Prevalence of Mental Health Disorders among Pregnant Women Living in Public Housing in Manitoba

by

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Abstract

Background: Women are more likely to experience a higher burden of mental health disorders than men. Pregnancy is one of the most sensitive and complex periods in a woman's life; the physical and psychological changes that take place during pregnancy can impact pregnant women's mental health. In Canada, approximately one in four women experience a mental health disorder during pregnancy or the postpartum period. Maternal mental health disorders include a range of disorders and symptoms, including but not limited to depression, anxiety, and psychosis. Housing is considered one of the most critical social determinants of physical and mental health, particularly among pregnant women. Public Housing (PH) is a government funded housing program that provides affordable housing to individuals or families with limited or fixed incomes. Finlayson et al., (2013), found higher proportion of women in PH than men. Women with mental health disorders during pregnancy and living in poor quality housing conditions are less likely to receive adequate prenatal care. They are also more likely to engage in unhealthy behaviours such as smoking and use of alcohol and other substances which are known to cause devastating consequences for mothers, babies, and the society. While there is evidence to suggest that people living in PH have a higher burden of mental health disorders, little is known about these disorders among pregnant women living in PH. This is despite the unique physiological and social changes that they experience as they transition to parenthood.

Objectives: The study examined the prevalence and incidence of mental health disorders (mood and anxiety, substance use, psychotic and personality disorders and any mental health disorders) among pregnant women who had a live singleton birth while living in PH and compared with pregnant women who did not live in PH during the study period.

Methods: A population-based retrospective cohort study was conducted among 2,226 pregnant women who lived in PH and 57,132 pregnant women who did not live in PH, aged 18 to 45 years

who experienced at least one pregnancy that resulted in a singleton, live birth between April 1, 2009 – March 31, 2018 in Manitoba. Descriptive statistics were used to describe maternal demographic characteristics (age, income quintiles, receipt of income assistance, high school completion, parity, Charlson Commodity Index, region of residence). Univariate and multiple logistic regressions were used to calculate the diagnostic prevalence of mental health disorders before conception among pregnant women in both groups. Negative binomial regression was used to compare the incidence rates of these disorders among the same two groups of women during pregnancy and postpartum period.

Results: When compared with the women who did not live in PH, women who lived in PH had significantly higher odds of being diagnosed with all mental health disorders five years before conception: (a) mood and anxiety disorder (OR, 2.08; 95% CI, 1.91, 2.26), (b) substance use disorder (OR, 3.03; 95% CI, 2.65-3.47), (c) personality disorder (OR, 2.85; 95% CI, 2.17-3.73), (d) psychotic disorder (OR 3.26; 95% CI, 2.25-4.72) and (e) any mental health disorders (OR 2.21; 95% CI, 2.03-2.41). However, I found no significant differences in the odds for mood & anxiety disorders, substance use disorders, and any mental health disorders when comparing women who lived in PH with their comparison after adjusting for the covariates. Personality and psychotic disorders could not be compared between women who lived and did not live in PH in the multivariable analysis due to the small number of events.

Furthermore, the unadjusted incident rates of mental health disorders diagnosed during pregnancy and after birth were significantly higher among women who lived in PH compared with their comparison for mood and anxiety disorders (RR, 1.23; 95% CI, 1.06-1.42), substance use disorders (RR, 1.54; 95% CI, 1.16-2.03), personality disorders (RR 2.71; 95% CI, 1.56-4.72*),* and any mental health disorders (RR 1.12; 95% CI, 0.99-1.27). There was no statistically significant different for psychotic disorders (RR 1.30; 95% CI, 0.48-3.61). After adjusting for the

covariates, the incident rate of substance use disorders was significantly lower among the women who lived in PH compared with women who did not live in PH. There were no significant differences in the incident rates for mood & anxiety disorders and any mental health disorders between the two groups.

Conclusion: Unadjusted models showed that women living in PH had higher diagnostic prevalence and incidence of mental health disorders when compared with those who did not live in PH. However, in the fully adjusted models, receipt of income assistance (IA), accounted for much of the observed differences in mental health disorders between those who lived and those who did not live in PH. This study highlights the critical importance of addressing income inequities among residents of public housing with limited financial resources to improve their overall health and social outcomes.

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INTRODUCTION

Pregnancy is one of the most sensitive and complex periods in a woman's life; the physical and psychological changes that take place during pregnancy can impact pregnant women's mental health (Chatterjee et al., 2021). In Canada, the presence of mental health disorders during the perinatal period is common and presents a substantial burden for public health with approximately one in four women who are pregnant or postpartum having a mental health disorder in the past year (Mota et al., 2019; Vesga-López et al., 2008). A person's mental health is shaped by the social and structural determinants; secure housing and adequate income are among the most critical social determinants of physical and mental health, particularly among pregnant women (MacKay & Wellner, 2013). Housing is a basic human right and comprises more than just physical shelter; it is where we live and where personal, social and economic life take place. Statistics Canada reported in 2021 that 10.1% of Manitobans are in core need for housing.

Many provincial social housing programs have been established to meet the housing needs of Manitoba residents. Public housing (PH) is one of many ways to reduce core housing needs by providing affordable housing to individuals and families with limited or fixed incomes. PH plays an essential role in Manitoba's housing system. Smith et al., (2013) showed that the residents of PH are disproportionately from the lowest socioeconomic status and are more likely to rely on income assistance than the rest of the population. Finlayson et al., (2013) reported a higher proportion of women residing in PH than men. Women with mental health disorders during pregnancy and living in poor quality housing conditions are less likely to receive adequate prenatal care and are more likely to engage in risky health behaviors such as smoking and use of alcohol and other substances which are known to cause adverse pregnancy outcomes (Grigoriadis

et al., 2013; Howard & Khalifeh, 2020; Korhonen et al., 2012; Mahmoodi et al., 2017; Räisänen et al., 2014; Stein et al., 2023).

Several studies suggested that people living in PH have a higher burden of mental health disorders (Bentley et al., 2018; Chartier et al., 2018; A. Hinds et al., 2019; Hinds et al., 2016; Simning et al., 2011; Smith et al., 2013). Even though the rate of mental health disorders is higher among people living in PH, little is known about mental health disorders among pregnant women living in PH. This information is important because pregnant women living with mental health disorders are more likely to have various undesirable birth outcomes including stillbirth, low birth weight, preterm delivery, intrauterine growth delay, and childhood emotional, cognitive and behavioural problems (Grigoriadis et al., 2013; Howard & Khalifeh, 2020; Korhonen et al., 2012; Mahmoodi et al., 2017; Räisänen et al., 2014; Stein et al., 2023). Therefore, the study examined the diagnostic prevalence and incidence rates of mental health disorders among women who have experienced pregnancy while living in PH. The study used the population-based administrative data housed in the Manitoba Population Research Data Repository (Repository) at the Manitoba Centre for Health Policy (MCHP) to examine the diagnostic prevalence and incidence of four types of mental health disorders among pregnant women who lived in PH.

1.0 Literature Review

Mental health disorders present a substantial burden for public health in Canada, with approximately one in five Canadians experiencing a mental health disorder in a given year (Smetanin et al., 2011). The World Health Organization (WHO) defines a mental health disorder as characterized by a clinically significant disturbance in an individual's cognition, emotional regulation, or behavior. It is usually characterized by disruptions in thinking, mood, or behaviour and is associated with distress or impairment in important areas of functioning (World Health Organization, 2018). Depression and bipolar disorder, substance use disorder, anxiety disorders,

schizophrenia, and post traumatic stress disorder are among the most common mental illnesses diagnosed each year (Miller, 2021). Those with mental health disorders are at higher risk of developing comorbidities, and experience lower life expectancy compared with the general population (Chesney et al., 2014; Lowe et al., 2021). Mental health disorders do not only impact individuals but have a significant impact on families, communities and the health care system (Smetanin et al., 2011). The Mental Health Commission of Canada (MHCC) estimated the annual economic cost of mental illness to be more than $50 billion or nearly $1,400 for every person living in Canada (MHCC, 2017). This includes increased health-care costs, lost productivity, and decreased health-related quality of life (Lim et al., 2008; Smetanin et al., 2011).

Compared with men, or women at other life stages, women of reproductive age are at a higher risk of having mental health disorders regardless of whether in the pregnancy or postpartum period (Johnson et al., 2019; Vesga-López et al., 2008). The prevalence of mental health disorder is higher among women than men (Patel et al., 2018; Pearson et al., 2013). Pregnancy is one of the most sensitive and complex periods in a woman's life; the physical and psychological changes that take place during pregnancy can impact women's mental health (Mota et al., 2019; Vesga-López et al., 2008; Molenaar et al., 2022; Abdelhafez et al., 2023; Furtado et al., 2018; Guintivano et al., 2018). When coupled with living in poor quality housing conditions, the risk for negative health outcomes is magnified for both mothers and their fetus (Biaggi et al., 2016; Katz et al., 2018). In Canada, the presence of mental health disorders during the perinatal period is common and presents a substantial burden for public health with approximately one in four women experiencing a mental health disorder during pregnancy or the postpartum period (Vesga-López et al.,2008). Maternal mental health disorders include a range of disorders and symptoms, including but not limited to depression, anxiety, and psychosis. Mental health disorders can onset for the first time during pregnancy and/or the postpartum

period, but can also be pre-existing. They are caused by a variety of factors – in isolation or in combination – such as a combination of biological, psychological, and social stressors including personal and family history of mental health disorders, low social support, poor marital relationship, and stressful life events (Norhayati et al., 2015; Bayrampour et al., 2015; Abdelhafez et al., 2023; Furtado et al., 2018; Guintivano et al., 2018). If these disorders are left untreated, they can cause devastating consequences for mothers, infants, and society. A person's mental health is shaped by social and structural determinants; secure housing and adequate income are among the most critical social determinants of physical and mental health, particularly among pregnant women (World Health Organization., 2018; MacKay & Wellner, 2013).

1.1 Housing as a Social Determinant of Health

Housing is a basic human right and an important social determinant of health and well-being which not only includes the guarantee of shelter, but also its quality (World Health Organization., 2018). In 1986, shelter was recognised as a basic prerequisite for health in the Ottawa Charter for Health Promotion (World Health Organization., 1986). Housing comprises more than just physical shelter; it is where we live and where personal, social and economic life take place. Without housing, it is difficult for people to maintain quality health, meet their basic and health-related needs on a sustainable basis and be productive in society. Statistics Canada in collaboration with the Canada Mortgage and Housing Corporation (CMHC) reported in 2021 that 1 in 10 households were in core housing need in Manitoba (Statistics Canada, 2021). Households with core housing need face one or more of the following challenges: they spend more than 30% of their gross income on housing, they live in overcrowded conditions, and their homes lack major facilities or require significant repair. The above-mentioned issues can cause, trigger or aggravate poor mental health. CMHC considers housing to be affordable if the household spends

less than 30% of a household's income on housing and can meet other basic necessities such as food, clothing, and medical care needs that contribute to health and well-being. Having safe and adequate housing contributes independently to the general well-being, psychological stability and social connectedness of individuals and families. In Manitoba, various social housing programs have been established to meet the housing needs of Manitoba residents.

1.2 Definition of Social Housing and Public Housing

Social housing is an umbrella term for government-funded housing programs, which include PH directly managed by the government (e.g., Manitoba Housing), not-for-profit and co-operative housing, rent supplement and Urban Native (Aboriginal) housing programs that receive government funding. Social housing is intended to provide affordable/subsidized housing to low-to-moderate income individuals who cannot afford to live in suitable and adequate housing in the private market (CMHC, 2023). In Canada, social housing represents about six percent of the overall housing market (Housing Services Corporation, 2014) with PH making up about two percent of the Canadian housing stock. This research will only consider residents of PH owned and managed by Manitoba Housing. PH is an important aspect of public policy with the aim of reducing core housing needs by providing quality housing to those in greatest need commonly defined by people's poor health, disability, and experiences of crisis (Bentley et al., 2018). The provision of PH aims to meet the basic physical need of shelter, as well as a variety of social and psychological needs. In PH, rent is geared to income where the rent is typically 30% of the total gross household income. PH plays an essential role in Manitoba's housing system.

Manitoba Housing

Manitoba Housing (MH) is a Crown Corporation established by statute (The Housing and Renewal Corporation Act) in 1967. The corporation's legal name is The Manitoba Housing and

Renewal Corporation (MHRC). Manitoba Housing is governed by a Board of Directors appointed by the Lieutenant Governor in Council, with policy direction provided by the government, as mandated by The Housing and Renewal Corporation Act. Manitoba Housing currently owns the province's housing portfolio and with a mandate to do the following:

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 the activities of the housing market to the benefit of Manitobans as a whole (MB Housing Annual report, 2022)

Manitoba Housing provides a wide array of affordable and subsidized rental housing to households who are living on low to moderate income through various housing programs. Manitoba Housing owns about 16,400 housing units in the portfolio, of which approximately 11,700 are managed directly by Manitoba Housing. Another 4,700 units are managed by non-profit/cooperative sponsor organisations or property management agencies. Manitoba Housing also provides subsidies and support to 17,700 housing units operated by cooperatives, private, or non-profit housing operators, including personal care homes or specialized program beds (MB Housing Annual report, 2022).

Manitoba Housing provides a range of quality housing including single family dwellings, semi-detached units, townhouses, and low-and high-rise apartments for individuals, families, and seniors. These housing units are distributed throughout neighbourhoods ranging from low to high socioeconomic status, and recipients of other housing benefits may reside in rental units dispersed throughout the province. Manitoba Housing supports around 34,100 individuals

annually, with half of the recipients being under the age of 20 (Finlayson et al., 2013). Among those over age of twenty, 65% are women (Finlayson et al., 2013).

1.3 Physical and Psychological Outcomes of Public Housing Residents

According to Mawani and Gilmour (2010), low-income Canadians are three to four times more likely to report poor to fair mental health than high-income Canadians. According to Smith et al., (2013), residents of PH have a disproportionately low socioeconomic status and are more likely to receive income assistance than the general population. PH ensures that affordable housing is available to low-to-moderate income individuals. Income assistance (IA) refers to the government program providing financial assistance to low-income individuals and households, as well as those with no independent income. As such, it is a measure of poverty and economic instability (MCHP Concept: Income Assistance). People residing in PH and as well receiving IA are among the most socioeconomically disadvantaged facing a significant burden of illness (Gardner et al., 2011).

PH may provide affordable and secure housing but has been associated with poor health driven by locational disadvantage, stigma, poor housing conditions and perceived safety problems (Adamkiewicz et al., 2014; Baker et al., 2013; Braubach & Fairburn, 2010). When compared with people residing in other housing options, residents in PH tend to have the lowest incomes, higher prevalence of chronic diseases, poorer education outcomes, and are more likely to experience premature death (Bentley et al., 2018; Chartier et al., 2018; A. Hinds et al., 2019; Hinds et al., 2016; Simning et al., 2011; Smith et al., 2013).

According to existing studies, one in every three people who live in PH has a mental health disorder, which is greater than the one in every four in the general population (Spencer, 2018). In a 2011 study of African–American PH residents using data from the National Survey of American Life, Simning, Van Wijngaarden & Conwell, 2011 found that the 12-month prevalence

of any anxiety disorder in PH residents was 1.8 times higher, mood disorder was 1.4 times higher, and substance use disorders were 2.2 times higher than in non–PH residents. Bentley et al., (2018) also examined no exposure and cumulative exposure to PH on all low-income Australians and reported that people with no exposure to PH report better mental health and less psychological distress than people who spend consecutive, cumulative time in PH over a 5-year period. In addition, a recent study from Mind, a United Kingdom (UK) mental health charity, surveyed 2009 people with mental health disorders across different housing sectors in England in 2018, of whom 1762 said they had a mental health problem and 668 were living in PH. The study showed that 33% of people with mental health disorders living in PH were dissatisfied with where they lived. The report also revealed that more than two-fifths (43%) of people with mental health disorders who live in PH have seen their mental health worsen as a result of where they live (Spencer, 2018). In Manitoba, a study conducted by Chartier et al., reported that the five-year diagnostic prevalence of mental health disorders for adults (aged 18 and older) in PH was higher compared to all adults in the general population (Chartier et al., 2018). However, studies showed that capped rents and stronger leasing agreements within PH may be beneficial to the mental health and well-being of tenants, through affordability as well as tenancy and security (Bentley et al., 2018; Shaw, 2004).

1.4 Pregnancy & Mental Health Disorders

Studies have shown that women consistently experience a higher burden of mental health disorders compared with men (Patel et al., 2018; Pearson et al., 2013). The Canadian Community Health Survey - Mental Health (CCHS-MH) conducted a survey on selected disorders among Canadians aged 15 years and older in 2012. Data collected included lifetime and 12-month rates of mental and substance use disorders. According to Pearson et al., the reports of the CCHS-MH survey estimated that within the previous 12 months, a higher proportion of women than men

have a generalized anxiety disorder (3.2% vs 2.0%) and depression (5.8% vs 3.6%) (2013). Mental health disorders are more common in women than men, and women frequently experience social, economic and environmental factors in different ways. (World Health Organization & Calouste Gulbenkian Foundation, 2014). Pregnancy and the postpartum period are another factor that contributes to physical and psychological changes that increase women's vulnerability to developing mental health disorders (Katz et al., 2018). In Canada, mental health disorder is common with approximately one in four women experiencing some form of mental health disorder during the perinatal period (Mota et al., 2019; Vesga-López et al., 2008; Molenaar et al., 2022). Maternal mental health disorders include a range of disorders including depression, anxiety, and psychosis. Some mental health disorders start during pregnancy or postpartum while others are pre-existing. Though postnatal depression is more commonly understood, both depression and anxiety are very common during pregnancy. Pregnancy is stressful under normal circumstances but coupled with mental health disorders and living in low-quality housing conditions, the risk of health problems is magnified for both mothers and their children. Women with pre-existing mental health disorders are more likely to have mental health disorders during pregnancy and after delivery (Dietz et al., 2007). A prior history of mental health disorder, particularly anxiety and depression, as well as a history of psychiatric treatment during a previous pregnancy is also a well-established risk factor for the development of perinatal anxiety and depression (Bayrampour et al., 2015; C et al., 2014; Giardinelli et al., 2012; Schofield & Kapoor, 2019; Verreault et al., 2014). Women with pre-existing mental health disorders are considered 'high risk' during pregnancy and postpartum period. These women are more likely to be young, single, have lower education level, have low social support, have multiple children, and have chronic concurrent diseases (Bayrampour et al., 2015; Schofield & Kapoor, 2019; Sudziute et al., 2020, Lancaster et al., 2010, Howard et al., 2014; Abdelhafez et

al., 2023; Furtado et al., 2018; Guintivano et al., 2018). They are also less likely to receive adequate prenatal care, obtain necessary nutrition, and are more likely to engage in harmful health behaviors such as smoking, excess alcohol consumption and other substances known to cause adverse pregnancy or birth outcomes (Grote et al., 2010; Lin et al., 2020). Several studies have described an increased risk of obstetric complications such as low birth weight, and preterm delivery in infants born to mothers with mental health disorders before and during pregnancy (Grote et al., 2010; Howard et al., 2023; Korhonen et al., 2012; Räisänen et al., 2014; Stein et al., 2023). Researchers have also reported complications related to maternal depression and anxiety in late pregnancy. These complications include an increased risk of having pre-eclampsia, operative delivery, and infant admission to intensive care for a variety of conditions including respiratory distress, hypoglycemia, and prematurity. Depression and anxiety symptoms during pregnancy have been associated with an increased risk of poor postpartum mental health and maternal-infant attachment (Norhayati et al., 2015; Rich-Edwards et al., 2006).

Data from large national surveys indicate the prevalence of depression and anxiety in pregnant women are as high as 12.4% (Richards et al., 2011) and 17% (Crawford et al., 2011; Richards et al., 2011) respectively. In another study, Benningfield et al., (2010) stated that of 174 opiate dependent pregnant women, about 65% reported psychiatric symptoms. A retrospective chart review carried out by Wachman et al., 2010 on 276 opiate dependent pregnant women found that 40% had been diagnosed with at least one psychiatric disorder and 26% were taking a minimum of two medications related to their mental health diagnosis. The use of psychotropic drugs, notably selective serotonin reuptake inhibitors (SSRIs) and serotonin norepinephrine reuptake inhibitors (SNRIs) during pregnancy has been linked to neonatal outcomes such as increased risk of congenital malformation and pulmonary hypertension (Kieler et al., 2012; Reis & Kllén, 2010; Singal et al., 2020). The use of SSRIs/SNRIs during late pregnancy has also been

linked with poor neonatal adaptation syndrome (Gentile, 2010). This high burden of maternal mental health disorders is concerning due to its detrimental effect to maternal health and has been linked to disrupted emotional regulation, impaired cognitive development and behavioural outcomes for infants and children (Grote et al., 2010; Lowe et al., 2021). These negative effects on the social, emotional, cognitive and physical development of children can continue into childhood and adolescence, thus adversely impacting the education and economic potentials of children in the society. Pregnancy can also be regarded as a unique opportunity to detect early serious medical conditions and health-risk behaviours in young women with mental health disorders, as well as to prevent future health problems for these mothers and their children (Fabre et al., 2021).

1.5 Gaps in Literature

Several studies have reported mental health disorders in pregnancy and postpartum periods using different study designs, with depression and anxiety being the most common (Bayrampour et al., 2015; Dietz et al., 2007; Giardinelli et al., 2012; Korhonen et al., 2012; Räisänen et al., 2014; Van Bussel et al., 2006, Molenaar et al., 2022). A few studies have examined the trajectory of mental health disorders before conception, during pregnancy and postpartum. For example, Dietz et al., (2007) & Molenaar et al., (2022) examined clinically identified maternal depression before, during, and after pregnancies ending in live births. The authors reported a higher prevalence of depression after pregnancy than before and during pregnancy. Also, Mota et al., (2019) &Vesga-López et al., (2008) examined different mental health disorders before, during and after pregnancy. The reports from these authors were similar with an increase in mental health disorders during postpartum compared to pre-pregnancy and pregnancy periods. Furthermore, several studies have suggested a higher prevalence of mental health disorders among PH residents (Hinds et al., 2019; Smith et al., 2013; Bentley et al., 2018;

Chartier et al., 2018; Finlayson et al., 2013). Similarly, Hinds et al., 2016 reported higher prevalence of chronic diseases, both physical and mental health conditions among PH residents. Despite the fact that PH residents have a higher potential burden of comorbidities, little is known about the burden of mental health disorders among pregnant women living in PH, due to the unique physiological and social changes they experience during pregnancy as well as their transition to parenthood. This study, therefore, identified and examined the most commonly studied mental health disorders among pregnant women who lived in PH in Manitoba.

1.6 Research Objectives and Research Questions

1.6.1 Research Objectives

Since people living in PH have a higher burden of mental health disorders and because pregnancy is a particularly vulnerable period where mental health disorders can have an impact on maternal and child birth outcomes, the objective of this study was to describe and examine the prevalence and incidence of selected mental health disorders (mood and anxiety, substance use, psychotic disorders and personality disorders) among pregnant women who lived in PH and compare these indicators with women who did not live in PH. Findings from this study can provide much-needed epidemiological data that can inform the development of programs and policies aimed at supporting health and well-being among pregnant women who lived in PH.

1.6.2. Research Questions

The thesis answered the following three research questions:

Question 1: Are there differences in the pre-existing diagnostic prevalence for each mental health disorder (mood and anxiety, substance use, psychotic, and personality disorders) between pregnant women who lived in PH and pregnant women who did not live in PH?

Hypothesis: Based on literature (Chartier et al., 2018; A. Hinds et al., 2019; Smith et al., 2013), I hypothesized that pregnant women who lived in PH will have a higher burden of pre-existing, diagnosed mental health disorders when compared with pregnant women who did not live in PH.

Question 2: Among pregnant women who lived in PH, what are the factors associated with having a pre-existing mental health disorder diagnosis?

Hypothesis: I hypothesized that the following factors will be associated with pregnant women in PH having a pre-existing diagnosed mental health disorder: maternal age and education attainment, maternal physical health comorbidities, number of children the mother has, whether the mother receives IA, the socioeconomic status of the neighborhood where the mother lives, and the geographic region where the mother lives.

Question 3: Do the diagnostic incidence rates of mental health disorders among pregnant women who lived in PH differ when compared with the diagnostic incidence rates for mental health disorders among women who did not live in PH during the pregnancy and postpartum periods?

Hypothesis: The diagnostic incidence rates for each individual mental health disorder (mood and anxiety, substance use, psychotic, and personality disorders) and for any mental health disorder will be higher among pregnant women who lived in PH when compared with pregnant women who did not live in PH during the pregnancy and postpartum periods, after adjusting for maternal characteristics (Dietz et al., 2007; Mota et al., 2019).

CHAPTER 2: MATERIAL AND METHODS

2.0 Research Methods

2.1 The Manitoba Population Research Data Repository

This cohort study used the population-based administrative databases from the Manitoba Population Research Data Repository (the Repository) to examine the diagnostic prevalence and incidence of mental health disorders among pregnant women who lived in public housing (PH). The Repository is a comprehensive collection of administrative, registry, survey and other databases primarily relating to residents of Manitoba. It was developed to describe and explain patterns of health care and profiles of health and illness, facilitating intersectoral research in areas such as health, education, and social services.

The Repository contains over 40 years of information on more than 99 percent of Manitobans who are covered by Manitoba's universal Health Services Insurance Plan. The Repository consists of databases grouped into six domains including health, social services, justice, education, registries, and support files (Figure 1). This information-rich environment provides unique opportunities to conduct population-wide research with very large samples and long-term observations at a lower cost than primary data collection often can provide (Jutte, Roos & Brownell, 2011; Roos et al., 2022). Due to the extensive use of the data in the Repository for population-based research, researchers have developed and implemented methods to achieve high-quality data linkage for conducting research while maintaining individual privacy and confidentiality. Using de-identified administrative data does not require informed consent from participants. Each individual has a scrambled identifying number that was used to link their information across these data sets. Access to these data was provided once the following requirements were completed: an MCHP accreditation session; MCHP project feasibility and data access review; and privacy, ethics, and data providers' permission (MCHP Repository).

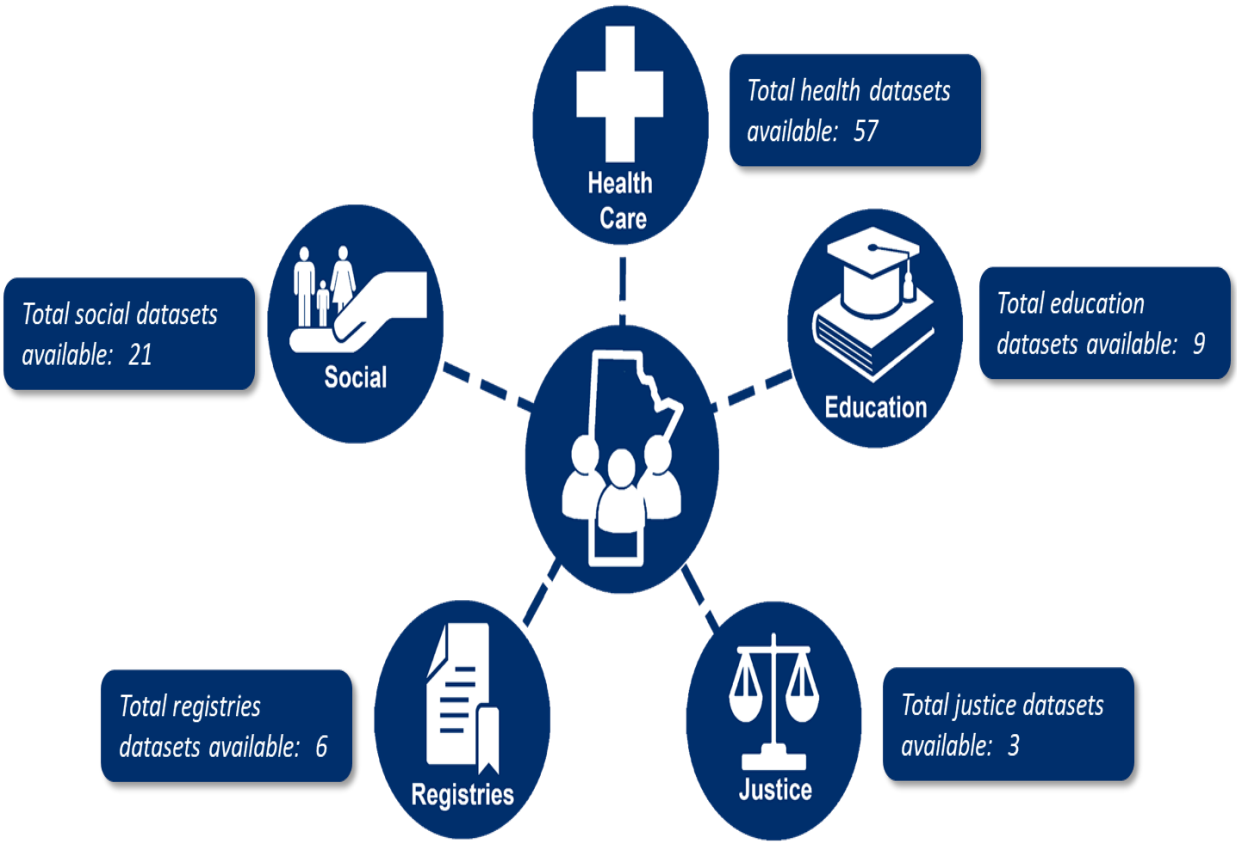

Figure 1: Manitoba Population Research Data Repository

2.2 Data Sources

Prior to transfer of data to the Repository housed at MCHP, identifying information such as an individual's name and street address are removed. A scrambled version of each person's Personal Health Identification Number (PHIN) and Family Registration Numbers, allows for de-identified linkage of records at individual and family level, while protecting privacy. The following databases were used to construct social services, sociodemographic, mental health and pregnancy status variables between 04/2009 to 03/2018:

- Hospital Discharge Abstract database contains clinical and demographic information on all hospital separation and was used to identify pregnancy status, birth outcomes, mental health disorders

- The Medical Services database contains clinical and demographic information on all patient physician visits, and was used to identify pregnancy status, birth outcomes and mental health outcomes.
- Drug Program Information Network (DPIN) collects a variety of information for each dispensation, including the date, drug name and drug identification number (DIN). DPIN data were used to identify mental health disorders based on the type of medications that are prescribed to people to treat these conditions.
- Canada Census (Statistics Canada) was used to obtain relevant community-level data on main socioeconomic characteristics such as the income quintile for the pregnant women's postal code of residence.
- Manitoba Health Insurance Registry was used to obtain relevant information on demographics such as age, geographic region (place of residence), and to determine when residents moved into or out of the province.
- Social Allowances Management Information Network (SAMIN) database was used to obtain information on households receiving financial support under the provincial Employment and Income Assistance program. This database was used to identify whether individuals in the study cohort received Employment and Income Assistance (Income Assistance or IA),
- Public housing (Tenant Management System or TMS) was used to identify residents living in units owned and managed by Manitoba Housing.
- Education Enrollment, Marks, and Assessments data was used to identify women's high school completion.
- Families First Screen (FFS) data was used to construct education level for some women without information on Manitoba high school completion.

A detailed description of each data source was included in Table 2.1. Data were linked at the individual level to address the study's research questions.

These databases were used to do the following:

1. Described the sociodemographic characteristics of pregnant women in Manitoba during the study period based on type of residence (public housing (PH)/not in PH).
2. Determined the pre-existing diagnostic prevalence of each mental health disorder among pregnant women who lived in PH compared with pregnant women who did not live in PH as well as whether these prevalences vary by maternal characteristics.
3. Determined the independent association of maternal characteristics with each diagnosed mental health disorder of the pregnant women who lived in PH
4. Compared the incidence rate of mental health disorders among pregnant women who lived and did not live in PH across the pregnancy and postpartum periods during the study period.

Table 2.1: Description of Databases, Years of Data Availability, Variables, And Role of The Variables in Data Analysis

Data Provider	Database Name	Years of Data Requested	Data Fields/Variables	Role in Data Analysis
Manitoba Health	Manitoba Health Insurance Registry	April 2004/2005 to March 2017/2018	Date of birth, start/end of coverage, reason for end of coverage, residential postal code	Used to determine the age and geographical location of a woman during pregnancy and delivery. Was used as a covariate in the model
Statistics Canada	Canada Census	DLI: 1971 to 2016 (every 5 years) CSDS: 1991, 2001, 2006, 2011, 2016	Average household income and level of education in the woman's area of residence.	Was used to determine the socioeconomic status of the woman. Was used as a covariate in the model.
Manitoba Education	Enrollment, assessment and Marks	April 1994/1995 to March 2017/2018	Demographic information, school enrolled, enroll dates, assessment outcomes (grade 3, 7/8, S1-S4), graduation, course completion information.	Was used to identify high school completion at the individual level. Was used as a covariate in the model.
Manitoba Families – Social Innovation Office	Employment Income Assistance (EIA)/Social Allowances Management Information Network (SAMIN) Data	April 2004/2005 to March 2017/2018	Client demographics, education level, receipt of income assistance	Was used to identify low income women who receive financial help to meet basic needs. Was used as a covariate in the model.
Manitoba Families	Tenant Management System (TMS)	April 2009/2010 to March 2017/2018	Client demographic, and housing information	Was used to identify women living in housing units managed by Manitoba Housing. Data will be used as an exposure variable.
Manitoba Health	Families First Screen	Screening data: January 1, 2003 to October 12, 2020. Home visiting Program data: January 1, 2009 to October 12, 2020	Marital status, education level, receipt of income assistance, and behavioural/social factors	Used to construct education level.
Manitoba Health	Hospital Abstracts	DAD/MADE: ICD-10-CA/CCI: 2004 to 2018	Patient demographic, admission and separation information and dates, diagnostic and procedure fields, hospital services and comorbidity.	Was to identify women who received any mental health-related hospitalization as well as information related to pregnancy and birth hospitalizations. Also needed for calculation of comorbidity indicators.
Manitoba Health	Medical Claims/Medical Services	April 2004/2005 to March 2017/2018	Patient demographics, service date, service information, diagnostic information, physician type.	For information on women who received a diagnosis or visit a physician for any care related to mental health disorders during pre-conception, pregnancy and postpartum period. For calculation of comorbidity indicators.
Manitoba Health	Drug Program Information Network (DPIN)	April 2004/2005 to March 2017/2018	Patient demographics, prescription dates, drug information, dispensation information.	Was used to identify women who have a diagnosis of any mental health disorder based on the prescribed medications. Also, for calculation of comorbidity indicators.

2.3 Cohort Formation and Time Period

According to Chartier et al., (2018), mental health disorders are classified as chronic diseases and are not always documented in administrative data on a regular basis (e.g., yearly); as a result, five-year diagnostic prevalence estimates for mental health disorders are more likely to identify someone living with a mental health disorder when compared with shorter time periods (e.g., 1-year diagnostic prevalence estimates). This study adopted the same method that Chartier et al (2018) used to calculate the five-year diagnostic prevalence of mental health disorders among pregnant women living in PH which impacted the way the analytic cohorts were constructed.

Study Period for All Three Research Questions: April 1, 2009 to March 31, 2018

The study period encompassed fiscal years April 1, 2009 – March 31, 2018. This specific time period was selected for two reasons. First, the study ended in 2018 due to availability of PH data. Second, the study commenced on April 1, 2009 because I calculated the five-year diagnostic prevalence for mental health disorders using information from healthcare contacts during the five years before conception. In 2004/05, hospital abstract data transitioned from International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) to International Classification of Diseases, Tenth Revision, Canada (ICD-10- CA) codes. By starting my study in 2009, I consistently used the hospital data ICD-10 CA coding.

Pregnancies Included in Analytic Cohort for All Three Research Questions

The hospital discharge abstract and Family First Screen were used to identify women who experienced at least one pregnancy that resulted in live birth (more than 20 weeks' gestation) in Manitoba during the study period (N=140,460). The study only considered pregnancies that resulted in singleton, live births, therefore women who experienced multiple births (twins,

triplets) were excluded (n=3,289). Further exclusion from the study were births to women aged <18 years or >45 years at time of delivery (n=3,158), those without health insurance coverage at time of delivery (n=182), women whose conception and delivery date were outside April 1, 2009 to March 31, 2018 (36,927) and those who were living in Churchill (n=79). The total number of women remaining after all the exclusions was 96,825. I then randomly selected one delivery for women with more than one delivery during the study period, using the same method as Heaman et al., (2018), and excluded the other deliveries from the analyses (n= 32,752). This simple random selection approach gave every delivery an equal chance of being selected for the study and ensured that only one pregnancy for each woman was included in analyses. The total number of women that remained after random selection was 64,073 women (See fig. 1).

Categorizing Pregnant Women by Residence in Public Housing (PH)

Manitoba Public Housing manages approximately 11,700 housing units located throughout the province (MB Housing Annual report, 2022). The cohort was categorized into pregnant women aged 18-45 years, who lived in a PH unit directly managed by Manitoba Housing for the entire duration of their pregnancy; and those who did not live in PH at any point during their pregnancy, based on their estimated conception date during the study period. Using a similar approach by Chartier et al., (2018) to create a Manitoba Housing cohort, I identified a total of 3,003 pregnant women who lived in PH during the study period. Among these women, those who moved in or out of PH during their pregnancy were excluded (n=777).

The comparison consisted of 61,070 pregnant women aged 18-45 years, who did not live in a PH unit managed by Manitoba Housing and who are present in the Manitoba Population Research Data Repository during the study period. Further exclusions were applied to the women

who did not live in PH, those who lived in PH five years prior to conception date (n=1,650) or ever lived in PH between April 1, 2009 to March 31, 2018 (n=2,288).

The final cohort for data analysis included 2,226 (3.75%) women who lived in PH and 57,132 (96.25%) women who did not live in PH.

Cohort for Questions 1 and 2

Questions 1 and 2 focused on pre-existing mental health disorders among pregnant women. Women with pre-existing mental health disorders are more likely to have mental health disorders during pregnancy and after delivery (Dietz et al., 2007). The analytic cohort for these two questions included women aged 18-45 years with a live birth where the conception date occurred between April 1, 2009 and June 10, 2017. The index date was the estimated date of conception for the pregnancy of the index child. The estimated date of conception was the start of a pregnancy, which was determined by subtracting the gestational weeks from the child's birthdate (Singal et al., 2017).

Analyses for these two questions calculated the pre-existing (i.e., before conception) diagnostic prevalence of each mental health disorder among pregnant women who lived and did not live in PH; identified whether or not these women came into contact with the healthcare system for a mental health disorder during the five years before conception. Hospital abstract and physician claims data were used to identify individuals with hospitalizations and physician visits for mental health-related disorders. DPIN was used to identify individuals with prescriptions for any psychotropic medications (Chartier et al., 2018; A. Hinds et al., 2019; Mota et al., 2019; Nickel et al., 2020). My cohort for the first and second questions were limited to women with continuous coverage under Manitoba Health from 5 years before conception up until the birth of the index child.

Cohort for Question 3

Pregnancy and the postpartum period are widely believed to be vulnerable stages for the development and exacerbation of mental disorders due to significant biological and psychosocial changes (Chatterjee et al., 2021; O'Hara et al., 2014). It is important to examine the incidence rate of mental health disorders during the perinatal period because when specific perinatal periods are compared to one another, it is possible to highlight a particular period during which intervention is most needed (Mota et al., 2019). A study conducted by Mota et al., 2019, compared the rate of mental disorders and suicide attempts within the same group of women across the pre-pregnancy, pregnancy, and postpartum periods. This study used a similar approach to examine the diagnostic incidence rate of mental health disorders, focusing on the pregnancy and postpartum periods (i.e., from conception up until 40 weeks after birth).

The analytic cohort for the third research question was limited to women with continuous coverage under Manitoba Health from 5 years before conception up until 40 weeks after the birth of the index child. This cohort comprised women aged 18-45 years with a live birth conceived and delivered between April 1, 2009 and June 10, 2017 (Heaman et al., 2012; Mota et al., 2019). To calculate the incidence rate, a two-time period was created to identify new diagnoses of mental health disorders from the estimated date of conception through the pregnancy period and a follow-up of 40 weeks after the live birth. This time periods were created in accordance with previous work to represent the average gestational period, and therefore the length of time would be the same for the two-time periods (Dietz et al., 2007; Mota et al., 2019). Women were followed for 40 weeks after the live birth associated with the index child or until March 31, 2018 (study end date), whichever comes first.

Incidence rates focus on identifying new cases for any given condition. As a result, for each mental health disorder, I used a five-year washout period to exclude women from incidence

rates calculations if they were identified as having the mental health disorder in questions 1 and 2; this was done for each mental health disorder separately and for the global measure of "any mental health disorders." Pregnant women were followed from the date of conception until 40 weeks after live birth to identify incident cases of mental health disorders during both the pregnancy and early postpartum periods (Figure 2). Women with continuous Manitoba Health insurance coverage during pregnancy and postpartum periods were included in this analytic cohort. The sample size for the analytic cohort varied for each outcome being examined. A flow chart detailing exclusions from the study population is provided in Figures 2 and 3.

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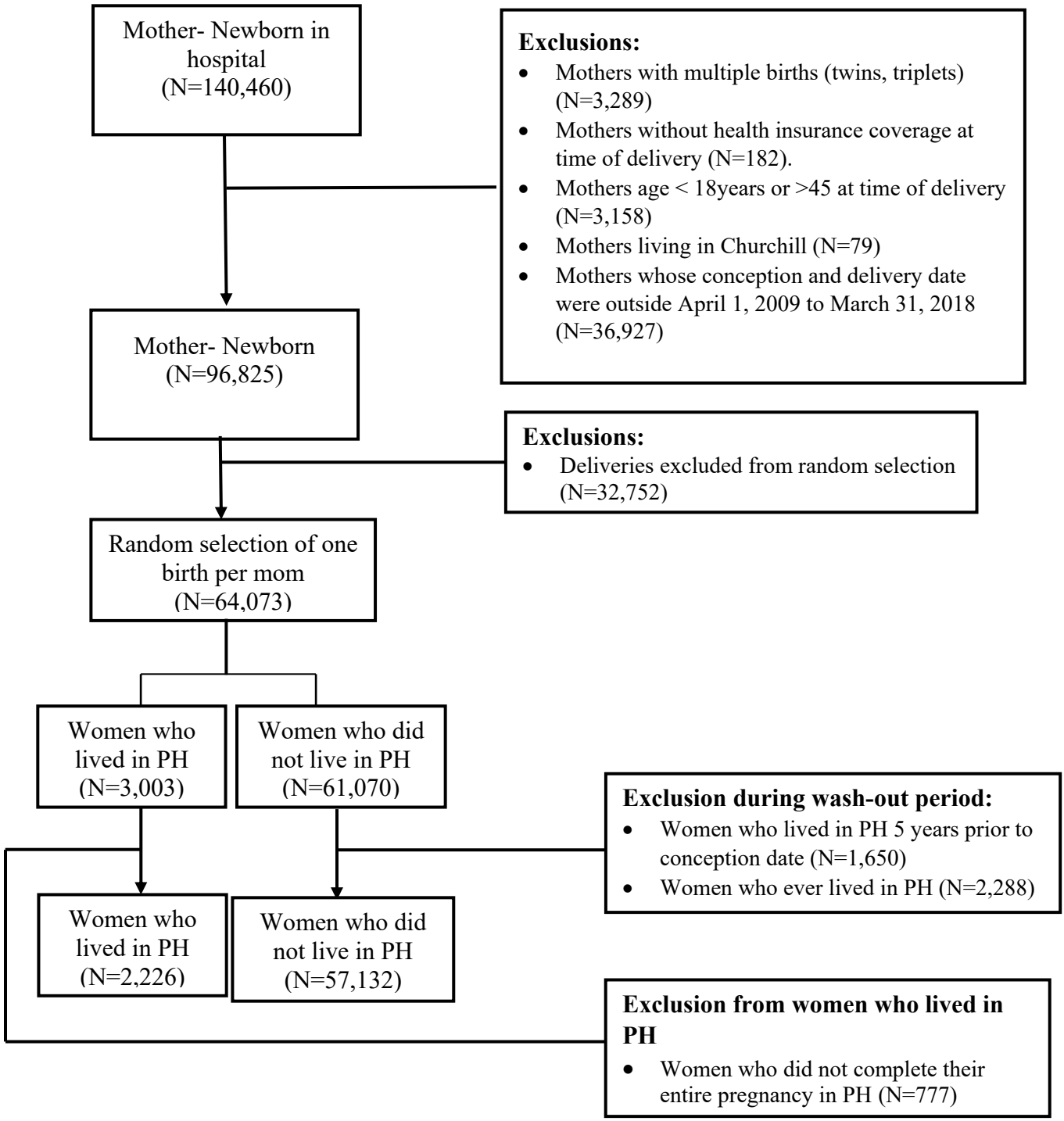

Figure 2: Study Flow Chart for Research Questions 1 & 2

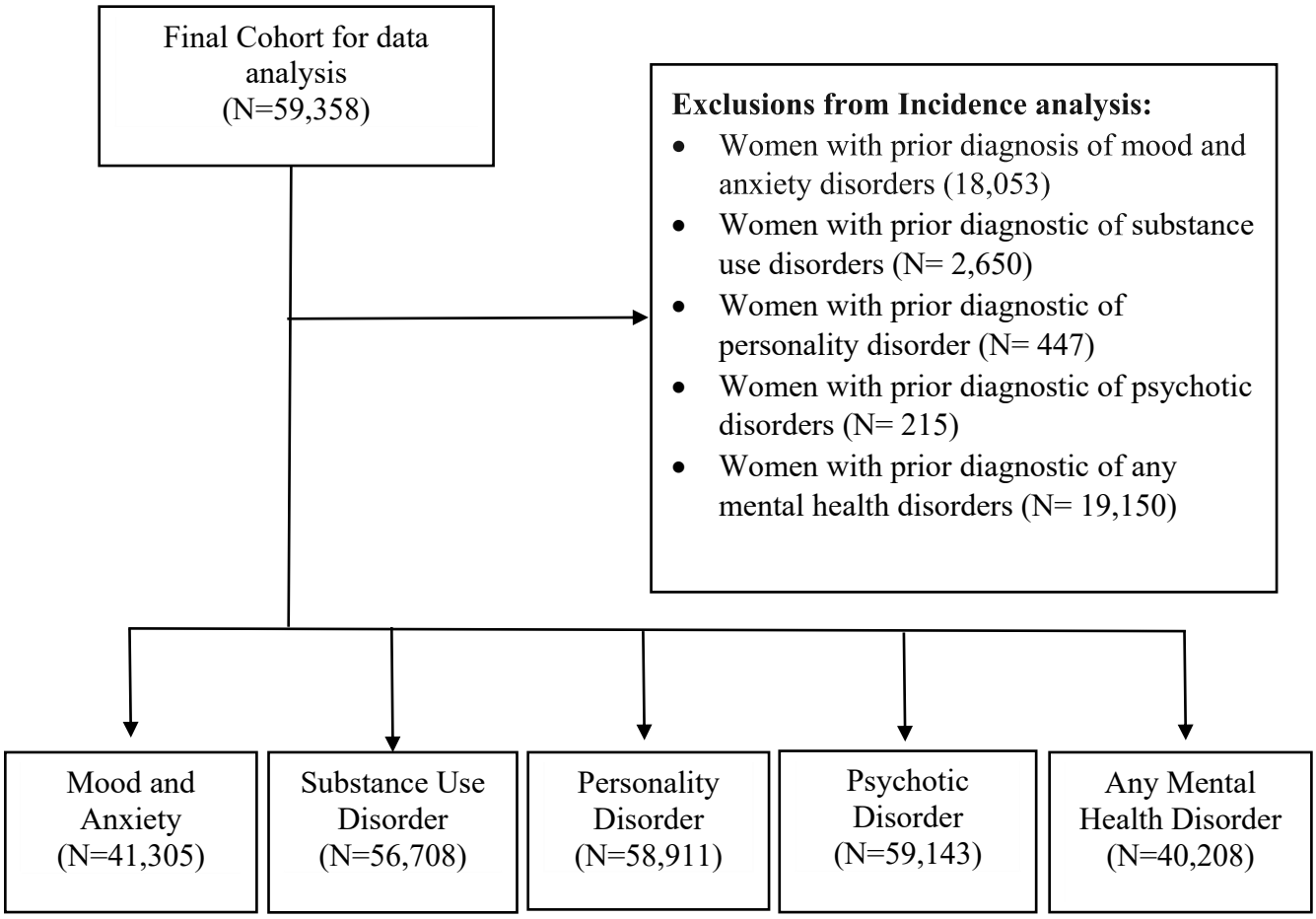

Figure 3: Study Flow Chart for Research Question 3

2.4 Study Variables

2.4.1 Public Housing While Pregnant

Pregnant women who lived in PH were the focus of my study; women who did not live in PH at any point during their pregnancy was the comparison of interest.

2.4.2 Outcome Variables

The primary outcomes of interest were mental health disorders. The study used the criteria established by Chartier et al., (2018) to define mental health disorders. These criteria used a combination of ICD-9-CM and ICD-10-CA codes from hospital abstracts and medical claims data as well as DPIN data to identify indicators of a (i) mood and anxiety disorder, (ii) substance use disorder, (iii) personality disorder, (iv) psychotic disorder, and (v) any mental health disorders (Appendix I). In line with previous research, the term diagnostic prevalence was used to refer to the percentage of pregnant women satisfying the criteria for a specific mental health disorder (Chartier et al., 2018). This means that a woman had a healthcare contact related to a specific mental health disorder. Outcome variables were dichotomous indicating whether or not a pregnant woman met the criteria for each mental health disorder. These variables are described in more detail in the following section.

2.4.2.1 Mood and Anxiety Disorders

This consists of a broad group of mental disorders including depressive (depressed mood and lack of interest in almost all activities), bipolar (periods of elevated mood and increased energy, and periods of depressed mood), and anxiety disorders (excessive fear, anxiety or worry and often avoidance of situations that provoke these strong emotions) (American Psychiatric Association, 2013).

An individual was considered to have a diagnosis for a mood or anxiety disorder if they met one of the following conditions:

- One or more hospitalizations with a diagnosis of depressive disorder, affective psychoses, neurotic depression, adjustment reaction or bipolar disorder; OR
- One or more hospitalizations with a diagnosis for an anxiety disorder, phobic disorder or obsessive-compulsive; OR
- One or more physician visits with a diagnosis of depressive disorder, affective psychoses, adjustment reaction or anxiety disorders AND
- One or more prescriptions of an antidepressant or mood stabilizer

2.4.2.2 Substance Use Disorders (SUD)

These are characterized by the excess use of and reliance on a drug, alcohol or other chemical that leads to severe negative effects on the user's health and well-being or the welfare of others (American Psychiatric Association, 2013). An individual was considered to have a diagnosis for a substance use disorder if they met one of the following conditions:

- One or more hospitalization with a diagnosis for alcohol or drug-induced psychosis, alcohol or drug dependence, or nondependent abuse of drugs; OR
- One or more physician visit with a diagnosis for alcohol or drug-induced psychoses, alcohol or drug dependence, or non-dependent abuse of drugs.

2.4.2.3 Personality Disorders

Personality Disorders are a diverse category of mental disorders that are characterized by long-term patterns of thoughts, emotional responses, and behaviours that cause serious personal and social difficulties, as well as a general impairment of functioning (American Psychiatric

Association, 2013). An individual was considered to have a diagnosis for a personality disorder if they met one of the following criteria:

- At least one hospitalization with a diagnosis for a personality disorder; OR
- At least one physician visit with a diagnosis for a personality disorder.

2.4.2.4 Psychotic Disorders

Psychotic disorders are characterized by extreme impairment of a person's ability to think clearly, respond emotionally, communicate effectively, understand reality, and behave appropriately. Delusions, hallucinations, and disorganized speech or behavior are symptoms associated with psychotic disorders (American Psychiatric Association, 2013; Sikich, 2013). An individual was considered to have a diagnosis for a psychotic disorder if they met at least one of the following criteria:

- At least one hospitalization with a diagnosis of a psychotic disorder; OR
- At least one physician visit with a diagnosis of a psychotic disorder.

2.4.2.5 Any mental health disorders.

A dichotomous "any mental health disorder" variable was created and defined as having at least one code for any of the mental health disorders that the study examined.

2.4.3 Independent Variables (Covariates)

The choice of independent variables was guided based on literature. Research has shown that several factors are linked to mental health disorders in adult women, including age, low income, low education, having multiple children, and the presence of multiple comorbidities. (Bentley et al., 2018; Chartier et al., 2018; A. Hinds et al., 2019; Hinds et al., 2016; Simning et al., 2011; Smith et al., 2013; Bayrampour et al., 2015; Schofield & Kapoor, 2019; Sudziute et al., 2020,

Lancaster et al., 2010, Howard et al., 2014; Abdelhafez et al., 2023; Furtado et al., 2018; Guintivano et al., 2018). Therefore, the following independent variables were considered;

2.4.3.1 Age

This variable was determined through the Manitoba Health Insurance Registry data. The maternal age of the study cohort was categorized into five groups based on (Heaman et al., 2012): 18-19 years, 20 to 24 years, 25 to 29 years, 30 to 34 years, 35 to 45 years.

2.4.3.2 Income Quintiles

Income quintiles are frequently used as a proxy measure of socio-economic status. The census data at MCHP do not provide information on an individual's specific income. Income quintiles are created by calculating the dissemination area's (DA)[1] average household income from the 2016 Statistics Canada Census, sorting each DA from lowest to highest average household income, and then grouping the DAs into five equally sized categories – or quintiles. The DA income quintile is an area-level measure that is then attributed to each person. There are five quintiles - with quintile 5 being the wealthiest and quintile 1 being the poorest. Each quintile represents roughly 20% of the population (MCHP Concept: Income Quintile, 2002).

2.4.3.3 Geographical Location

The Manitoba Health Insurance Registry data provided information on pregnant women's geographic region of residence based on the postal code; geographic variables that can be created using these data include the Regional Health Authority of residence and the Winnipeg Community Areas (CAs) of residence. There are five regional health authorities in Manitoba - Winnipeg Regional Health Authority (WRHA), Northern Health Region, Interlake-Eastern

[1] The DA is the smallest standard geographic area for which Census data are disseminated; DAs are uniform in population size - 400 to 700 persons.

Regional Health Authority, Prairie Mountain Health, and Southern Health-Santé Sud (See Figure 6.0). As the WRHA has a population larger than all other regions combined, the locations of public housing (PH) and mental health indicators are also presented for the Winnipeg CAs. There are 12 CAs which are the planning districts within the Winnipeg Regional Health Authority. The CAs are St. James–Assiniboia, Assiniboine South, Fort Garry, St. Vital, St. Boniface, Transcona, River East (includes East St. Paul), Seven Oaks (includes West St. Paul), Inkster, Point Douglas, Downtown, and River Heights (See figure 5.0). To ensure there were enough women for reliable mental health indicator estimates, the Winnipeg CAs were paired for analysis, as suggested by the WRHA: St. James-Assiniboia/Assiniboine South, Fort Garry/River Heights, St. Vital/St. Boniface, Seven Oaks/Inkster, River East/Transcona, and Point Douglas/Downtown.

2.4.3.4 Employment and Income Assistance (EIA)

Financial support allocated by the provincial government to individuals and/or their dependents who meet a standard financial need test that qualifies them for benefits (MCHP Concept: EIA). It is administered through the Employment and Income Assistance program. A woman was considered as receiving income assistance if she received income assistance for at least 6 continuous months any time during the 5 years before conception for diagnostic prevalence calculations; and at least 6 continuous months during pregnancy and 40 weeks after the live birth event for the incidence calculations (Chartier et al., 2018; Heaman et al., 2012).

2.4.3.5 Parity

Parity is the number of times a woman has given birth after 20 weeks' gestation regardless of whether the infant is born alive or dead (MCHP Concept: Parity, 2002). Parity was classified as primiparous or multiparous. A woman was considered primiparous if she has had one birth at more than 20 weeks' gestation regardless of whether the infant is born alive or dead

while a woman who has had two or more births at more than 20 weeks gestation is considered multiparous (Heaman et al., 2012).

2.4.3.6 Charlson Comorbidity Index (CCI)

The Charlson Comorbidity Index (CCI) measures patient comorbidity based on the ICD diagnoses codes of individual patients found in administrative data. Each comorbidity category has an associated weight, based on the adjusted risk of one-year mortality, and the sum of all the weights results in a single comorbidity score for the patient. A score of zero indicates there were no comorbidities identified in the administrative data. The higher the score, the more likely the predicted outcome will result in higher health service resource use and/or mortality. The CCI was used to describe and adjust for pregnant women's physical health comorbidities. Scores for the data analysis ranged from 0, 1 and 2+. The CCI was calculated for each pregnant woman in the cohort using the SAS macro code provided at MCHP, as described in the CCI Concept Description. (MCHP Concept; CCI, 2002).

2.4.3.7 High School Completion

This variable measured the level of education attainment. There are three criteria that were used in sequential order to identify graduates from the enrollment and marks data set. A woman was considered a high school graduate if the Manitoba Education student record indicates that she graduated. Before 2009/10, some schools did not use this variable consistently, so for those without "Year End Status" variable in the student marks data, a woman was considered a high school graduate if she has earned a minimum requirement of 28 credit in 2007-2008, 29 course credits in 2008-2009, and a minimum of 30 credits in 2009-2010 and beyond. To ensure that all graduates were captured, for those students not identified as graduates through the year-end status variable or total number of high school credits, any students who had completed four

or more grade 12 credits were also counted as graduates. (MCHP Concept: High School Completion). For women who did not complete high school in Manitoba, the FFS data was used to identify whether or not the mother completed high school.

2.4.4 Missing Data on the Education Variable

For some women, the variable measuring education attainment relied on FFS data. FFS data are only available for ~80% of the population (Heaman et al., 2018). The FFS was used to identify women in Manitoba who either did not complete high school or had missing education records on the Manitoba Education record. Overall, the missing rate for high school completion within the study cohort was 5.2%. To reduce loss of sample size in my analytic cohorts, I created a missing category with a value of "unknown." Therefore, education level was categorized as less than grade 12, grade 12 or above, or "unknown." Women with missing data were then included in the regression analyses using these "unknown" category (Groenwold et al., 2012).

2.5 Data Analysis

Descriptive Analyses

Descriptive statistics described the maternal characteristics such as age group, income quintiles, receipt of IA, education level, parity, CCI and geographical location (health regions and Winnipeg Community Areas) for (i) women who lived in PH for their entire pregnancy and (ii) women who did not live in PH at any point while pregnant. The differences between the women who lived in PH and their comparison were assessed using Student's *t*-test for normal continuous variable and Pearson Chi-square test was used to analyze the categorical variables for estimated proportions respectively.

Inferential Analyses

Question 1: Are there differences in the pre-existing diagnostic prevalence for each mental health disorder (mood and anxiety, substance use, psychotic, and personality disorders) between pregnant women who lived in PH and who did not live in PH?

Hypothesis: Based on literature (Chartier et al., 2018; A. Hinds et al., 2019; Smith et al., 2013), I hypothesized that pregnant women who lived in PH will have a higher burden of pre-existing mental health disorder when compared with pregnant women who did not live in PH after adjusting for maternal characteristics (age, income quintile, receipt of IA, education level, parity, CCI and region of residence).

Analysis: I used binary logistic regression models to test this hypothesis. The outcome variable was whether or not a pregnant woman met the criteria for having a pre-existing mental health disorder at the time of conception. The predictor variable of interest was whether or not the mother lived in PH for the entirety of her pregnancy (i.e., from conception to delivery of a live birth; women who moved into or out of PH while pregnant were excluded from the analyses). I conducted univariable logistic regression models that only included the predictor (PH) and the outcome (whether or not the woman had a mental health disorder). The multivariable models adjusted for age, region of residence, receipt of IA, income quintile, high school completion, CCI, and parity. Both unadjusted and adjusted Odds Ratios (ORs), along with corresponding 95% Confidence Intervals (CIs), were reported and a priori significance level of 0.05 was used to identify statistically significant differences in diagnostic prevalence. These analyses were repeated separately for each mental health disorder (mood and anxiety, substance use, psychotic, personality disorders) as the outcome and for the global measure of whether or not the woman had any of the four mental health disorders.

Question 2: For pregnant women who lived in PH, what are the factors that are associated with having a pre-existing diagnosis of mental health disorder?

Hypothesis: I hypothesized that maternal characteristics were associated with whether a pregnant woman living in public housing has a pre-existing diagnosed mental health disorder. I also hypothesized that associations will be stronger for women who lived in PH when compared with women who did not.

Analysis: First, I stratified my cohort by whether or not they lived in PH. I ran two sets of binary logistic regression models—one set for women who lived in PH while pregnant and the second set for women who did not live in PH—to identify factors independently associated with whether or not a pregnant woman had a prevalent mental health disorder at the time of conception. For both sets of models, whether or not the woman had a pre-existing mental health disorder (mood and anxiety, substance use, psychotic, personality disorders, and any of these mental health disorder) was the outcome of interest. I used maternal characteristics (i.e., age, region of residence, income quintiles, education, receipt of IA, CCI, and parity) as predictors in my models. I reported both unadjusted and adjusted Odds Ratios (ORs) along with corresponding 95% Confidence Intervals (CIs) and used an a priori significance level of 0.05 to identify statistically significant associations of the predictors with the diagnosis of pre-existing mental health disorders.

Question 3: Do the diagnostic incidence rates of mental health disorders among pregnant women who lived in PH differ when compared with the diagnostic incidence rates for mental health disorders among women who did not live in PH during the pregnancy and postpartum periods?

Hypothesis: I hypothesized that the diagnostic incidence rates for each individual mental health disorder (mood and anxiety, substance use, psychotic, and personality disorders) and for any mental health disorders will be higher among pregnant women who lived in PH when compared

with pregnant women who did not live in PH during the pregnancy and postpartum periods, after adjusting for maternal characteristics (Dietz et al., 2007; Mota et al., 2019).

Analysis: Each mental health disorder was modeled as a count variable. The rates of each mental health disorder were calculated from the estimated date of conception through a 40-week pregnancy period and a follow-up of 40 weeks after the live birth. This time periods were created in accordance with previous work to represent the average gestational period, and therefore the length of time would be the same for the two-time periods (Dietz et al., 2007; Mota et al., 2019). Women without pre-existing mental health disorders in both groups were followed from the time of conception to 40 weeks after the live births. To calculate the incident rate of each mental health disorder, I first determined the distribution of the incidence diagnosis of mental health disorders. Due to overdispersion of the data (the variance of the data was significantly greater than the mean), a negative binomial distribution was considered as an appropriate model for the analysis. A Pearson Chi-square goodness of fit test was used to determine the appropriateness of this model. The rates of mental health disorders were compared and estimated between women who lived and did not live in PH using generalized linear models with negative binomial distribution with a log link function and the logarithm of the 40-weekly time periods as an offset in the models. Also, each mental health disorder was categorized based on its timing (i.e., prenatally – first diagnosis occurred during pregnancy, or postpartum, with the first diagnosis occurring within 40 weeks of the infant's birth). Models were adjusted for age, region of residence, income quintiles, receipt of IA, CCI, high school completion, and parity group. The results from these models were expressed as unadjusted rate ratios (RRs) and adjusted RRs, and 95% CIs. I repeated analysis for each outcome (mood and anxiety, substance use, and any mental health disorders) occurring in pregnant and postpartum (up to 40 weeks) separately. Due to the small number of cases in psychotic and personality disorders, only the crude RRs

were reported. Statistical analyses were performed using SAS® statistical analysis software version 9.4.

2.6 Ethics Consideration and Data Access Approval

To access the data, proposal and feasibility forms were first submitted to MCHP. Data access also required completing annual accreditation sessions at MCHP and a completed University of Manitoba-Manitoba Centre for Health Policy researcher agreement. All analyses were conducted at secure MCHP facilities. To protect confidentiality and anonymity, strict MCHP vetting procedures were adhered to prior to the release of all analyses. This study received ethical approval from the University of Manitoba Health Research Ethics Board (Ethics file No. HS26037 (H2023:188)). This study was also approved by the Provincial Health Research Privacy Committee (PHRPC No. P2023-62). The Provincial Health Research Privacy Committee reviews studies to ensure privacy and confidentiality. The study obtained approvals from all the non-health data providers including Manitoba Families, and Manitoba Education, Early Childhood Learning.

CHAPTER THREE: DIAGNOSTIC PREVALENCE OF MENTAL HEALTH DISORDERS BEFORE CONCEPTION

3.0 RESULTS AND INTERPRETATIONS

3.1 Characteristics of Analytic Cohort

After exclusions, the final analytic cohort included 2,226 (3.75%) women who lived in public housing (PH) and 57,132 (96.25%) women from the general population who did not live in PH.

Table 3.1 describes the demographic characteristics of the women who lived in PH and women who did not live in PH. Compared to the women who did not live in PH, women who lived in PH tend to be younger (mean age 27 versus 29, respectively). Most of the women in both cohorts lived in the Winnipeg region with 61.77% of women who lived in PH and 49.88% of women who did not live in PH. The women who did not live in PH were distributed mostly equally across income quintiles, while 55.71% of the women who lived in PH lived in neighborhoods from the lowest income quintile and only 3.37% lived in neighborhoods from the highest income quintile.

In terms of high school completion, 55.00% of women who lived in PH had completed high school education compared with 81.50% of women who did not live in PH. Slightly more than 82% (82.21) of women in PH cohort received employment and income assistance compared to 8.47% of women who did not live in PH. In term of parity, 80.46% of women who lived in PH are multiparous compared with 57.38% in women who did not live in PH In Winnipeg, most of the women in PH lived in four Winnipeg CAs during the study period: River East (15.13%), Inkster (11.27%), Point Douglas (12.29%) and Downtown (20.51%) while women who did not live in PH resided in River East (14.06%), Downtown (9.99%), Fort Garry (9.17%) and Seven Oaks (9.60%).

Women who lived in PH had a higher burden of physician-diagnosed chronic physical illness compared to the women who did not live in PH based on the CCI score (13.57% versus 8.74% respectively).

Table 3.1: Demographic characteristics of Cohort Population between 2009/10-2017/18, age 18-45

Sociodemographic characteristics	**PH Cohort**		**Non-PH Cohort**		**p-value**
	2,226 (3.75%)		**57,132 (96.25%)**		
Mean age of mother at birth of index child – (mean, SD)	26.7 (6.07)		29.12 (5.65)		<.0001
Age-group of Mother					
18-19	270	12.13	2, 653	4.64	
20-24	660	29.65	10,097	17.67	
25-29	596	26.77	16,512	28.90	<.0001
30-34	431	19.36	17,491	30.62	
35+	269	12.08	10,379	18.16	
Neighborhood Income Quintile (IQ)					
Q1 (lowest)	1,240	55.71	11,617	20.33	
Q2	466	20.93	11,969	20.95	
Q3	288	12.94	11,167	19.55	<.0001
Q4	157	7.05	11,948	20.91	
Q5 (highest)	75	3.37	10,431	18.26	
Receipt of Income Assistance (IA)					
Yes	1,830	82.21	4,838	8.47	<.0001
No	396	17.79	52,294	91.53	
Education Level					
< Grade 12	889	40.00	7,496	13.10	<.0001
>= Grade 12	1,226	55.00	46,573	81.50	
Unknown	111	5.00	3,063	5.40	
Parity					
Primiparous	431	19.36	24,351	42.62	
Multiparous	1,795	80.64	32,781	57.38	<.0001
Charlson Comorbidity Index Score					
Charlson 0	1,887	84.77	51,322	89.83	
Charlson 1	302	13.57	4,992	8.74	<.0001
Charlson 2+	37	1.66	818	1.43	
Regional Health Authority					
Southern Health-Santé Sud (SO)	166	7.46	10, 513	18.40	
Interlake-Eastern (IE)	137	6.15	5,522	9.67	
Prairie Mountain Health (WE)	271	12.17	6,951	12.17	<.0001
Northern Health Region (NO)	277	12.44	5,649	9.89	
Winnipeg RHA (WP)	1,375	61.77	28, 497	49.88	
Winnipeg Community Areas (CAs) - 1375					
W01 - St. James-Assiniboia	65	4.73	2,387	8.38	
W02 - Assiniboine South	51	3.71	1,126	3.71	

W03 - Fort Garry	79	5.75	2,612	9.17	
W04 - St. Vital	119	8.65	2,541	8.92	
W05 - St. Boniface	30	2.18	2,558	8.98	<.0001
W06 - Transcona	75	5.45	1,871	6.57	
W07 - River East	208	15.13	4,006	14.06	
W08 - Seven Oaks	88	6.40	2,737	9.60	
W09 - Inkster	155	11.27	1,298	4.55	
W10 - Point Douglas	169	12.29	2,230	7.83	
W11 - Downtown	282	20.51	2,846	9.99	
W12 - River Heights	54	3.93	2,285	8.02	

†Chi-square test for categorical variables; t-test for numeric variables
Frequencies expressed as n (%)

3.2 Comparing the Pre-Conception Diagnostic Prevalence of Mental Health Disorders Among Women Who Lived and Did Not Live in Public Housing.

This section presents results that answer the first research question.

Table 3.2 displays the sample sizes for outcomes, prevalences, and the unadjusted odds ratios comparing the mental health disorders (mood and anxiety, substance use, psychotic, and personality disorders and for any mental health disorder) between women who lived in public housing (PH) and women who did not live in PH**.** The pre-conception, five-year diagnostic prevalence of mental health disorders was higher among women who lived in PH compared with women who did not live in PH. The most common mental health disorder was mood and anxiety disorders, followed by substance use disorders, personality disorders, and psychotic disorders. In the unadjusted analyses, the women who lived in PH had significantly higher odds of being diagnosed with each of the mental health disorders (and the any mental disorder category) during the 5 years before conception when compared with the women who did not live in PH: (a) mood and anxiety disorder (OR, 2.07; 95% CI, 1.90, 2.25), (b) substance use disorder (OR, 3.03; 95% CI, 2.65-3.47), (c) personality disorder (OR, 2.85; 95% CI, 2.17-3.73), (d) psychotic disorder (OR 3.26; 95% CI, 2.25-4.72) and (e) any mental health disorders (OR 2.20; 95% CI, 2.03-2.40).

In multivariable analyses, I found no significant differences in the odds for mood & anxiety disorders, substance use disorders, and any mental health disorders when comparing women who lived in PH with women who did not live in PH. I was unable to compare the diagnostic prevalence of personality and psychotic disorders between the two groups in multivariable analyses due to the small cell sizes. To understand the lack of statistical significance between the groups, I used a blocked entry of covariates approach, entering the covariates in a sequential manner similar to Finlayson et al., (2013), Chiou et al., (2023) & Mravčík et al., (2020). I first entered demographic variables such as age group, parity, high

school completion, region of residence, and CCI score into the model. The odds of having mood & anxiety disorders, substance use disorders and any mental health disorders were statistically significantly higher for those women who lived in PH when compared with women who did not live in PH. I then entered area-level income (IQ); the differences in odds decreased but remained significantly higher among women who lived in PH. Finally, I included whether or not the woman received income assistance (IA) into the model, the differences between the women who lived in PH and women who did not live in PH became non-significant for mood & anxiety disorders, substance use disorders, and any mental health disorders (Table 3.2).

Based on these results, I then tested whether the association between living in PH and being diagnosed with a mental disorder differed between those who did and did not receive IA by interacting the receipt of IA with living in PH (Table 3.3). Among women who *do not receive* IA, living in publicly funded housing was associated with an increased odds of being diagnosed with a mood and anxiety disorder (aOR 1.62; 95% CI 1.31-1.99), a substance use disorder (aOR 1.65; 95% CI 1.12-2.43), and any mental health disorder (aOR 1.68; 95% CI 1.37-2.07). Among women who *receive* IA, living in PH was associated with decreased odds of being diagnosed with a substance use disorder (aOR 0.78; 95% CI 0.66-0.92); I found no other statistically significant associations among women who receive IA (Table 3.3). I also tested whether the associations between receiving IA and being diagnosed with a mental health disorder differed between those who lived and did not live in PH. Receiving IA was associated with increased odds of being diagnosed with a mental health disorder among those who lived in PH and among those who did not live in PH (Appendix II).

Table 3.2: Odds Ratios (OR) Comparing the Pre-Conception, 5 Year Diagnostic Prevalence of Mental Health Disorders Among Women Who Lived in Public Housing and Their Comparisons in Manitoba, Canada.

Predictor	**Mental Health Disorders**				**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Full Model**
	Yes	**%**	**No**	**%**	**OR (95% CI) ***	**aOR (95% CI) [a]**	**aOR (95% CI) [b]**	**aOR (95% CI) [c]**	**aOR (95% CI) [d]**
Any mental Health disorders									
Women who lived in PH	1,122	50.40	1.104	49.60	**2.20 (2.03-2.40)**	**1.93 (1.77-2.11)**	**1.88 (1.72-2.06)**	1.05 (0.96-1.16)	1.05 (0.95-1.16)
Women who did not live in PH	18,028	31.55	39,104	68.45	Reference	Reference	Reference	Reference	Reference
Mood and Anxiety Disorder									
Women who lived in PH	1,040	46.72	1,186	53.28	**2.07 (1.90-2.25)**	**1.85 (1.70-2.03)**	**1.82 (1.67-1.99)**	1.04 (0.94-1.15)	1.04 (0.94-1.15)
Women who did not live in PH	17,013	29.78	40, 119	70.22	Reference	Reference	Reference	Reference	Reference
Substance Use Disorder									
Women who lived in PH	260	11.7	1966	88.3	**3.03 (2.65-3.47)**	**1.94 (1.68-2.24)**	**1.72 (1.49-1.99)**	0.90 (0.77-1.04)	0.85 (0.73-1.00)
Women who did not live in PH	2,390	4.2	54,742	95.8	Reference	Reference	Reference	Reference	Reference
Personality Disorder									
Women who lived in PH	47	2.1	2,179	97.9	**3.01 (2.22-4.09)**				
Women who did not live in PH	406	0.7	56,726	99.3	Reference				
Psychotic Disorder									
Women who lived in PH	25	1.1	2,201	98.9	**3.41 (2.24-5.18)**				
Women who did not live in PH	190	0.4	57,942	99.6	Reference				

Frequencies expressed as n (%)
Bolded values are statistically significant at $\alpha = .05$.
*Model 1: Unadjusted Odds Ratios (OR) with 95% CI (Confidence Intervals) are derived from Logistic Regression models
Note: Any mental health disorders include the following disorders: Mood & anxiety, substance use, personality and psychotic disorders.
[a]Model 2- Adjusted for demographic covariates (age group, RHA, parity, high school completion and CCI score)
[b]Model 3: Model 2 plus income quintiles (Q1-Q5)
[c]Model 4: Model 2 plus receipt of income assistance
[d]Full model- Adjusted for all covariates (age group, income quintiles receipt of IA, RHA, parity, high school completion, and CCI score)

Table 3.3: Odds Ratios (OR) Comparing the Pre-Conception, 5 Year Diagnostic Prevalence of Mental Health Disorders Among Women Who Lived in Public Housing (PH) and Their Comparisons: Stratified by Receipt of IA

Predictors	**Mental Health Disorders**	
Associations between living in PH and being diagnosed with a MH disorder: stratified by whether or not the woman receives IA		
	Any Mental Health Disorder	
	OR (95% CI) *	**aOR (95% CI) ****
Among women who receive IA: Comparing those who lived in PH (n=962) vs those who did not live in PH (n=2,616)	0.94 (0.85-1.05)	0.92 (0.83-1.03)
Among women who do not receive IA: Comparing those who lived in PH (n=160) vs those who did not live in PH (n=15,412)	**1.62 (1.33-1.99)**	**1.68 (1.37-2.07)**
	Mood & Anxiety Disorder	
Among women who receive IA: Comparing those who lived in PH (n=895) vs those who did not live in PH (n=2,434)	0.95 (0.85-1.05)	0.93 (0.83-1.04)
Among women who do not receive IA: Comparing those who lived in PH (n=145) vs those who did not live in PH (n=14,579)	**1.49 (1.22-1.84)**	**1.62 (1.31-1.99)**
	Substance Use Disorder	
Among women who receive IA: Comparing those who lived in PH (n=231) vs those who did not live in PH (n=721)	**0.83 (0.70-0.97)**	**0.78 (0.66-0.92)**
Among women who do not receive IA: Comparing those who live in PH (n=29) vs those who did not live in PH (n=1,669)	**2.40 (1.64-3.51)**	**1.65 (1.12-2.43)**

Bolded values are statistically significant at $\alpha = .05$.

Note: Any mental health disorders include the following disorders: Mood & anxiety, substance use, personality and psychotic disorders.

* Unadjusted ORs for interaction between housing and receipt of IA are derived from Logistic Regression models

** Adjusted ORs for covariates for interaction between housing and receipt of IA.

3.3 Predictors of Having a Mental Health Diagnosis Among Women Who Lived in Public Housing (PH)

This section presents results that identify statistically significant predictors of being diagnosed with a mental health disorder among pregnant women who lived in public housing (PH).

3.3.1 Any Mental Health Disorder

Table 3.4 shows the prevalence, ORs and 95% CIs for the unadjusted and adjusted logistic regression models identifying statistically significant predictors of being diagnosed with any mental health disorder among women who lived in PH. Among pregnant women who lived in PH, I compared those diagnosed any mental health disorder with those who were not diagnosed with any mental health disorder; women with a diagnosis of any mental health disorder more likely to receive income assistance (85.74% vs. 78.62%), live in lowest income neighbourhood (56.24 vs. 55.62%), less likely to complete high school (52.50% vs. 57.70%), more often had comorbidities (17.65% vs. 9.42%), and more likely to live in Point Douglas/Downtown (33.38% vs. 32.16%).

Table 3.4 shows that in the unadjusted models, among those living in public housing, pregnant women who were older (when compared with women who were 18-19), received IA, did not complete grade 12, were multiparous, had more diagnosed physical health comorbidities, and lived in the Prairie Mountain Health Region (compared with living in Winnipeg) had higher odds of being diagnosed with any mental health disorder.

In the fully adjusted model, being older, receiving IA, not completing grade 12, having physical health comorbidities, and living in the Prairie Mountain Region remained statistically significant; however, being multiparous became non-significant. Winnipeg Community Areas

were not included in the fully adjusted model because of small cell sizes and the models failed to converge.

Table 3.4: Sociodemographic characteristics, Unadjusted and Adjusted Odds Ratios (OR) and 95% Confidence Intervals (CIs) Comparing the Pre-Conception, 5 Year Diagnostic Prevalence of Any Mental Health Disorder Among Women Who Lived in Public Housing (PH)

Covariates	**Any Mental Health Disorder**		**Crude OR (95% CI)**	**Crude P-value**	**aOR (95% CI)**	**P-value**
	Yes (n (%))	**No (n (%))**				
PH Residents (n=2226)	1,122 (50.40)	1,104 (49.60)				
Age-group of Mother						
18-19	82 (7.31)	188 (17.03)	Reference	-	Reference	-
20-24	298 (26.56)	362 (32.79)	**1.89 (1.40-2.55)**	<.0001	**1.90 (1.36-2.64)**	0.0001
25-29	333 (29.68)	263(23.82)	**2.88 (2.12-3.91)**	<.0001	**2.99 (2.09-4.28)**	<.0001
30-34	251 (22.37)	180 (16.30)	**3.17 (2.29-4.37)**	<.0001	**3.42 (2.34-5.02)**	<.0001
35+	158 (14.08)	111 (10.05)	**3.26 (2.29-4.65)**	<.0001	**3.57 (2.35-5.42)**	<.0001
Neighborhood Income Quintile						
IQ1 (lowest)	631 (56.24)	613 (55.62)	1.22 (0.75-1.97)	0.428	0.76 (0.45-1.29)	0.316
IQ2	237 (21.12)	230 (20.74)	1.22 (0.74-2.02)	0.443	0.83 (0.48-1.41)	0.485
IQ3	147 (13.10)	141 (12.77)	1.24 (0.73-2.09)	0.425	0.91 (0.52-1.59)	0.749
IQ4	75 (6.68)	82 (7.43)	1.09 (0.62-1.91)	0.775	0.93 (0.51-1.69)	0.824
IQ5 (highest)	32 (2.85)	38 (3.44)	Reference	-	Reference	
Receipt of income assistance						
Yes	962 (85.74)	868 (78.62)	**1.65 (1.32-2.06)**	<.0001	**1.41 (1.11-1.78)**	0.0054
No	160 (14.26)	236 (21.38)	Reference	-	Reference	-
Education Level						
< Grade 12	480 (42.78)	409 (37.05)	**1.27 (1.07-1.51)**	<.0001	**1.49 (1.23-1.79)**	<.0001
>= Grade 12	589 (52.50)	637 (57.70)	Reference	-	Reference	-
Unknown	53 (4.72)	58 (5.25)	0.99 (0.67-1.46)	0.158	0.88 (0.58-1.32)	0.537
Parity						
Primiparous	178 (15.86)	253 (22.92)	Reference	-	Reference	-
Multiparous	944 (84.14)	851 (77.08)	**1.58 (1.27-1.95)**	<.0001	0.85 (0.65-1.11)	0.228

Charlson Comorbidity Index Score						
Charlson 0	897 (79.95)	990 (89.67)	Reference	-	Reference	
Charlson 1	198 (17.65)	104 (9.42)	**2.10 (1.63-2.71)**	<.0001	**1.84 (1.42-2.40)**	<.0001
Charlson 2+	27 (2.41)	10 (0.91)	**2.98 (1.43-6.18)**	0.008	**2.45 (1.15-5.22)**	0.021
Region of Residence						
Interlake-Eastern (IE)	77 (6.86)	60 (5.43)	1.17 (0.83-1.67)	0.373	1.16 (0.80-1.69)	0.423
Northern Health (NO)	91 (8.11)	186 (16.85)	**0.45 (0.34-0.59)**	<.0001	**0.44 (0.33-0.61)**	<.0001
Southern Health-Santé Sud (SO)	67 (5.97)	99 (8.97)	**0.62 (0.44-0.84)**	0.003	**0.62 (0.44-0.87)**	0.007
Prairie Mountain Health (WE)	168 (14.97)	103 (9.33)	**1.49 (1.14-1.95)**	0.003	**1.41 (1.06-1.87)**	0.017
Winnipeg RHA (WP)	719 (64.08)	656 (59.42)	Reference	-	Reference	-
Winnipeg Community Areas (CAs)						
St. James-Assiniboia /Assiniboine South	68 (9.46)	48 (7.32)	1.25 (0.82-1.88)	0.298		
Fort Garry/River Heights	71 (9.87)	62 (9.45)	1.01 (0.68-1.48)	0.973		
St. Vital/St. Boniface	72 (10.01)	78 (11.74)	0.82 (0.55-1.19)	0.239		
River East/Transcona	160 (22.25)	123 (18.75)	1.14 (0.85-1.54)	0.379		
Seven Oaks /Inkster	108 (15.02)	135 (2058)	**0.70 (0.51-0.96)**	0.028		
Point Douglas/Downtown	240 (33.38)	211 (32.16)	Reference	-		

Frequencies expressed as n (%)

Note: income not found was merged with Q1 due to small cell sizes and corresponding rules regarding privacy.

Bolded values are statistically significant at $\alpha = .05$.

*OR: Odds Ratios with 95% CI (Confidence Intervals) are derived from Logistic Regression models

**aOR: Odds Ratios with 95% CI (Confidence Intervals) are derived from Logistic Regression models, adjusted for age group, high school completion, neighborhood income quintile, Region of residence, CCI, parity and income assistance.

3.3.2 Mood and Anxiety Disorders

Table 3.5 shows the prevalence, ORs and 95% CIs for the unadjusted and adjusted logistic regression models identifying statistically significant predictors of being diagnosed with a mood and anxiety disorder among women who lived in PH. Approximately 29.52% of women were aged 25 to 29, 26.73% of women aged 20 to 24, 22.79% of women aged 30 to 34, 14.52% of women were aged 35-39. Only 6.44% of women aged 18-19 were diagnosed with mood & anxiety disorders. With each successive increase in area-level income, there was a decrease in the diagnostic prevalence of mood & anxiety disorder and there were no statistically significant differences between all the income groups for women who lived in PH. At an individual level, there was a statistically significant difference with those who received IA with or without mood and anxiety disorder (86.06% versus 78.84%). Approximately 84.71% of women with mood and anxiety disorder are multiparous versus 77.07% without the disorder. The prevalence of physician-diagnosed physical comorbidities was two times higher among women with mood and anxiety disorder compared with women without the disorder (18.65% versus 9.11%). Table 3.5 also presents the geographic distribution of where women lived across the province.

In unadjusted models, the odds of being diagnosed with a mood and anxiety disorder among women aged 20-24, 25-29, 30-34, and 35+ years were significantly higher than those in the reference age group of 18-19 (OR: 2.21, 3.20, 3.70, 3.88). Unadjusted models also showed that receiving IA, completing high school, parity, being diagnosed with physical comorbidities and region of residence were significantly associated with being diagnosed with a mood and anxiety disorder; area-level income was not associated with being diagnosed with a mood & anxiety disorder. Associations remained the same after adjustment. Winnipeg Community Areas were not included in the fully adjusted model because of small cell sizes and the models failed to converge.

Table 3.5: Sociodemographic characteristics, Unadjusted and Adjusted Odds Ratios (OR) and 95% Confidence Intervals (CIs) of Diagnostic Prevalence of Mood & Anxiety Disorder 5 years before conception Among Women Who Lived in PH.

Covariates	**Mood and Anxiety Disorder**		**Crude OR (95% CI) ***	**Crude p value**	**Adjusted OR (95% CI) ****	**p-value**
	Yes (n (%))	**No (n (%))**				
PH Residents (n=2226)	1,040 (46.70)	1,186 (53.30)				
Age-group of Mother						
18-19	67 (6.44)	203 (17.12)	Reference	-	Reference	-
20-24	278 (26.73)	382 (32.21)	**2.21 (1.61-3.03)**	<.0001	**2.19 (1.55-3.10)**	<.0001
25-29	307 (29.52)	289 (24.37)	**3.22 (2.33-4.43)**	<0.001	**3.21 (2.21-4.67)**	<.0001
30-34	237 (22.79)	194 (16.36)	**3.70 (2.65-5.17)**	<.0001	**3.83 (2.58-5.69)**	<.0001
35+	151 (14.52)	118 (9.95)	**3.88 (2.69-5.59)**	<.0001	**4.01 (2.62-6.21)**	<.0001
Neighborhood Income Quintile						
IQ1 (lowest)	590 (56.73)	655 (55.23)	1.27 (0.78-2.08)	0.338	0.72 (0.42-1.23)	0.226
IQ2	217 (20.87)	249 (20.99)	1.23 (0.74-2.05)	0.441	0.76 (0.44-1.32)	0.327
IQ3	134 (12.88)	154 (12.98)	1.23 (0.73-2.09)	0.443	0.84 (0.47-1.48)	0.538
IQ4	70 (6.73)	87 (7.34)	1.14 (0.64-2.01)	0.658	0.97 (0.53-1.79)	0.926
IQ5 (highest)	29 (2.79)	41(3.46)	Reference	-	Reference	-
Receipt of income assistance						
Yes	895 (86.06)	935 (78.84)	**1.66 (1.32-2.08)**	<.0001	**1.40 (1.10-1.78)**	0.007
No	145 (13.94)	251 (21.16)	Reference	-	Reference	
Education Level						
< Grade 12	438 (42.12)	451 (38.03)	1.19 (1.00-1.42)	0.0465	**1.41 (1.17-1.70)**	0.0003
>= Grade 12	550 (52.88)	676 (57.00)	Reference	-	Reference	-
Unknown	52 (5.00)	59 (4.97)	1.08 (0.73-1.60)	0.6751	0.98 (0.64-1.49)	0.913
Parity						
Primiparous	159 (15.29)	272 (22.93)	Reference	<.0001	Reference	-
Multiparous	881 (84.71)	914 (77.07)	**1.64 (1.33-2.05)**	-	0.86 (0.66-1.14)	0.304
Charlson Comorbidity Index Score						
Charlson 0	820 (78.85)	1067 (89.97)	Reference	-	Reference	-
Charlson 1	194 (18.65)	108 (9.11)	**2.34 (1.82-3.01)**	<.0001	**2.05 (1.58-2.67)**	<.0001
Charlson 2+	26 (2.50)	11 (0.93)	**3.07 (1.51-6.26)**	0.005	**2.50 (1.19-5.28)**	0.016
Region of Residence						

Interlake-Eastern (IE)	74 (7.12)	63 (5.31)	1.21 (0.85-1.72)	0.279	1.22 (0.84-1.77)	0.290
Northern Health Region (NO)	70 (6.73)	207 (17.45)	**0.35 (0.26-0.47)**	<.0001	**0.34 (0.25-0.47)**	<.0001
Prairie Mountain Health (WE)	160 (15.83)	111 (9.36)	**1.49 (1.14-1.94)**	0.003	**1.41 (1.06-1.87)**	0.012
Southern Health-Santé Sud (SO)	59 (5.67)	107 (9.02)	**0.56 (0.40-0.80)**	0.0006	**0.57 (0.40-0.81)**	0.002
Winnipeg RHA (WP)	677 (65.10)	698 (58.85)	Reference	-	Reference	-
Winnipeg Community Areas (CAs)						
St. James-Assiniboia /Assiniboine South	65 (9.60)	51 (7.31)	1.33 (0.88-2.00)	0.177		
Fort Garry/River Heights	69 (10.19)	64 (9.17)	1.12 (0.76-1.65)	0.560		
St. Vital/St. Boniface	67 (9.90)	82 (11.75)	0.85 (0.59-1.23)	0.319		
River East/Transcona	155 (22.90)	128 (18.34)	1.26 (0.94-1.70)	1.283		
Seven Oaks /Inkster	100 (14.77)	143 (20.49)	**0.73 (0.53-0.98)**	0.04		
Point Douglas/Downtown	221 (32.64)	230 (32.95)	Reference	-		

Frequencies expressed as n (%)

Note: income not found was merged with Q1 due to small cell sizes and corresponding rules regarding privacy.

Bolded values are statistically significant at $\alpha = .05$.

*OR: Odds Ratios with 95% CI (Confidence Intervals) are derived from Logistic Regression models

**aOR: Odds Ratios with 95% CI (Confidence Intervals) are derived from Logistic Regression models, adjusted for age group, high school completion, neighborhood income quintile, region of residence, CCI, parity and income assistance.

3.3.3 Substance Use Disorders

Table 3.6 presents results that identify statistically significant predictors of being diagnosed with a substance use disorder among women who lived in PH. Women who lived in PH with substance use disorder were more likely to live in lowest income quintiles (58.85% vs. 55.54%), more likely to received income assistance (88.85% vs. 81.33%), and less likely to complete high school (52.31% vs. 38.30%) than women without substance use disorder. In addition, women with substance use disorder more often had comorbidities (17.69% vs. 13.02%), and the majority lived in Point Douglas/Downtown (40.46% vs. 31.70%). In the unadjusted logistic regression models, maternal age group, receiving IA, completing high school, and having physical health comorbidities were significantly associated with being diagnosed with a substance use disorder during the five years prior to conception. Region of residence, Winnipeg community areas, parity, and area-level income were not statistically significant associated with being diagnosed with a substance use disorder. In the fully adjusted model, parity became significantly associated with being diagnosed with a substance use disorder, with multiparous women living in PH less likely to be diagnosed than primiparous women living in PH; all other factors remained the same after adjusting for the covariates in the model. Winnipeg Community Areas were not included in the fully adjusted model because of small cell sizes and the models failed to converge.

Table 3.6: Sociodemographic characteristics, Unadjusted and Adjusted Odds Ratios (OR) and 95% Confidence Intervals (CIs) of Diagnostic Prevalence of Substance Use Disorder 5 years before conception Among Women Who Lived in PH.

Covariates	Substance Use Disorder		Crude OR (95% CI) *	Crude P-Value	Adjusted OR (95% CI) **	Adjusted P-Value
	Yes (n (%))	No (n (%))				
PH Residents (n=2226)	260 (11.70)	1966 (88.30)				
Age-group of Mother						
18-19	24 (9.23)	246 (12.51)	Reference	-	Reference	-
20-24	52 (20.00)	608 (30.93)	0.88 (0.53-1.45)	0.610	1.12 (0.65-1.92)	0.693
25-29	87 (33.46)	509 (25.89)	**1.75 (10.8-2.82)**	0.021	**2.65 (1.50-4.68)**	0.0008
30-34	57 (21.92)	374 (19.02)	1.56 (0.94-2.58)	0.082	**2.38 (1.30-4.34)**	0.006
35+	40 (15.38)	229 (11.65)	**1.79 (1.05-3.06)**	0.034	**2.78 (1.46-5.28)**	0.002
Neighborhood Income Quintile						
IQ1 (lowest)	153 (58.85)	1092 (55.54)	1.27 (0.57-2.82)	0.562	1.10 (0.48-2.54)	0.823
IQ2	48 (18.46)	418 (21.26)	1.03 (0.45-2.39)	0.939	0.99 (0.42-2.36)	0.999
IQ3	33 (12.69)	255 (12.97)	1.17 (0.49-2.76)	0.729	1.17 (0.48-2.82)	0.713
IQ4	19 (7.31)	138 (7.02)	1.24 (0.50-3.09)	0.647	1.16 (0.45-2.94)	0.761
IQ5 (highest)	7 (2.69)	63 (3.20)	Reference	-	Reference	
Receipt of income assistance						
Yes	291 (88.85)	1,599 (81.33)	**1.83 (1.22-2.73)**	0.003	**1.76 (1.15-2.68)**	0.0009
No	29 (11.15)	367 (18.67)	Reference	-	Reference	-
Education Level						
< Grade 12	136 (52.31)	753 (38.30)	**1.80 (1.38-2.35)**	<.0001	**1.96 (1.48-2.49)**	<.0001
>= Grade 12	112 (43.08)	1,114 (56.66)	Reference	-	Reference	-
Unknown	12(4.62)	99 (5.04)	1.21 (0.64-2.26)	0.561	1.01 (0.52-1.93)	0.985
Parity						
Primiparous	48 (18.46)	383 (19.48)	Reference	-	Reference	-
Multiparous	212 (81.54)	1583 (80.52)	1.07 (0.77-1.49)	0.696	**0.55 (0.36-0.84)**	0.006
Charlson Comorbidity Index Score						
Charlson 0	205 (78.85)	1682 (85.55)	Reference	-	Reference	-
Charlson 1	46 (17.69)	256 (13.02)	**1.47 (1.04-2.08)**	0.028	1.34 (0.94-1.92)	0.104
Charlson 2+	9 (3.46)	28 (1.42)	**2.64 (1.23-5.67)**	0.013	**2.41 (1.09-5.36)**	0.030
Region of Residence						

Interlake-Eastern (IE)	13 (5.00)	124 (6.31)	0.73 (0.40-1.32)	0.295	0.71 (0.39-1.32)	0.281
Northern Health Region (NO)	33 (12.69)	244 (12.41)	0.94 (0.63-1.40)	0.759	1.01 (0.65-1.56)	0.984
Southern Health-Santé Sud (SO)	13 (5.00)	153 (7.78)	0.59 (0.33-1.06)	0.302	0.62 (0.34-1.15)	0.130
Prairie Mountain Health (WE)	28 (10.77))	243 (12.36)	0.80 (0.53-1.22)	0.079	0.79 (0.51-1.23)	0.298
Winnipeg RHA (WP)	173 (66.54)	1202(61.14)	Reference	-	Reference	
Winnipeg Community Areas (CAs)						
St. James-Assiniboia /Assiniboine South	12 (6.94)	104 (8.65)	0.63 (0.33-1.20)	0.160		
Fort Garry/River Heights	13 (7.51)	120 (9.98)	0.59 (0.32-1.10)	0.099		
St. Vital/St. Boniface	18 (10.40)	131 (10.90)	0.75 (0.43-1.30)	0.304		
River East/Transcona	30 (17.34)	253 (21.05)	0.65 (0.41-1.02)	0.060		
Seven Oaks /Inkster	30 (17.34)	213 (17.72)	0.77 (0.48-1.21)	0.267		
Point Douglas/Downtown	70 (40.46)	381 (31.70)	Reference	-		

Frequencies expressed as n (%)
Bolded values are statistically significant at $\alpha = .05$.
Note: income not found was merged with Q1 due to small cell sizes and corresponding rules regarding privacy.
*OR: Odds Ratios with 95% CI (Confidence Intervals) are derived from Logistic Regression models
**aOR: Odds Ratios with 95% CI (Confidence Intervals) are derived from Logistic Regression models, adjusted for age group, high school completion, neighborhood income quintile, Region of residence CCI, parity, and employment & income assistance.

3.3.4 Personality Disorders

The cross tabulations of the diagnosis of psychotic disorder across the sociodemographic characteristics could not be reported due to small number of events as most of the cell counts were less than six in most of the categories, even after regrouping the covariates. Therefore, statistical analysis to measure the association was not computed as these may contribute to low variability to the outcome effect.

3.3.5 Psychotic Disorders

The cross tabulations of the diagnosis of psychotic disorder across the sociodemographic characteristics could not be reported due to small number of events as most of the cell counts were less than six in most of the categories, even after regrouping the covariates. Therefore, statistical analysis to measure the association was not computed as these may contribute to low variability to the outcome effect.

3.4 Sensitivity analysis – Exploring Potential Bias between Included and Excluded Pregnant Women in PH on Observed Results

I conducted a sensitivity analysis to test for differences between pregnant women included and excluded from my analytic cohort of women who live in PH. I identified a total of 3,003 pregnant women who lived in PH during the study period; 2,226 (74.1%) were included in the study and 777 (25.9%) were excluded because they who moved into or out of PH while pregnant.

The differences in the sociodemographic characteristics between the included and excluded groups were compared using standardized differences of proportions which is a method of comparing groups that is robust to changes in sample size. Standardized differences with a value more than 0.10 (10%) were considered significant. Results showed that age group, receipt of IA, region of residence and Winnipeg Community Areas were significantly different between included and excluded groups (Table 3.7).

In the unadjusted logistic regression model comparing women included in my study with women who were excluded, included women had lower odds of receiving a diagnosis for a substance use disorder 5 years prior conception date (OR= 0.74, 95% CI= 0.58-0.93) and receiving a diagnosis for a personality disorder (OR= 0.60, 95% CI= 0.37-0.97) than women excluded from my study. There were no associations between the two groups with having a diagnosed mood and anxiety disorders, psychotic disorders and any mental health disorders. However, in the adjusted model, the associations were significant for mood and anxiety disorders, substance use disorders and any mental health disorder (Table 3.8). Personality and psychotic disorders were not adjusted for in the final model due to the small number of cases.

Table 3.7: Sociodemographic characteristics of pregnant women who lived in PH (N=2226) compared to pregnant women who did not live in PH (N=777) for the entire duration of their pregnancy between 2009/10-2017/18, age 18-45

Sociodemographic characteristics	**Women who lived in PH**		**Women who did not in PH for their entire pregnancy**		**Standardized Differences**
	2,226 (74.1%)		777 (25.9%)		
	Count	(%)	Count	(%)	
Mean age of mother – (mean, SD)	26.7 (6.07)		26.0 (5.37)		**0.12**
Age-group of Mother					
18-19	270	12.13	74	9.52	0.08
20-24	660	29.65	281	36.16	**0.13**
25-29	596	26.77	225	28.96	0.04
30-34	431	19.36	133	17.12	0.06
35+	269	12.08	64	8.24	**0.13**
Neighborhood Income Quintile					
Q1 (lowest)	1,240	55.71	399	51.35	0.09
Q2	466	20.93	169	21.75	0.02
Q3	288	12.94	109	14.03	0.03
Q4	157	7.05	69	8.88	0.07
Q5 (highest)	75	3.37	31	3.99	0.05
Receipt of Income Assistance					
Yes	1,830	82.21	520	66.92	**0.36**
No	396	17.79	257	33.08	**0.36**
Education Level					
< Grade 12	889	39.94	294	37.84	0.04
>= Grade 12	1,226	55.08	445	57.27	0.04
Unknown	111	4.99	38	4.89	0.004
Parity					
Primiparous	431	19.36	158	20.33	0.02
Multiparous	1,795	80.64	619	79.67	0.02
Charlson Comorbidity Index Score					
Charlson 0	1,887	84.77	661	85.07	0.008
Charlson 1	302	13.57	100	12.87	0.02
Charlson 2+	37	1.66	16	2.06	0.03

Winnipeg Community Areas (CAs)					
W01 - St. James-Assiniboia	65	4.73	13	3.04	0.08
W02 - Assiniboine South	51	3.71	8	1.87	0.10
W03 - Fort Garry	79	5.75	34	7.94	0.04
W04 - St. Vital	119	8.65	31	7.24	0.06
W05 - St. Boniface	30	2.18	18	4.21	0.07
W06 - Transcona	75	5.45	14	3.27	0.10
W07 - River East	208	15.13	52	12.15	0.10
W08 - Seven Oaks	88	6.40	15	3.50	**0.12**
W09 - Inkster	155	11.27	52	12.15	0.01
W10 - Point Douglas	169	12.29	78	18.22	0.09
W11 - Downtown	282	20.51	97	22.66	0.005
W12 - River Heights	54	3.93	16	3.74	0.02
Region of Residence					
Southern Health-Santé Sud (SO)	166	7.46	77	9.91	0.09
Interlake-Eastern (IE	137	6.15	62	7.98	0.07
Prairie Mountain Health (WE)	271	12.17	125	16.09	**0.11**
Northern Health Region (NO)	277	12.44	85	10.94	0.05
Winnipeg RHA (WP)	1,375	61.77	428	55.08	**0.14**

†Chi-square test for categorical variables; t-test for numeric variables
Frequencies expressed as n (%)
Standardized difference= difference in means or proportions divided by standard error.

Table 3.8: Prevalence, Crude and Adjusted Odds Ratios (OR) of Mental Health Disorders 5 Years Before Conception Between Pregnant Women Who Lived in PH and Pregnant Women Who Did Not Live in PH (N=777) For the Entire Duration of Their Pregnancy

Predictor	**Mental Health Disorders**					
	Yes	**%**	**No**	**%**	**OR (95% CI) ***	**aOR (95% CI) ****
Any mental Health disorders						
Women who lived in PH (N=2,226)	1,122	50.40	1.104	49.60	0.87 (0.75-1.04)	**0.82 (0.69-0.97)**
Women who lived in PH for their entire pregnancy (N=777)	416	53.54	361	46.46	Reference	Reference
Mood and Anxiety Disorder						
Women who lived in PH	1,040	46.70	1,186	53.30	0.85 (0.72-1.00)	**0.80 (0.67-0.95)**
Women who did not in PH for their entire pregnancy	394	50.71	383	49.29	Reference	Reference
Substance Use Disorder						
Women who lived in PH	260	11.70	1966	88.30	**0.74 (0.58-0.93)**	**0.65 (0.51-0.82)**
Women who did not in PH for their entire pregnancy	118	15.19	659	84.81	Reference	Reference
Personality Disorder						
Women who lived in PH	47	2.14	2,179	97.86	**0.60 (0.37-0.97)**	
Women who did not in PH for their entire pregnancy	27	3.47	750	96.53	Reference	
Psychotic Disorder						
Women who lived in PH	25	1.10	2,201	98.90	0.72 (0.36-1.45)	
Women who did not in PH for their entire pregnancy	12	1.54	765	98.46	Reference	

Frequencies expressed as n (%)
Bolded values are statistically significant at $\alpha = .05$.
*OR: Odds Ratios with 95% CI (Confidence Intervals) are derived from Logistic Regression models
**aOR: Odds Ratios with 95% CI (Confidence Intervals) are derived from Logistic Regression models, adjusted for age group, high school completion, neighborhood income quintile, region of residence, CCI, parity, and receipt of IA
Note: Any mental health disorders include the following disorders: Mood & anxiety, substance use, personality and psychotic disorders.

CHAPTER FOUR: INCIDENCE RATES OF MENTAL HEALTH DISORDERS IN PREGNANCY AND AFTER BIRTH

4.0 Results and Interpretations

The analytic cohort used for chapter 4 was the same cohort that was used for Chapter 3. Table 3.1 describes the demographic characteristics of women who lived in public housing (PH) and women who did not live in PH. The analytic cohort for research question three used two different definitions of mental health disorders, one to exclude women with pre-existing mental health disorders within the five years before conception, and the other to retain women without prior diagnosis of the mental health disorders. I used a five-year washout period to exclude women from incidence rates calculations if they were identified as having the mental health disorder in research questions 1 and 2. Pregnant women without prior diagnosis were followed from the date of conception until 40 weeks after live births to calculate incident rates of mental health disorders during both the pregnancy and postpartum periods.

4.1 Incidence Rates of Mental Health Disorders Between Women Who Lived in PH And Their Comparison.

This section provides the answer to the third research question; examining the difference in the diagnostic incidence rates of mental health disorders among pregnant women who lived in PH when compared with the diagnostic incidence rates for mental health disorders among women who did not live in PH during the pregnancy and postpartum periods. I hypothesized that the diagnostic incidence rates for each individual mental health disorder (mood and anxiety, substance use, psychotic, and personality disorders and for any mental health disorder) will be higher among pregnant women who lived in PH when compared with pregnant women who did not live in PH during the pregnancy and postpartum periods, after adjusting for maternal characteristics.

With the exclusion of individuals with prior diagnostic prevalence of mental health disorders from the cohort, the sample size for each outcome varies. Table 3.4, Table 3.5 and Table 3.6 present the frequencies and sociodemographic characteristics of women without prior diagnosis of any mental health disorders, mood and anxiety disorders and substance use disorders. Due to a small number of events for personality and psychotic disorders, no frequency distributions were reported. The distribution of the incident diagnoses of mental health disorders was determined and negative binomial distribution was an appropriate model for the analysis. I estimated the incident rates of each mental health disorder using negative binomial distribution with a log link function and logarithm of the 40-weekly time periods as offset in the models.

Table 4.1 displays the sample size, the crude rate ratios (RRs) and adjusted rate ratios (aRRs) that compare the incident rates of mental health disorders during pregnancy and after a live birth for each mental health outcome among women who lived in PH and their comparisons. The same pattern that was observed in the diagnostic prevalence of mental health disorder prior to conception was also observed in the diagnostic incident rates of mental health disorders. The most common incident mental health disorder was mood and anxiety disorders, followed by substance use disorders, personality disorder and psychotic disorders.

When compared with women who did not live in PH, women who lived in PH had significantly higher unadjusted incident rates for diagnostic mood and anxiety disorders (RR, 1.23; 95% CI, 1.06-1.42), substance use disorders (RR, 1.54; 95% CI, 1.16-2.03), personality disorder (RR 2.71; 95% CI, 1.56-4.72*),* and any mental health disorders (RR 1.2; 95% CI, 1.03-1.38). The incident rate of psychotic disorders was not statistically significantly different between the women who did and who did not live in PH (RR 1.30; 95% CI, 0.48-3.61) (Table 4.1). However, only three of the mental health outcomes were modeled in the multivariable analysis. After adjusting for other covariates in the model, the incident rate of substance use disorders was

significantly lower among the women who lived in PH when compared with women who did not live in PH. There were no significant differences in the incident rates for mood & anxiety disorders and any mental health disorders when comparing the two groups after adjustment (Figure 4.1).

I conducted an ancillary analysis to understand why the significance of my results changed in the fully adjusted models (Table 4.1). I used Finlayson's (2013) blocked entry of covariates approach, entering the covariates in sequential fashion. I first entered demographic variables such as age group, income quintiles, parity, high school completion, region of residence, and CCI score in the model (Model 2). The incident rates of diagnostic mood & anxiety disorders, substance use disorders, and any mental health disorders were statistically significantly higher for those women who lived in PH. When income quintile was entered in model 3, there remained significant differences in the incident rates for mood and anxiety disorders, substance use disorders and any mental health disorders between women who lived and did not live in PH. In the final step, I entered receiving IA into the model (full model); the differences between the two groups became non-significant for mood & anxiety disorders (aRR, 0.98; 95% CI 0.84-1.14) and any mental health disorders (aRR, 0.90; 95% CI 0.77-1.05); and the women who lived in PH had a significantly lower rate for substance use disorders (aRR, **0.65; 95% CI 0.50-0.84)** when compared with the women who did not live in PH (Table 4.1).

Based on these results, I then tested whether the association between living in PH and having an incident diagnosis for a mental health disorder differed between those who did and did not receive IA using by interacting receipt of income assistance with living in PH. Among women who *received IA*, living in PH was associated with a decreased incidence of being diagnosed with substance use disorders (aRR, 0.62; 95% CI, 0.46-0.81) and found no differences in the incident rate of being diagnosed with mood and anxiety disorders (aRR, 0.97; 95% CI,

0.81-1.16) and any mental health disorders (aRR, 0.88; 95% CI, 0.73-1.05). Among women who *did not receive IA*, I found no differences in the incidence rates for having a mental health disorder between women who lived in PH and women who did not live in PH (Table 4.2).

I also tested whether the associations between receiving IA and having an incident MHD differed between women who lived and did not live in PH. Among women who lived in PH, receiving IA was associated with increased rates of having an incident diagnosis of mood & anxiety disorders (aRR,1.56; 95% CI, 1.14-2.14), substance use disorders (aRR, 3.41; 95% CI, 1.56-7.45), and any mental health disorders (aRR,1.59; 95% CI, 1.16-2.20). Among women who did not live in PH, receiving IA was also associated with increased incidence for all three outcomes in both unadjusted and adjusted model. (Appendix III)

Table 4.1: Sample size, Incidence, Unadjusted and Adjusted Rate Ratios Estimates (RR) of Mental Health Disorders between pregnant women who lived and did not live in PH in Manitoba, Canada.

Predictor	Mental Health Disorders		Model 1	Model 2	Model 3	Full Model
	Yes (%)	No (%)	RR (95% CI) [a]	aRR (95% CI) [b]	aRR (95% CI) [c]	aRR (95% CI) [d]
Any mental Health disorders						
Women who lived in PH (N=1,104)	207 (18.75)	897 (81.25)	**1.20 (1.04-1.39)**	**1.22 (1.06-1.41)**	**1.23 (1.06-1.42)**	0.90 (0.77-1.05)
Women who did not live in PH (N=39,104)	5,769 (14.75)	33,335 (85.25)	Reference	Reference	Reference	Reference
Mood and Anxiety Disorder						
Women who lived in PH (N= 1,186)	216 (18.21)	970 (81.79)	**1.23 (1.06-1.42)**	**1.28 (1.11-1.47)**	**1.30 (1.12-1.49)**	0.98 (0.84-1.14)
Women who did not live in PH (N=40,119)	5,703(14.22)	34,416(85.78)	Reference	Reference	Reference	Reference
Substance Use Disorder						
Women who lived in PH (N= 1,966)	76 (3.9)	1,890 (96.1)	**1.51 (1.13-2.03)**	**1.37 (1.05-1.80)**	**1.32 (1.03-1.70)**	**0.65 (0.50-0.84)**
Women who did not live in PH (N=54,742)	771 (1.4)	53, 971 (98.6)	Reference	Reference	Reference	Reference
Personality Disorder						
Women who lived in PH (N=2,179)	16 (0.7)	2,163 (99.3)	**2.71 (1.56-4.72)**			
Women who did not live in PH (N=56,726)	132 (0.2)	56,594(99.8)	Reference			
Psychotic Disorder						
Women who lived in PH (N= 2,201)	s	2,197 (99.8)	1.30 (0.48-3.61)			
Women who did not live in PH (56,942)	74 (0.1)	56,868 (99.9)	Reference			

Frequencies expressed as n (%); Bolded values are statistically significant at $\alpha = .05$. s= suppressed

Note: Any mental health disorders include the following disorders: mood & anxiety, substance use, personality and psychotic disorders.

[a]Model 1: Unadjusted Rate Ratios with 95% CI (Confidence Intervals) are derived from Negative Binomial Regression models

[b]Model 2- Adjusted Rate Ratios for demographic covariates (age group, RHA, parity, high school completion, and CCI score)

[c]Model 3: Model 2 plus income quintiles (Q1-Q5),

[d]Full model: Adjusted for all covariates (age group, income quintiles receipt of IA, RHA, parity, high school completion, and CCI score)

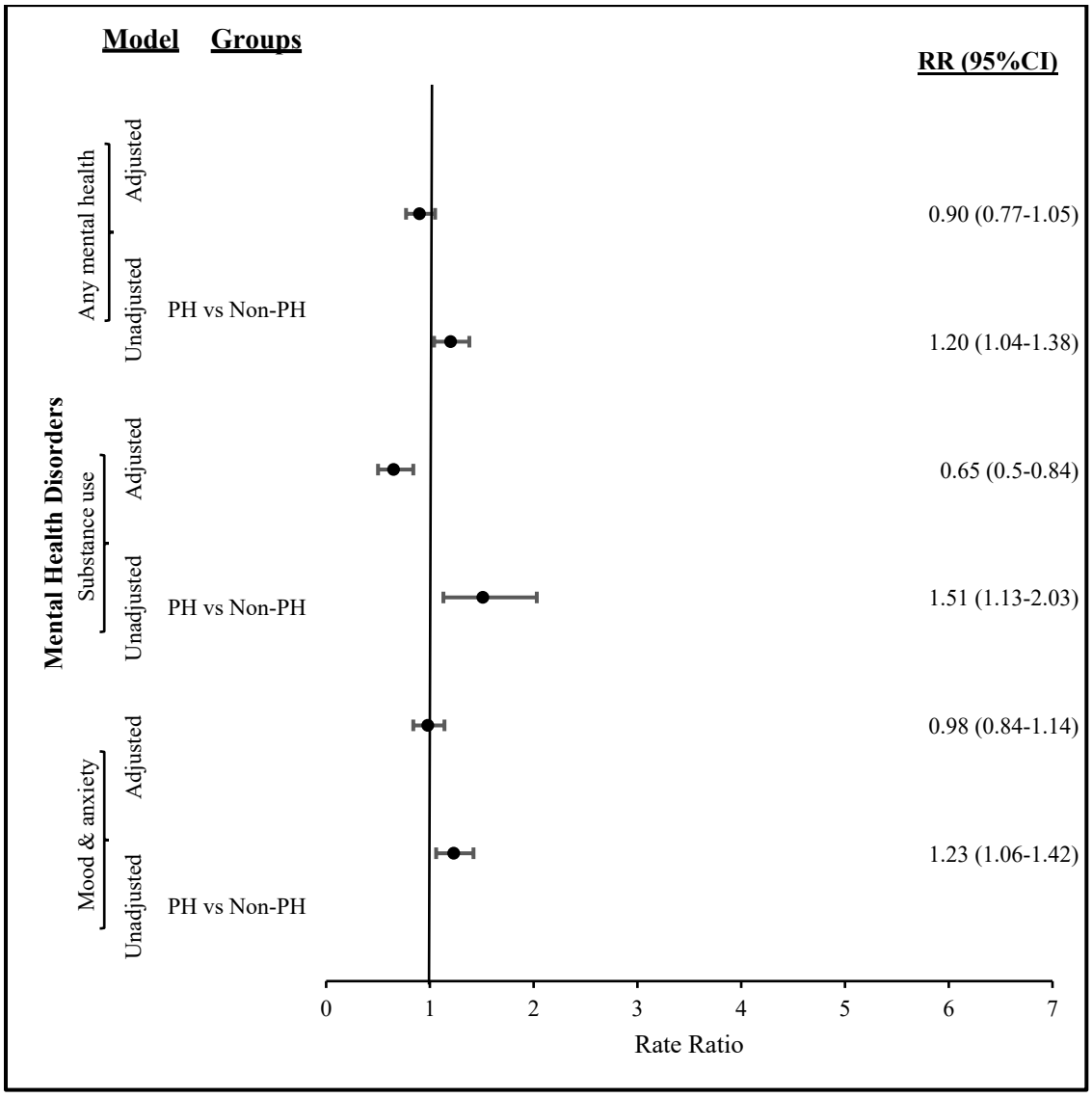

Figure 4.1: Incidences of Mental Health Disorders Between Women Who Lived in PH (PH) and Their Comparison (Non-PH)
Outcomes: Mood & anxiety, substance use, and any mental health disorders
Note: Any mental health disorders include the following disorders: Mood & anxiety, substance use, personality and psychotic disorders.
Unadjusted Rate Ratios with 95% CI (Confidence Intervals) are derived from Negative Binomial Regression models
Adjusted Rate Ratios for all covariates (age group, income quintiles, receipt of IA, RHA, parity, high school completion and CCI score)

Table 4.2: Unadjusted Rate Ratio, Adjusted Rate Ratios (RR) of Mental Health Disorders Between Women Who Live and Do Not Live in PH by Receipt of Income Assistance

Predictors	Mental Health Disorders	
Associations between living in PH and being diagnosed with a MH disorder: stratified by whether or not the woman receives IA		
	Any Mental Health Disorder	
	RR (95% CI) *	**aRR (95% CI) ****
Among women who receive IA: Comparing those who lived in PH vs those who did not live in PH	**0.82 (0.68-0.98)**	0.88 (0.73-1.05)
Among women who do not receive IA: Comparing those who lived in PH vs those who did not live in PH	0.95 (0.71-1.27)	0.99 (0.75-1.32)
	Mood & Anxiety Disorder	
Among women who receive IA: Comparing those who lived in PH vs those who did not live in PH	0.90 (0.74-1.08)	0.97 (0.81-1.16)
Among women who do not receive IA: Comparing those who lived in PH vs those who did not live in PH	0.98 (0.74-1.30)	1.05 (0.80-1.39)
	Substance use disorder	
Among women who receive IA: Comparing those who lived in PH vs those who did not live in PH	**0.64 (0.46-0.90)**	**0.62 (0.46-0.81)**
Among women who do not receive IA: Comparing those who lived in PH vs those who did not live in PH	0.87 (0.41-1.89)	0.79 (0.37-1.67)

Bolded values are statistically significant at $\alpha = .05$.
Note: Any mental health disorders include the following disorders: Mood & anxiety, substance use, personality and psychotic disorders.
*RR: Unadjusted Rate Ratio for interaction between housing and receipt of IA are derived from Negative Binomial Regression models
**aRR: Adjusted for covariates for interaction between housing and receipt of IA.

4.2. Incidences Rates of Mental Health Disorders by Time Period

4.2.1 Incidences Rates of Mental Health Disorders During Pregnancy Between Women Who Lived in PH and Their Comparison.

In the second analysis, the incident rate of each mental health disorder between women who lived in PH and women who did not live in PH was categorized based on its timing (i.e., prenatally – first diagnosis occurred during pregnancy, or postpartum, with first diagnosis occurred within 40 weeks of the infant's birth). Table 4.3 shows the rate ratio (RR) and aRRs for diagnostic incident rates of mental health disorders during pregnancy between women who lived in PH and their comparison. During pregnancy, incident rates of mood and anxiety disorders (RR 1.27, 95% CI 1.03-1.56*)*, substance use disorders *(*RR 2.04, 95% CI 1.27-3.30) and any mental health disorders (RR 1.26, 95% CI 1.01-1.53) were higher for the women who lived in PH cohort compared with their comparison. However, in the adjusted model, the differences decreased and there were no differences in association between the two groups (Table 4.3).

4.2.2 Incidences Rates of Mental Health Disorders After Birth between Women Who Did Live in PH and Their Comparison

Table 4.3 shows the rate ratio and aRRs for diagnostic incidences of mental health disorders after birth between women who lived in PH and those who did not live in PH. Women who lived in PH had higher incident rates of mood and anxiety disorders (RR 1.21, 95% CI 0.99-1.48), substance use disorders *(*RR 1.35, 95% CI 0.94-1.92) and any mental health disorders (RR 1.16, 95% CI 0.94-1.42) after birth compared with women who did not live in PH. However, these associations were not statistically different between women who lived in PH and their comparison. After adjustment, the associations decreased and became statistically significant for substance use disorders (aRR 0.58, 95% CI 0.42-0.79); there were no associations between the two groups after birth for diagnosed mood and anxiety disorders (aRR 0.98, 95% CI 0.80-1.20) and any mental health disorders (aRR 0.89, 95% CI 0.72-1.09) (Figure 4.2).

4.2.3 Incident Rates of Mental Health Disorders During Pregnancy and After Birth Among Women Who Lived in PH and Did Not Live in PH.

Table 4.4 shows the incident rate of mental health disorders among women who lived in PH and those who did not live in PH across the time period. The incident rate of mood and anxiety disorder after birth compared to during pregnancy was not statistically significant (aRR: 1.08; 95% CI 0.82-1.41) for women who lived in PH, but was statistically significant (aRR: 1.09; 95% CI, 1.02-1.16) for the women who did not live in PH. For the diagnostic incident rate of substance use disorder, the rate was statistically significant after birth compared to during pregnancy in both women who lived in PH (aRR, 1.94; 95% CI, 1.19-3.17) and women who did not live in PH (aRR, 2.59; 95% CI, 2.20-3.05). The incident rate of any mental health disorders after birth compared to during pregnancy was not statistically significant (aRR: 1.10; 95% CI 0.84-1.45) for women who lived in PH, but was statistically significant (aRR: 1.14; 95% CI 1.08-1.22) for women who did not live in PH.

Table 4.3: Unadjusted and Adjusted Rate Ratio (RR) of Mental Health Disorders between Women who lived in PH and Women who did not live in PH across Time period

Mental Health Disorders	**Predictors**		**Comparing those who lived in PH vs those who did not live in PH**	
	Women who lived in PH	**Women who did not live in PH**		
Any mental health Disorder (N=6,003)	**During Pregnancy**		**RR (95% CI) ***	**aRR (95% CI) ****
(N=2,851)	100 (9.06)	2,751 (7.04)	**1.26 (1.01-1.53)**	0.91 (0.74-1.13)
	After Birth			
(N=3,182)	111 (10.05)	3,071 (7.85)	1.16 (0.94-1.42)	0.89 (0.72-1.09)
Mood & Anxiety Disorder (N=5919)	**During Pregnancy**			
(n=2,858)	104 (8.77)	2,754 (6.86)	**1.27 (1.03-1.56)**	1.00 (0.80-1.21)
	After Birth			
(n=3,061)	112 (9.44)	2,949 (7.35)	1.21 (0.99-1.48)	0.98 (0.80-1.20)
Substance Use Disorder (N=847)	**During Pregnancy**			
(n=244)	26 (1.32)	218 (0.40)	**2.04 (1.27-3.30)**	0.77 (0.49-1.18)
	After Birth			
(n=603)	50 (2.54)	553 (1.01)	1.35 (0.94-1.92)	**0.58 (0.42-0.79)**

Bolded values are statistically significant at $\alpha = .05$.
*RR: Rate Ratios with 95% CI (Confidence Intervals) are derived from Negative Binomial Regression models
Note: Any mental health disorders include the following disorders: Mood & anxiety, substance use, personality and psychotic disorders.
**Adjusted RRs: adjusted for all covariates (age group, income quintiles, receipt of IA, RHA, parity, high school completion, and CCI score)

Table 4.4: Unadjusted and Adjusted Rate Ratios (RR) and 95% Confidence Intervals (CIs) of Mental Health Disorders among Women Who Lived in PH and Women Who Did Not Live in PH by Time period

Predictors	**Mental Health Disorders**	
Associations between time period and being diagnosed with a MH Disorder: stratified by whether or not the woman lives in public housing		
	Any Mental Health Disorder	
	RR (95% CI) *	**aRR (95% CI) ****
Among women who lived in PH: After Birth (n=100) vs During pregnancy (n=111)	1.09 (0.82-1.45)	1.10 (0.84-1.45)
Among women who did not live in PH: After Birth (n=3,071) vs During Pregnancy (n=2,751)	**1.18 (1.10-1.28)**	**1.14 (1.08-1.22)**
	Mood & Anxiety Disorder	
Among women who lived in PH: After Birth (n=112) vs During pregnancy (n=104)	1.07 (0.81-1.41)	1.08 (0.82-1.41)
Among women who did not live in PH: After Birth (n=2,754) vs During Pregnancy (n=2,949)	**1.11 (1.03-1.20)**	**1.09 (1.02-1.16)**
	Substance use disorder	
Among women who lived in PH: After Birth (n=50) vs During pregnancy (n=26)	**1.99 (1.15-3.45)**	**1.94 (1.19-3.17)**
Among women who did not live in PH: After Birth (n=553) vs During Pregnancy (n=218)	**3.02 (2.42-3.77)**	**2.59 (2.20-3.05)**

Bolded values are statistically significant at $\alpha = .05$.

*RR: Rate Ratios with 95% CI (Confidence Intervals) are derived from Negative Binomial Regression models Note: Any mental health disorders include the following disorders: Mood & anxiety, substance use, personality and psychotic disorders.

**Adjusted RRs: adjusted for all covariates (age group, income quintiles, receipt of IA, RHA, parity, high school completion and CCI score)

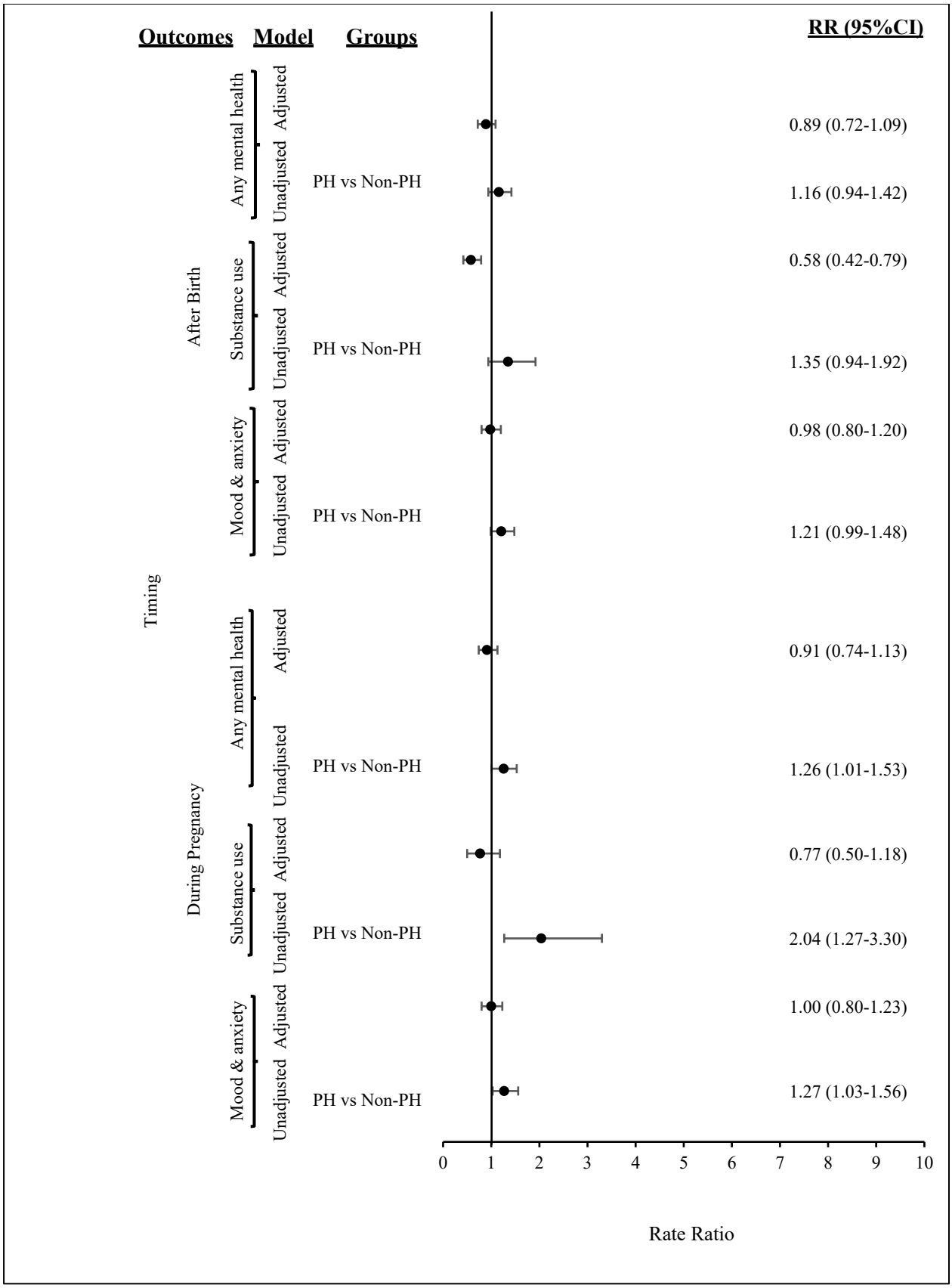
Outcomes
Model
Groups
RR (95%CI)
Timing
After Birth
During Pregnancy
Any mental health
Substance use
Mood & anxiety
Adjusted
Unadjusted
PH vs Non-PH
0.89 (0.72-1.09)
1.16 (0.94-1.42)
0.58 (0.42-0.79)
1.35 (0.94-1.92)
0.98 (0.80-1.20)
1.21 (0.99-1.48)
0.91 (0.74-1.13)
1.26 (1.01-1.53)
0.77 (0.50-1.18)
2.04 (1.27-3.30)
1.00 (0.80-1.23)
1.27 (1.03-1.56)
0 1 2 3 4 5 6 7 8 9 10
Rate Ratio

Figure 4.2: Incident rate of Mental health between women who lived in PH (PH) vs. women who did not live in PH (Non-PH) by Time Period
Outcomes: Mood & anxiety, substance use and any mental health disorders
Note: Any mental health disorders include the following disorders: Mood & anxiety, substance use, personality and psychotic disorders.
Unadjusted Rate Ratios with 95% CI (Confidence Intervals) are derived from Negative Binomial Regression models
Adjusted Rate Ratios for all covariates (age group, income quintiles, receipt of IA, RHA, parity, high school completion, and CCI score)

CHAPTER FIVE: DISCUSSION

5.1 Summary of Findings

The overall objective of my thesis was to examine the incidence and prevalence of mental health disorders among pregnant women who had a live singleton birth while living in public housing (PH). I found that women who lived in PH tended to be younger, more likely to live in lower income neighbourhoods, receive income assistance (IA), have more children, and live with more chronic health conditions, and are less likely to complete high school compared with their comparison. Women who lived in PH have higher diagnostic prevalence of mental health disorders when compared with women who did not live in PH. This supports my hypothesis that women who lived in PH are more likely to have a higher prevalence of mental health disorders when compared with women who did not live in PH. My study showed that social determinants such as receiving IA, not completing grade 12, and region of residence were associated with an increased prevalence of being diagnosed with mental health disorders among women who live in PH. These sociodemographic characteristics are consistent with findings from other previous studies that analyzed data from the Manitoba Population Research Data Repository (Finlayson et al., 2013; Hinds et al., 2019; Hinds et al., 2016). Finally, the incidence of newly diagnosed mental health disorders arising during pregnancy or after birth were higher among women who lived in PH when compared with those who did not live in PH. Notably, the study found lower rates of mental health disorders during pregnancy relative to the postpartum period, which is consistent with previous literature (Mota et al., 2019; Van Bussel et al., 2006; Vesga-López et al., 2008; Molenaar et al., 2022).

5.2 Discussion of Findings

5.2.1 Comparison in The Diagnostic Prevalence of Mental Health Disorders Between Pregnant Women Who Did Live and Did Not Live in PH.

Women who lived in PH have higher diagnostic prevalence of the mental health disorders when compared with women who did not live in PH. These findings are consistent with previous population-based studies highlighting that public housing residents have a higher likelihood of diagnostic prevalence for most mental health disorders when compared with the general population (Bentley et al., 2018; Chartier et al., 2018; A. Hinds et al., 2019; Hinds et al., 2016; Simning et al., 2011; Smith et al., 2013). Previous research found that residency in PH 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). Smith et al., (2013) reported mood and anxiety disorders were 1.6 times higher among social housing residents, with higher odds of schizophrenia compared to other Manitobans. Chartier et al., (2018) reported higher diagnostic prevalence of mental health disorders for adults in PH compared to all adults in the general population. Mood and anxiety disorders was found to be the most prevalent mental health disorders, followed by substance use disorders, personality disorder and psychotic disorders, which are also consistent with other previous studies, (Chartier et al., 2018; Hinds et al., 2019; Hinds et al., 2016). It is unsurprising that mental health disorders are significantly higher among women who lived in PH. The current study showed that women who lived in PH are of lower socioeconomic status and are at higher risk for mental health disorders. Poor mental health and poverty is plausibly linked to PH entry and pattern of tenancy, and independent of PH. Hinds et al., (2016) reported that PH residents are low income and often had high burden of chronic physical health and mental health conditions before moving into PH. Poverty is a key determinant of mental health, with people with low incomes more likely to experience mental health disorders (Ridley et al., 2020). Women who live in poverty are more likely to develop

mental health disorders, while women with mental illness are more likely to slide into poverty due to stigma and limited financial resources (Inglis et al., 2023; Ridley et al., 2020). PH serves as a crucial mechanism for providing affordable and stable housing for low-income families, individuals with physical and mental disabilities, and those experiencing adverse life events such as joblessness and homelessness. These individuals are prioritized and have shorter wait times during housing application process, thereby, leading to overrepresentation of residents with low-income, physical and mental health conditions (Fenelon, 2023; Freund et al., 2023; Simning et al., 2011).

Despite these consistent findings, the current study found no statistically significant differences in mental health disorders between those who lived and those who did not live in PH, after adjusting for covariates. I conducted an ancillary analysis to better understand the lack of significant differences in mental health disorder diagnoses between those who lived and did not live in PH. I used a blocked entry of covariates approach, entering the covariates in a sequential manner similar to Finlayson et al., (2013), Chiou et al., (2023) & Mravčík et al., (2020). This helped to 'disentangle' the socioeconomic status of neighbourhoods from the individual-level income as reported by Chartier et al., (2018). Area-level and individual-level income were sequentially added to the model. The analysis showed that individual-level income (receipt of IA) accounted for the differences in diagnostic prevalence of mental health disorders between women who lived and did not live in PH, and not the area-level income where the PH is located.

While Finlayson et al. (2013) did not examine the association between PH and receipt of IA with the diagnosis of mental health disorders, this current study examined this relationship. Specifically, it assessed whether the association between living in PH and being diagnosed with a mental health disorder differed based on receipt of IA. This is achieved by using the interaction

term between receipt of IA and living in PH. The further analysis showed that among women who *receive* IA, living in PH was associated with decreased odds of being diagnosed with a substance use disorder, with no significant associations for diagnostic prevalence of mood and anxiety disorders and any mental health disorders.

Hinds et al., (2016) identified that public housing residents are socioeconomically disadvantaged and rely more on income assistance compared to the general population. The lower odds of substance use disorders found in this study may suggest that income assistance and affordable housing are important and helpful programs that offer individuals a sense of stability; thereby reducing rent burden and mitigating financial stress that contribute to substance use disorders or other mental health disorders, ()highlighting the importance of social support programs in improving mental health outcomes for low-income individuals (Fenelon, 2023; Gold, 2020). Furthermore, the lack of associations for mood and anxiety disorders and any mental health disorders between low-income women who lived and did not live in PH may be explained by findings from some studies that PH residents experience equivalent or better health outcomes compared to other low-income residents not living in PH (Hinds et al., 2018; Smith et al., 2013). Financial and housing stability among residents of PH can significantly improve mental health by reducing anxiety and depression. Studies have showed that low-income residents not living in PH may face adverse health impacts due to stress from navigating less stable and less affordable housing options in the traditional housing market (Baker et al., 2017; Swope & Hernandez, 2019). Housing instability can also reduce financial resources needed for other basic necessities such as food, utilities and healthcare which support improved mental and physical health (Bird et al., 2018; Headen et al., 2022; Sandel & Desmond, 2017) . The current

study findings agreed with Finlayson et al., (2013), indicating that poverty (low income), irrespective of residence in PH, contributed to health and social outcomes.

5.2.2 Predictors of Diagnostic Prevalence of Mental Health Disorders among Women Who did live in PH.

This objective examined the association of the predictors with the pre-existing diagnosis of mental health disorders 5 years before conception among women who lived in PH. The association of the predictors with each mental health disorder are discussed beginning with mood and anxiety disorders as the most prevalent mental health disorders.

Mood & Anxiety Disorders

After adjusting for covariates, women who did live in PH with mood and anxiety disorder diagnosis are more likely to be older, receive IA, be diagnosed with physical comorbidities, living in Prairie Mountain Health, and have a lower likelihood of completing high school. Most of these findings agreed with previous studies which have reported that women with pre-existing mental health disorders are more likely to have low income, lower education levels, and chronic concurrent diseases (Bayrampour et al., 2015; Schofield & Kapoor, 2019; Sudziute et al., 2020, Lancaster et al., 2010; Howard et al., 2014; Abdelhafez et al., 2023; Furtado et al., 2018; Guintivano et al., 2018). Additionally, women in northern and southern regions have lower odds of being diagnosed with mood and anxiety disorders in the regression models. The possible reasons for this finding could be due to limited access to adequate resources and services for identifying and treating mental health disorders (Canadian Institute for Health Information, 2019, Moroz et al., 2020), people with mental health disorders often feel stigmatized, dismissed, and undervalued by health providers, making it difficult to discuss their mental health concerns (Hamilton et al., 2016; Henderson et al., 2024; Knaak et al., 2017; Knaak & Patten, 2016; Maranzan, 2016) or limitations of data in capturing mental health disorders in rural areas of the

province (Chartier et al., 2016, Chartier et al., 2018; Manitoba Health Provincial Information Management and Analytics, 2021). Conversely, the increased odds of mood and anxiety disorders in the Prairie Mountain region may be related to the larger geographical area it covers, and greater availability of mental health services for adults (McPherson et al., 2019; Prairie Mountain Health).

Substance Use disorders

Women who lived in PH with diagnostic prevalence of substance use disorders were more likely to be older, received IA, did not complete high school, have multiple children and have more than one physical health comorbidities. The study found no association with region of residence and area-level income with being diagnosed with substance use disorders. With each successive increase in area-level income, there was a decrease in the diagnostic prevalence of substance use disorder despite the lack of significance for women who lived in PH. These sociodemographic characteristics are similar to the previous studies (Bayrampour et al., 2015; Schofield & Kapoor, 2019; Sudziute et al., 2020, Lancaster et al., 2010, Howard et al., 2014; Brown et al., 2019; Evans et al., 2023). Although the differentiation of substance use types was beyond the scope of this study, it is well-established that pregnant women with SUDs face numerous medical and obstetrical complications depending on the substances involved (Finnegan, 2013; Korhonen et al., 2012; Räisänen et al., 2014; Stein et al., 2023; Prince et al., 2024; Evans et al., 2023).

These women are also less likely to receive adequate prenatal care, obtain necessary nutrition, and are more likely to engage in harmful health behaviors, leading to adverse pregnancy and birth outcomes (Grote et al., 2010; Lin et al., 2020; Finnegan, 2013)). Furthermore, they are at an increased risk of contracting sexually transmitted infections such as HIV, syphilis, and hepatitis C (Public Health Agency of Canada, 2020b; Finnegan, 2013; Ilika et

al., 2015). In addition, the higher odds of physical health conditions among women in PH with SUDs was consistent with other findings. Hinds et al., (2016) & Hinds et al., (2018) reported a high prevalence of chronic physical health conditions among public housing residents, and Brown et al., (2019) reported that women with chronic physicial conditions were at higher risk for susbtance use disorders during the perinatal period. The possible explanations for increased risk of mental health disorders among women with chronic physical conditions are disease manangement stress, hormonal changes and adaptation of motherhood (Brown et al., 2019). The study supports the need to screen all pregnant women for substance use prior to conception and monitoring them postpartum. Early identification of substance use can lead to timely interventions that support both the mother's and the baby's health.

Any Mental Health Disorders

Among women who lived in PH, the fully adjusted model showed that being older, receiving IA, not completing grade 12, having physical health comorbidities, and living in the Prairie Mountain region, were statistically significantly associated with increased odds of being diagnosed with any mental health disorders among women who did live in PH. Decreased odds were found for women in northern and southern regions, possibly due to similar reasons mentioned earlier (Canadian Institute for Health Information, 2019, Moroz et al., 2020, Hamilton et al., 2016; Henderson et al., 2024; Knaak et al., 2017; Knaak & Patten, 2016; Maranzan, 2016), Chartier et al., 2016; Chartier et al., 2018; Manitoba Health Provincial Information Management and Analytics, 2021). The observed increase in odds of any mental health disorders in the Prairie Mountain region could be attributed to the geographical areas that the region covers and increased accessibility to mental health services for adults within the Prairie Mountain health region (McPherson et al., 2019; Prairie Mountain Health).

5.2.3 Comparing Incidence Rates of Mental Health Disorders Between Women Who lived and Women Who did not live in PH

This objective compared incidence rates of mental health disorders whether arising in pregnancy or after birth for women who had a singleton live birth and without pre-existing mental health disorders in both groups.

The crude incidence rates for mood and anxiety disorders, substance use disorders, personality disorders and any mental health disorders were higher among women who lived in PH compared with women who did not live in PH. The only exception to this pattern was seen in psychotic disorders, where the crude incidence rate showed no difference between women who lived and those who did not lived in PH. These findings are also consistent with other previous studies (Chartier et al., 2018; A. Hinds et al., 2019; Simning et al., 2011; Smith et al., 2013).

After adjusting for covariates, differences in the incidence rates of mood and anxiety disorders and any mental health disorders were not significant, while the rates of women who lived in PH having substance use disorders flipped and became lower than the rates for women who did not live in PH. I also conducted an ancillary analysis to better understand the lack of or decreased significant differences in the incidence rates of mental health disorder diagnoses between those who lived and did not live in PH. I used a blocked entry of covariates approach, entering the covariates in a sequential manner similar to Finlayson et al., (2013) & Mravčík et al., (2020). The demographic characteristics, area-level and individual-level income were sequentially added to the model. The results indicated that individual-level income (receipt of IA) accounted for the differences in the incidence rates of mood and anxiety disorders, substance use disorders and any mental health disorders between women who lived and those who did not live in PH. This finding suggested that poverty, rather than the location or residency in public housing, is the contributing factor influencing mental health outcomes

5.2.4 Incidence Rates of Mental Health Disorders Between Women Who lived in PH and those who did not, by Time Period

During pregnancy, the incident rates of mood and anxiety disorders, substance use disorders and any mental health disorders were higher for women who lived in PH compared with women who did not live in PH. These findings are congruent with other literature (Chartier et al., 2018; A. Hinds et al., 2019; Simning et al., 2011; Smith et al., 2013). However, the differences in the incidence rates were attenuated in the fully adjusted model and there were no statistically significant associations between women who lived and did not live in PH.

After birth, the incident rates of mood and anxiety disorders, substance use disorder, and any mental health disorders were higher for women who lived in PH compared with women who did not live in PH (Chartier et al., 2018; A. Hinds et al., 2019; Simning et al., 2011; Smith et al., 2013). Despite the increased rates of mental health disorders, I found no associations between the two groups in the unadjusted model. However, in the fully adjusted model, the association between PH and substance use disorder was statistically significant, with women who lived in PH having lower rates of substance use disorder after birth compared with women who did not live not in PH.

The findings showed that women who lived in PH are more likely to be diagnosed with mental health disorders during pregnancy and after birth compared with women who did not live in PH. These differences in incidence rates of mental health disorders were attenuated and were not statistically significant between those who lived and did not live in PH with the exception of substance use disorder after birth after adjusting for the covariates. Even though, residents of PH are socioeconomically disadvantaged and more likely to have physical and mental comorbidities, previous studies reported that the health of PH residents are better than the low-income residents

in other housing options (Hinds et al., 2019; Hinds et al., 2018; Smith et al., 2013). The provision of affordable housing and income assistance to the PH residents are important mechanisms that alleviate the financial stress and housing instability that other low-income people not living in PH encountered, thereby reducing the risk of being diagnosed with mental health disorders and improving the overall maternal mental and physical wellbeing (Baker et al., 2013; Fenelon, 2023; Freund et al., 2023; Gold, 2020; Headen et al., 2022; Sandel & Desmond, 2017; Swope & Hernández, 2019; Bird et al., 2018). The study showed that poverty as measured by the receipt of IA was the most significant predictor that explained the differences in the rates of mental health disorders between women who lived and did not live in PH.

5.2.5 Incidence Rates of Mental Health Disorders by Time Period Among Women Who Did Live and Did Not Live in PH

Incidence rates of mental health disorders (mood and anxiety, substance use and any mental health disorders) were significantly higher postpartum than during pregnancy for women who lived in PH and women who did not live in PH. Among women who lived in PH, no statistically significant associations were found between the pregnancy and postpartum periods for rates of mood and anxiety disorders and any mental health disorders but there was a significant association in the rate of substance use disorder. For women who did not live in PH, significance differences were found between the two periods for the rates of all mental health disorders. These findings were consistent with previous studies that examined the trajectory of mental health disorders before conception, during pregnancy, and after birth. Dietz et al. (2007) were among the first to clinically identify maternal depression before, during, and after pregnancies culminating in live births, reporting a higher prevalence of depression in the postpartum period compared to the preconception and pregnancy stages. Similarly, Vesga-López et al., (2008) examined the prevalence of psychiatric disorders, including substance use and

mood disorders, across these stages and found an increased likelihood of mental health disorders during the postpartum period relative to during pregnancy. Further supporting these findings, a study conducted in Manitoba reported that during the perinatal period, the pregnancy stage was associated with a lower incidence of diagnosed mood or anxiety disorders, substance use disorders, psychotic disorders, and suicide attempts compared to the postpartum period (Mota et al., 2019). Molenaar et al., (2022) also observed that inpatient admission rates for both first-time and recurrent depressive disorders were lower during pregnancy compared to the preconception and postpartum periods. These findings are quite congruent with this current study that reported similar rate of newly physician-diagnosed mental health disorders arising during pregnancy and after birth.

The current study identified a significant increase in the diagnosis of substance use disorder during postpartum for women who lived and did not live in PH compared with during pregnancy. The lower rates of substance use during the pregnancy period may be due to most women who use alcohol and substances considered pregnancy as a strong motivator to quit or reduce their use during pregnancy (Balogun et al., 2021; Mota et al., 2019; Prince et al., 2024; Forray et al., 2016) and possibly resume substance use in the postpartum period (Mota et al., 2019; Forray et al., 2016)). In addition, stigma related to mental health disorders can hinder women's willingness to disclose or seek help and receive appropriate care during pregnancy (Garapati et al., 2023; Martin & Parlier-ahmad, 2021; Gopman, 2014; Oni et al., 2022; Prince et al., 2024), fear of child apprehension by child welfare services (Balogun et al., 2021; Finnegan, 2013; Gopman, 2014; Mota et al., 2019; Oni et al., 2022; Elms et al., 2018), lack of information about and access to specific treatment programs during pregnancy (Balogun et al., 2021; Gopman, 2014; Prince et al., 2024), long wait times associated with treatment facilities (Coombs et al., 2021; Elms et al., 2018), and lack of transportation and childcare (Gopman, 2014) thereby

preventing the diagnostic process during pregnancy. Also, women can be highly vulnerable to various mental health disorders during postpartum period due to the physical, emotional and psychological changes. The postpartum increase of mental health disorder diagnosis may suggest that these disorders begin to rise after birth due to genetic predisposition, hormonal changes, traumatic event of labour and delivery, sleep deprivation, adjustment to motherhood, and infant care (Brown et al., 2019; Mota et al., 2019; Rai et al., 2015; Aber et al., 2013).

5.3 The Impact of Poverty, Public Housing, and Pregnancy on Mental Health: Exploring the Interconnections and Implications for Low-Income Women

The relationship between pregnancy, housing, and mental health disorders is plausibly connected. Housing and income are key social determinants that significantly impact mental health especially among the low-income population (Martens et al., 2014; World Health Organization. & Foundation, 2014; MacKay & Wellner, 2013). Studies showed that poverty and mental health have a complex, bidirectional relationship; poor mental health can increase the risk of falling into poverty while poverty is a significant risk factor for poor mental health (Inglis et al., 2023; Ridley et al., 2020). The present study found that living in public housing (PH) was not a significant predictor of mental health disorders, when other factors were considered. However, income assistance, a measure of poverty, greatly impacts the mental health of low-income women in both PH and other housing options. The study confirmed that a significant percentage of women living in PH are in poverty and are at the highest risk of developing new or exacerbating existing mental health disorders.

Similarly, pregnancy and childbirth are significant life events that shape health outcomes throughout an individual's life. The physical and psychological effects of pregnancy and childbirth can induce mental health disorders, putting mother and their children at risk of adverse

negative health outcomes (Finnegan, 2013; Garapati et al., 2023; Grote et al., 2010; Katz et al., 2018; Rai et al., 2015; Stein et al., 2014; Wall-Wieler et al., 2020; Abdelhafez et al., 2023; Furtado et al., 2018; Guintivano et al., 2018). Furthermore, poverty and pregnancy have been linked to maternal and child negative health outcomes (Katz et al., 2018; Roos et al., 2019; Yang-Huang et al., 2021; Grote et al., 2010; Lin et al., 2020). Given these findings, PH can be considered as a protector factor for low-income pregnant women with mental health disorders, as it provides housing stability and affordability, reduces financial stress and potentially lowers the exacerbation of mental health disorders. However, provision of stable and affordable housing may not always be sufficient for pregnant women with low incomes as they experience multiple unmet needs. Therefore, addressing the multifaceted factors contributing to mental health disorders among low-income pregnant women requires a holistic approach that includes targeted interventions and policy changes aimed at improving mental health outcomes in this vulnerable population.

5.4 Knowledge Gap Filled

While other studies have examined mental health disorders among PH residents, this is the first to use population-based data to examine the prevalence and incidence of mental health disorders among pregnant women who lived in PH before conception, during pregnancy and after birth. The most significant study finding is that among women who *receive* IA, women who lived in PH have lower odds and rates of substance use disorders when compared with women who did not live in PH. The study also confirmed that poverty, rather than the location of public housing based on area-level income, was found to be an important contributing factor to most of the observed differences in the prevalences and incidences of mental health disorders among women who lived in PH and those who did not, before conception, during pregnancy and postpartum period.

5.5 Strengths and Limitations of The Study

5.5.1 Strength of the Study

The major strength of this study was the use of the Manitoba Population Research Data Repository that captures all residents of Manitoba who are covered by the Manitoba Health Services Insurance Plan, which provides ability to link whole-population administrative datasets to identify a large population-based cohort of individuals. A second strength was that the study relied on health administrative data which include all records of physician-diagnosed mental health disorders and the ability to link multiple databases to identify the cohorts. This means that the study was not subject to recall and respondent bias as would have been in a study dependent on self-reported mental health. A third strength was the ability of the hospital abstract data to capture all pregnant women having hospital births.

5.5.2 Limitation of the Study

However, the study had some limitations. First, I only identified PH residents when a pregnant woman is living in a unit directly owned and managed by the provincial government under Manitoba Housing. Many other social housing programs are not directly managed by the government, but rather by cooperatives, non-profit organizations, and property management agencies. Because Manitoba Housing does not directly manage these housing units, individual-level data are not available to them, nor to MCHP; these records are maintained by the organization that manages the units (Finlayson et al., 2013; A. Hinds et al., 2019, 2020). The inability to capture pregnant women who live in affordable housing units, receive subsidies and support from the government under Manitoba Housing may have underestimated the prevalence, incidence of mental health disorders and potentially weakened the association found in this study.

Second, relying on administrative data to measure mental health disorders means that it is likely the study could have underestimated the true prevalence and incidence rate of mental health disorders; this was because I was limited to mental health disorders where the pregnant woman had a mental health contact with a physician or nurse practitioners (Chartier et al., 2018). There was no access to diagnoses, treatments or services provided by non-physicians such as psychologists, social workers, and counsellors. Also, the study did not capture pregnant women who meet standard diagnostic criteria for a mental health disorder but did not receive a relevant diagnostic code or who experienced mental health disorders but did not seek treatment. This limitation could underestimate the prevalence and the incidence rates of mental health disorders in the study cohort. Third, the study did not include women who moved in or moved out of PH while pregnant. Therefore, the prevalence and incidence of mental health disorders among women who lived in PH may be underestimated.

A fourth limitation was that I lack individual-level information on pregnant women's income. As a result of this limitation using an area-level measure which may result in misclassification (e.g., identifying a pregnant woman as low income based on where she lives when she may not be low income); this misclassification may bias results towards the null. To mitigate the impact of this, I included individual-level data on whether the pregnant woman received income assistance in addition to area-based household income.

5.6 Future Direction

This study did not examine the effect of fetal loss on the incidence of mental health disorders among women living in PH; this is an area where the literature is limited. Pregnancy loss is considered a risk factor for developing mental health problems (Cuenca, 2022; Demontigny et al., 2020; Strumpf et al., 2022), therefore, future research should consider examining the onset of mental health disorders in women living in PH following fetal loss,

including spontaneous and elective abortion. It is highly necessary to identify women who may be at risk of mental health problems, understand their psychological needs and to provide relevant services for them.

This study was limited to residents of public housing owned and managed by Manitoba Housing due to the absence of individual-level data on residents of other forms of social housing, such as those managed by cooperative and non-profit organizations. This study also observed a significant decline in the number of housing units managed by Manitoba Housing due to privatization and transferring public housing to private and non-profit sectors (Bernas et al., 2023; Cooper, 2018), contrary to what previous studies reported (Finlayson et al., 2013 & Hinds et al., 2018). As of September 2021, Manitoba Housing transferred the management of 1,511 social housing units to the community housing sector through Community-Based Service Delivery (MB Housing Annual report, 2022). Manitoba Housing does not directly manage these housing units, but often pays rent subsidies to private landlords for low-income tenants living in other forms of public housing. However, data are available for low-income individuals receiving rental subsidies to reside in private housing. These individuals may continuously face financial hardship in meeting other basic necessitates which can cause undue stress and impact their mental health. Future research needs to compare the social and health outcomes of public housing residents with those of low-income individuals receiving rental subsidies.

The study likely underestimated the prevalence and incidence of mental health disorders among the study cohort due to the current practice of capturing only diagnoses made by physicians or nurse practitioners. To ensure comprehensive record of all mental health disorders, including those diagnosed by non-physicians, future research should endeavour to develop a method to access the clinical text documentations by the non-physicians, thereby enhancing identification of these diagnoses for both administrative and research purposes.

5.7 Policy Recommendations

Growing evidence connects economic inequality and poor mental health. This study contributes to the heightening public awareness about the highest risk of common mental health disorders among women living in public housing (PH) and receiving income assistance (IA) in Manitoba. Women who live in poverty are more likely to develop mental illness, while women with mental illness are more likely to slide into poverty. It shows that residents of Manitoba public housing face numerous social, economic, and health challenges, with financial instability being a significant risk factor for mental health disorders, particularly during pregnancy and the postpartum period. As recommended by Finlayson et al. (2013), the Manitoba government should develop, maintain, and promote a comprehensive list of social, economic, and other related programs and services to increase awareness and accessibility for individuals in social housing and on low incomes. Women receiving IA may have limited access to mental health services and other resources, emphasizing the need for collaboration among public housing providers, health authorities, and the Manitoba government to ensure these women are informed about available support programs and services. This can enhance access to integrated mental health and social care services, improving mental health and overall well-being of women and their families. The study also underscores the importance of policies and programs that address income and health inequities, support pregnant women in PH, and prevent future health issues for their children. Additionally, it highlights regional disparities in the diagnosis of mental health disorders among pregnant women in PH in the southern and northern regions, suggesting the implementation of targeted mental health resources and stigma reduction programs in these areas.

The current study supports previous research indicating that women are more at risk for mental health disorders during the postpartum period than during pregnancy. Pregnancy and the postpartum period are considered sensitive times with increased vulnerability to mental health

disorders. Given the known devastating consequences of mental health disorders on maternal and child health outcomes, these findings advocate for a holistic approach to prenatal and postnatal care for women of childbearing age. Pregnancy period can offer a unique possibility to detect and intervene in the case of mental health disorders; this study underscores the need for targeted mental health screening and appropriate intervention program for women, ensuring early detection and support during the perinatal period. These findings underscore the critical importance of ensuring that healthcare providers working with pregnant and postpartum women are thoroughly trained to screen for and identify mental health disorders during both prenatal and postnatal visits. Moreover, it is essential that these providers facilitate prompt referrals to appropriate health and social services, thereby enabling timely interventions aimed at improving both maternal and fetal health outcomes. Therefore, addressing maternal mental health needs has positive implications for the well-being of women, their children and families, as well as their wider communities and society.

5.8 Conclusion

This study contributes to the body of evidence by examining the prevalence and incidence of mental health disorders among pregnant women who lived in PH. The study found higher prevalences and incidences of mental health disorders among women who lived in PH compared with those who did not live in PH in the unadjusted model. However, after adjusting for covariates, particularly the receipt of income assistance (IA), poverty emerged as the most significant predictor for being diagnosed with mental health disorders within this population. This study highlights the critical importance of addressing income inequities among residents of public housing with limited financial resources to enhance their health and social outcomes. Effort to improve the health and social well-being of low-income individuals benefit society as a

whole, which results in a decrease in health-care expenditure, an increase in health-related quality of life and an improvement in economic productivity.

5.9 Knowledge Translation

Part of the requirement for the use of data in the Repository is to share research findings with data providers. First of all, findings from this study will be shared with the program administrators including, Manitoba Health, Regional Health Authorities, health care administrators, Manitoba Families, Manitoba Education and Early Childhood Learning, and community organizations. Discussions with these sectors will help determine if the findings of the study can be used to inform future investments for programing, services and support systems aimed at improving the health and well-being of pregnant women living in PH. I will use valuable tools such as infographics and newsletters through social media accounts and websites of relevant organizations to communicate research findings to broader audiences. I will work with partnering organizations to organize workshops and presentations to increase the general public's awareness of research findings and their implications. I will also share my findings with the broader academic community by publishing my findings in peer-reviewed journals and presenting my work at conferences such as Mental Health for All (MH4A) Conference by the Canadian Mental Health Association.

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Appendices

Appendix I: Mental Health Disorders Definitions

Indicators	Definitions
Mood & Anxiety Disorders	• One or more hospitalizations with a diagnosis of depressive disorder, affective psychoses, neurotic depression, adjustment reaction or bipolar disorder; OR • One or more hospitalizations with a diagnosis for an anxiety disorder, phobic disorder or obsessive-compulsive; (ICD-10-CA codes F30-34, F38, F40, F41, F41.1-41.3, F41.8-9, F42-43, F53); OR • One or more physician visits with a diagnosis of depressive disorder, affective psychoses, adjustment reaction or anxiety disorders with the ICD 9th revision Clinical Modification (ICD-9-CM diagnosis code 296, 311, 309, 300); AND • One or more prescriptions of an antidepressant or mood stabilizer (ATC codes N03AB02, N03AB52, N03AF01, N05AN01, N05BA, N06A)
Substance Use Disorders	• One or more hospitalization with a diagnosis for alcohol or drug-induced psychosis, alcohol or drug dependence, or nondependent abuse of drugs (ICD-10-CA diagnosis code F10-F19, F55, Z50.2, Z50.3); OR • One or more physician visit with a diagnosis for alcohol or drug-induced psychoses, alcohol or drug dependence, or non-dependent abuse of drugs (ICD-9-CM diagnosis code 291, 292, 303, 304, 305).
Personality disorder	• At least one hospitalization with a diagnosis for a personality disorder (ICD-10-CA code F21, F60-62, F69); OR • At least one physician visit with a diagnosis for a personality disorder (ICD-9-CM code of 301).
Psychotic disorder	• At least one hospitalization with a diagnosis of a psychotic disorder (ICD-10-CA code F11.5, F12.5, F13.5, F14.5, F15.5, F16.5, F18.5, F19.5, F20, F 22-25, F28-29); OR • At least one physician visit with a diagnosis of a psychotic (ICD-9-CM code of 295, 297, 298).
Any Mental Health Disorder	• As having at least one code for any mental health disorders that the study examined.

Appendix II: Unadjusted Odds Ratio, Adjusted Odd Ratios (OR) of Diagnostic Prevalence of Mental Health Disorders Between Women Who Did Live in PH and Their Comparison, by Receipt of Income Assistance

Predictors (PH and receipt of IA)				**Any mental health Disorder**		**Mood & Anxiety Disorder**		**Substance use disorder**	
Women residing in PH	**Receipt of IA**	**Women residing in PH**	**Receipt of IA**	**OR (95% CI) ***	**aOR (95% CI) ****	**OR (95% CI) ***	**aOR (95% CI) ****	**OR (95% CI) ***	**aOR (95% CI) ****
Yes	Yes	Yes	No	**1.63 (1.31-2.04)**	**1.50 (1.20-1.88)**	**1.66 (1.32-2.07)**	**1.51 (1.20-1.90)**	**1.83 (1.22-2.73)**	**1.78 (1.18-2.68)**
Yes	Yes	No	Yes	0.94 (0.85-1.05)	0.92 (0.83-1.03)	0.95 (0.85-1.05)	0.93 (0.83-1.04)	**0.83 (0.70-0.97)**	**0.78 (0.66-0.92)**
Yes	Yes	No	No	**2.65 (2.41-2.91)**	**2.52 (2.29-2.78)**	**2.48 (2.26-2.72)**	**2.43 (2.20-2.69)**	**4.38 (3.79-5.07)**	**2.94 (2.51-3.44)**
Yes	No	No	Yes	**0.58 (0.47-0.71)**	**0.62 (0.50-0.76)**	**0.57 (0.46-0.71)**	**0.62 (0.50-0.77)**	**0.45 (0.31-0.66)**	**0.44 (0.30-0.65)**
Yes	No	No	No	**1.62 (1.33-1.99)**	**1.68 (1.37-2.07)**	**1.49 (1.22-1.84)**	**1.61 (1.31-1.99)**	**2.40 (1.64-3.51)**	**1.65 (1.12-2.43)**
No	Yes	No	No	**2.82 (2.65-2.99)**	**2.73 (2.56-2.91)**	**2.62 (2.47-2.78)**	**2.62 (2.45-2.79)**	**5.31 (4.84-5.83)**	**3.77 (3.40-4.19)**

Bolded values are statistically significant at $\alpha = .05$
Note: Any mental health disorders include the following disorders: Mood & anxiety, substance use, personality and psychotic disorders.
* Unadjusted ORs for interaction between housing and receipt of IA are derived from Logistic Regression models
**Adjusted for covariates for interaction between housing and receipt of IA.

Appendix III: Unadjusted Rate Ratio, Adjusted Rate Ratios (RR) of Incident Rates of Mental Health Disorders Between Women Who Did Live in PH and Their Comparison, Stratified by Receipt of Income Assistance

Predictors (PH by receipt of IA)				**Any mental health Disorder**		**Mood & Anxiety Disorder**		**Substance use disorder**	
Women residing in PH	**Receipt of IA**	**Women residing in PH**	**Receipt of IA**	**RR (95% CI)**	**aRR (95% CI)**	**RR (95% CI)**	**aRR (95% CI)**	**RR (95% CI)**	**aRR (95% CI)**
Yes	Yes	Yes	No	**1.55 (1.12-2.15)**	**1.59 (1.16-2.20)**	**1.52 (1.10-2.09)**	**1.56 (1.14-2.14)**	**3.87 (1.72-8.7)**	**3.41 (1.56-7.45)**
Yes	Yes	No	Yes	**0.81 (0.67-0.98)**	0.88 (0.73-1.05)	0.90 (0.74-1.08)	0.97 (0.81-1.16)	**0.64 (0.46-0.90)**	**0.61 (0.46-0.81)**
Yes	Yes	No	No	**1.48 (1.25-1.76)**	**1.58 (1.34-1.88)**	**1.49 (1.26-1.76)**	**1.64 (1.39-1.94)**	**3.40 (2.49-4.62)**	**2.69 (2.04-3.55)**
Yes	No	No	Yes	**0.52 (0.38-0.69)**	**0.53 (0.41-0.73)**	**0.59 (0.44-0.79)**	**0.62 (0.46-0.83)**	**0.17 (0.08-0.36)**	**0.18 (0.08-0.38)**
Yes	No	No	No	0.95 (0.71-1.26)	0.99 (0.75-1.32)	0.98 (0.74-1.30)	1.05 (0.80-1.39)	0.88 (0.40-1.89)	0.79 (0.37-1.67)
No	Yes	No	No	**1.83 (1.65-2.04)**	**1.82 (1.64-2.02)**	**1.67 (1.50-1.86)**	**1.70 (1.53-1.89)**	**5.28 (4.32-6.46)**	**4.38 (3.66-5.26)**

Bolded values are statistically significant at $\alpha = .05$.
Note: Any mental health disorders include the following disorders: Mood & anxiety, substance use, personality and psychotic disorders.
Unadjusted RRs for interaction between housing and receipt of IA are derived from Negative Binomial Regression models
Adjusted for covariates for interaction between housing and receipt of IA.

Appendix IV: Unadjusted and Adjusted Rate Ratios (RR) of Mental Health Disorders between Women Who Did Live in PH and Their Comparison across Time period

Predictors (PH by Time Period)				**Any mental health Disorder**		**Mood & Anxiety Disorder**		**Substance use disorder**	
Women residing in PH	**Time Period**	**Women residing in PH**	**Time Period**	**RR (95% CI)**	**aRR (95% CI)**	**RR (95% CI)**	**aRR (95% CI)**	**RR (95% CI)**	**aRR (95% CI)**
Yes	After Birth	Yes	During pregnancy	1.09 (0.82-1.45)	1.10 (0.84-1.45)	1.07 (0.81-1.41)	1.08 (0.82-1.41)	**1.99 (1.15-3.45)**	**1.94 (1.19-3.17)**
Yes	After Birth	No	After Birth	1.16 (0.94-1.42)	0.89 (0.72-1.09)	1.21 (0.99-1.48)	0.98 (0.80-1.20)	1.35 (0.94-1.92)	**0.58 (0.42-0.79)**
Yes	After Birth	No	During pregnancy	**1.37 (1.11-1.68)**	1.02 (0.83-1.25)	**1.35 (1.10-1.65)**	1.07 (0.87-1.31)	**4.07 (2.79-5.95)**	**1.49 (1.07-2.08)**
Yes	During pregnancy	No	After Birth	1.06 (0.86-1.31)	**0.80 (0.65-0.99)**	1.13 (0.92-1.40)	0.92 (0.74-1.13)	0.68 (0.43-1.07)	**0.30 (0.19-0.45)**
Yes	During pregnancy	No	During pregnancy	**1.26 (1.01-1.53**)	0.91 (0.74-1.13)	**1.27 (1.03-1.56)**	1.00 (0.80-1.23)	**2.04 (1.27-3.30)**	0.77 (0.50-1.18)
No	After Birth	No	During pregnancy	**1.18 (1.09-1.28)**	**1.14 (1.08-1.22)**	**1.11 (1.03-1.20)**	**1.09 (1.02-1.16)**	**3.02 (2.42-3.77)**	**2.59 (2.20-3.05)**

Frequencies expressed as n (%)
Bolded values are statistically significant at $\alpha = .05$.
*RR: Rate Ratios with 95% CI (Confidence Intervals) for interaction between housing and time periods are derived from Negative Binomial Regression models
*aRR: Adjusted Rate Ratios with 95% CI (Confidence Intervals) for covariates for interaction between housing and time periods
Note: Any mental health disorders include the following disorders: Mood & anxiety, substance use, personality and psychotic disorders.
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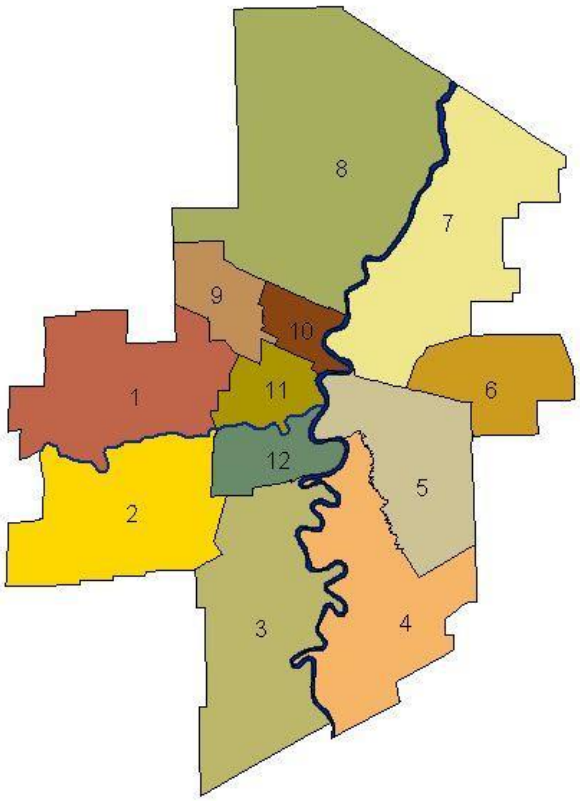

1 - St. James-Assiniboia
2 - Assiniboine South
3 - Fort Garry
4 - St. Vital
5 - St. Boniface
6 - Transcona
7 - River East (includes East St. Paul)
8 - Seven Oaks (includes West St. Paul)
9 - Inkster
10 - Point Douglas
11 - Downtown
12 - River Heights

Figure 4: Winnipeg Community Areas Boundaries

Figure 5: Manitoba Health Regions

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