with you and providing you with important policy relevant research.

Yours sincerely,

[redacted]

Aynslie Hinds
PhD Student
Department of Community Health Sciences
University of Manitoba

cc: Catherine Gates, Director, Policy and Program Development, Employment and Income Assistance, Manitoba Jobs and the Economy
Deborah Malazdrewicz, Executive Director, Health Information Management, Manitoba Health, Healthy Living and Seniors
Marc Silva, HIPC Coordinator, Manitoba Health, Healthy Living and Seniors
Jo-Anne Baribeau, Repository Access Coordinator, Manitoba Centre for Health Policy
Lisa Lix, Professor, Department of Community Health Sciences

Enclosed: Project Synopsis

Approved By:

[redacted]

Hugh Eliasson

Public Housing, Health, and Residential Mobility: A Population-Based Analysis

A Research Proposal by Aynslie Hinds

Background

Public housing is a form of housing tenure for low-income individuals and families in which the property is owned and managed by a government housing authority or corporation. Generally, public housing residents are in poorer health[1,2,3,4] and have different patterns of health service use[3,5] than the general population. Most research on public housing residents has involved cross-sectional survey data. Population-based, longitudinal studies can inform planning for the distribution and types of health services to best serve this population.

Purpose and Objectives

The purpose of this research is to examine the association between public housing and sociodemographic characteristics, health status, health service use, and housing stability. The research objectives are to:

1. Identify predictors of an application for public housing.
2. Identify predictors of duration of public housing residency.
3. Characterize the health service use trajectories of public housing tenants and test their association with housing stability.
4. Test for differences in health service use between public housing tenants and non-public housing tenants over time.

Methods

This research will use linked databases from 2000 to 2013 from the Population Health Research Data Repository housed at the Manitoba Centre for Health Policy. Applicants to and residents of public housing will be identified using the Tenant Management System database from the Ministry of Housing and Community Development. The other datasets that will be used include: Hospital Discharge Abstracts, Physician Billing Claims, Drug Program Information Network, Admission, Discharge and Transfer (ADT) database, E-Triage, the Emergency Department Information System, Social Assistance Management Information Network (SAMIN), the Population Registry, and the Canadian Census.

The first objective will compare a cohort who applied to Manitoba Housing in 2005 or 2006 with a matched cohort who did not apply for public housing; the study cohort will not include individuals residing in Churchill or current residents of Manitoba Housing. To be included in the study cohort, individuals must be covered under the Manitoba Health Insurance Plan in the year they applied and the year prior to their application. The study cohort will be matched 1-to-1 to a cohort selected from the general population based on sex, age, and region of residence. The matched cohort will not include individuals who applied to Manitoba Housing in 2004, 2005, or 2006, were listed on a Manitoba Housing application as a co-habitant, were residing in Manitoba Housing, and were residing in Churchill. The matched cohort must be covered under the Manitoba Health Insurance Plan during the same period as their study cohort counterparts. The relative contribution of sociodemographic, health status, health service use, and housing stability variables for predicting applications to public housing will be tested using logistic regression. Sociodemographic variables will include sex, age, marital status, family composition, receipt of income assistance, and income quintile. Health status will be measured using the Charlson Comorbidity Index and Aggregated Diagnostic Groups. Health service use will be based on the number of hospital separations, length of stay, number of emergency department/urgent care (ED/UC) visits, number of physician visits, continuity of care, and pharmaceutical use. Residential mobility will be determined from changes in 6-digit postal code. The analysis may be stratified by region of residence and/or sex of the applicant. Goodness of fit and reclassification statistics will be used to evaluate model fit and predictive performance. The final model will be validated using measures of predictive performance in a sample of individuals who applied to Manitoba Housing for the first time in 2011.

The second objective will identify a cohort who moved into Manitoba Housing in 2007 or 2008, resided at least one month, were the primary applicant, and were covered by the Manitoba Health Insurance Plan the year they moved in and the year prior. The cohort will exclude residents of Churchill. Duration of residence in Manitoba Housing will be modeled using Cox Proportional Hazards regression by entering the variables grouped by type (i.e., demographic, health status, health service use, etc.). Censored data will occur when a tenant loses coverage under the Manitoba Health Insurance Plan, they die, or the study period ends (2013). The analysis may be stratified by region of residence, sex of the applicant, move-out reason, and/or length of tenure. Goodness of fit and reclassification statistics will be used to evaluate model fit and the utility of the models.

The third objective will identify a cohort who moved into Manitoba Housing in 2007 or 2008, resided at least six months, were the primary applicant, and were covered by the Manitoba Health Insurance Plan in the year they moved in and the year prior. Residents of Churchill will be excluded. Health service use will be compiled on a monthly basis; measures of health service use will include number of hospital separations, number of physician visits, number of ED/UC visits, and number of prescription drugs dispensed. ED/UC visits will be measured only for Winnipeg residents due to the availability of the data. Growth mixture modeling will be used to classify tenants based on their health service use patterns one year pre-tenancy in Manitoba Housing and up to five years after moving out. Associations between class membership and various covariates, including residential mobility, will be tested.

The fourth objective will compare the health service use of the cohort from objective three to a cohort from the general population. Individuals residing in Manitoba Housing and residents of Churchill will be ineligible to be part of the comparison cohort. The comparison cohort will be created in two ways; 1) matched 1-to-1 based on age, sex, and region of residence, and 2) using propensity scores. A sensitivity analysis will be conducted to compare the results from these two matching processes. Generalized linear models will be used to test for differences in utilization between the cohorts. Covariates will be entered into the models grouped by type (i.e., socio-demographic, health status, residential mobility, etc.). The analysis may be stratified by sex of the applicant, region of residence, move-out reason, and/or length of housing tenure. Model fit will be assessed using various descriptive and inferential measures.

Significance

This research will inform policies around public housing investments, including the location and types of supports and services that could be allocated to improve the health and wellness of public housing residents. Additionally, the findings may provide insight into who would benefit from public housing as well as the types of supports to assist individuals from needing public housing. Lastly, this study will add to the paucity of existing Canadian literature on the health and health service use of public housing residents.

Study Limitations

There are a number of considerations, including the accuracy of postal codes and how this is related to health service use, the potential to underestimate residential mobility, and the potential to underestimate comorbid conditions. These issues may be mitigated by the longitudinal nature of the study design and by assessing data quality.

Study Strengths

There are many benefits to using administrative data for the proposed research. These include the availability of longitudinal individual-level information for the entire population of Manitoba, near complete information on health care use without recall bias, the ability to link multiple databases, the ability to identify all applicants and residents of Manitoba Housing and their healthcare use, the ability to create cohorts from the general population for comparison purposes, and the ability to track changes in housing over time.

References

1. Digenis-Bury, E. C., Brooks, D. R., Chen, L., Ostrem, M., & Horsburgh, C. R. (2008). Use of a Population-Based Survey to Describe the Health of Boston Public Housing Residents. *American Journal of Public Health*, *98*(1), 85–91. doi:10.2105/AJPH.2006.094912
2. Ruel, E., Oakley, D., Wilson, G. E., & Maddox, R. (2010a). Is Public Housing the Cause of Poor Health or a Safety Net for the Unhealthy Poor ? *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, *87*(5), 827–838. doi:10.1007/s11524-010-9484-y
3. Smith, M., Finlayson, G., Martens, P., Dunn, J., Prior, H., Taylor, C., … Hinds, A. (2013). *Social Housing in Manitoba Part II: Social Housing and Health in Manitoba: A First Look.* Winnipeg, MB. Manitoba Centre for Health Policy.
4. Wiggers, J., Radvan, D., Clover, K., Hazell, T., Alexander, J., & Considine, R. (2001). Public housing, public health: Health needs of public housing tenants. *Australian and New Zealand Journal of Public Health*, *25*(2), 111–114.
5. Simning, A., van Wijngaarden, E., Fisher, S. G., Richardson, T. M., & Conwell, Y. (2012). Mental healthcare need and service utilization in older adults living in public housing. *American Journal of Geriatric Psychiatry*, *20*(5), 441–451. doi:10.1097/JGP.0b013e31822003a7

Winnipeg Regional Health Authority
Caring for Health

Office régional de la santé de Winnipeg
À l'écoute de notre santé

Research & Evaluation Unit

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November 13, 2014

Ms. Aynslie Hinds
PhD Student, Department of Community Health Sciences
University of Manitoba
S113 – 750 Bannatyne Avenue
Winnipeg, MB R3E 0W3

Dear Ms. Hinds:

Re: "Public Housing, Health, and Residential Mobility: A Population-Based Analysis"

We are pleased to inform you that your research request for the above-named study that was submitted in November 2014 has been approved by the Winnipeg Regional Health Authority (WRHA) Research Access and Approval Committee.

Specifically,

I approve the request for access and use of the Admission, Discharge, and Transfer, and E-Triage, and the Emergency Department Information System databases which are housed in the Population Health Research Data Repository at MCHP as detailed in your HIPC application.

We extend best wishes for successful completion of your study.

Yours sincerely,

[redacted]

Dr. Colleen J. Metge, BSc (Pharm), PhD
Director, Evaluation Platform, Centre for Healthcare Innovation
Chair, WRHA Research Access and Approval Committee
Winnipeg Regional Health Authority

cc: Christina von Schindler, Chief Privacy Officer, WRHA
Dan Skwarchuk, Senior Executive Director, Division of Quality and System Performance, WRHA
Deborah Malazdrewicz, Executive Director, Health Information Management, Manitoba Health, Healthy Living and Seniors
Marc Silva, HIPC Coordinator
Jo-Anne Baribeau, MCHP Repository Access Coordinator