Urban Aboriginal Health Counts: Barriers to Access to Health Services and their Relationship with Cardiovascular Disease and Hypertension in an Urban First Nations Population

Robert Abtan

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Abstract

Background: Hypertension and cardiovascular disease (CVD) contribute to morbidity and mortality among First Nations peoples. Despite increased urbanization of this group, there is little data on the health of this community in an urban environment.

Objective: To examine the association between barriers to access to health services and the prevalence of hypertension and CVD in an urban First Nations population.

Methods: Data were obtained from the Our Health Counts survey, which used Respondent-Driven Sampling, a chain-referral sampling technique. Analysis was done using newly proposed, modified multivariable logistic regression models.

Results: The prevalence of hypertension in this urban First Nations population was associated with poor access to both traditional and conventional health services. CVD was associated with housing conditions and poor diet.

Conclusion: Given the importance of access to conventional and traditional care, and housing variables, a holistic, culturally appropriate perspective may be important for maintaining cardiac health in this community.

Keywords: Respondent-Driven Sampling, Multivariable Methods, Cardiovascular Disease, Hypertension, First Nations, Indigenous, Aboriginal, Regression, Health Access, Community-Based Research

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Note: Although this thesis has been vetted by the *De dwa da dehs nye>s* Aboriginal Health Access Centre (DAHAC), the opinions in this thesis do not necessarily reflect those of the DAHAC and the DAHAC reserves the right to their own additional interpretations of this work and analyses.

Table of Contents

List of Tables

List of Figures

List of Abbreviations

Term	Abbreviation
Cardiovascular Disease	CVD
Our Health Counts	OHC
Respondent-Driven Sampling	RDS
Body Mass Index	BMI
Non-Insured Health Benefits	NIHB
National Household Survey	NHS
First Nations Regional Longitudinal Health Survey	RHS
Aboriginal Peoples Survey	APS
Canadian Community Health Survey	CCHS
Urban Aboriginal People's Survey	UAPS
Urban Aboriginal Health Center	UAHC
Socioeconomic Status	SES
Generalized Linear Model	GLM
Generalized Linear Mixed Models	GLMM
Autoregressive Moving-Average Error Processes	ARMA
Autoregressive	AR
Primary Care Provider	PCP
Ownership, Control, Access, Possession	OCAP
Odds Ratio	OR
Confidence Interval	CI

Chapter 1: Introduction

Indigenous peoples in Canada experience a disproportionate burden of adverse health outcomes such as hypertension, cardiovascular disease (CVD), and metabolic disorders, in comparison to the non-Indigenous population (1-8). In particular, cardiac conditions, such as hypertension and CVD, are common problems, which continue to contribute to elevated morbidity and mortality within this group (4-9). According to the 2012 APS, 15% of the off-reserve First Nations population reported high blood pressure, making it one of the most common conditions in this group (10). The Heart Research Institute (9) reported that Indigenous peoples are 1.5 to 2 times more likely to develop heart disease as compared to the general Canadian population. Furthermore, it has been suggested that the burden of morbidity and mortality experienced by the Indigenous population in Canada from CVD and hypertension is actually increasing (1). The health disparities observed in this group may be influenced by social, economic, and political inequities this population has experienced historically and continues to experience today (7, 11). In recent years, the Indigenous population in Canada, which includes First Nations peoples, has become increasingly urbanized, with more than half of the population living in urban cities and towns (2, 12-15). Despite this migration, there is a lack of health research on urban First Nations peoples as compared to the First Nations population living on reserves (2, 14, 16). This is significant, as it has been suggested that health inequalities and risk factors affecting Indigenous peoples living in rural areas and First Nations peoples living on reserves are also prevalent among Indigenous peoples living in urban areas (14).

Transitioning to urban areas can introduce new challenges for Indigenous residents, particularly with respect to locating appropriate traditional and conventional health services (2, 14). According to the Urban Aboriginal People's Survey (UAPS), which captures data on urban Indigenous peoples throughout Canada, 72% of Indigenous residents of urban areas considered access to traditional healing practices to be as important, or more important than mainstream care (2). However, only 30% had "very easy" access to it (2). It has also been reported that urban Indigenous peoples may have trouble interfacing with the health care system (2, 8). Examples of this have included Indigenous residents experiencing problems finding specialty services, as well as reporting a lower than average frequency of seeing a doctor as compared to their non-Indigenous counterparts (2, 8).

Other barriers experienced by urban Indigenous peoples have included low socioeconomic status, lack of culturally safe care, discrimination, lack of financial and transportation support, housing vulnerability and homelessness, and isolation from their social and cultural support networks (2, 17, 18). In this study, challenges First Nations peoples could face in an urban environment in regards to accessing health care were classified as "barriers to access to health services". A total of four overarching barriers were identified: Access to health services, access to food and nutrition, housing and mobility, and socioeconomic status (SES). Each barrier, with the exception of SES, was multi-faceted and divided into a number of individual variables.

To examine disparities in this population, the study used data from the Our Health Counts (OHC) research study, which contained health and demographic variables on an urban First Nations population from Hamilton, Ontario. This study was completed in partnership with the *De dwa da dehs nye>s* Aboriginal Health Access Centre in Hamilton, ON which maintains ownership and control of the data and leant them to the research team for study purposes. Moreover, the *De dwa da dehs nye>s* Aboriginal Health Access Centre developed these research questions, oversees interpretation of study results and are equal partners in all aspects of this research study. This relationship is formalized in the Research Agreement in the Our Health Counts Community Report (19, Appendix A). Data were obtained using Respondent-Driven Sampling (RDS), a novel chain-referral sampling technique for sampling difficult, hard to reach populations (14, 20). Moreover, as there is no clear statistical approach for the multivariable analysis of RDS data, this study serves as an illustrative example of two potential methods for the analysis of this data type. The objectives of this study were thus two-fold:

1. To explore the impact of barriers to access to health services on the prevalence of both CVD and hypertension in an urban First Nations population.
2. To further explore the use and validity of regression models for the RDS sampling method.

Chapter 2: Literature Review

2.1 Indigenous Peoples in Canada

Indigenous Peoples in Canada are the descendants of the original inhabitants of Canada, before the arrival of European explorers (21). The Constitution act of 1982 officially recognized the three main indigenous groups: Indians[1], Inuit, and Métis peoples (2, 21, 22). In this study, the term "Indigenous" refers to all those who self-identify into one of the three main groups. In 2011, the National Household Survey (NHS) reported that the population of Indigenous peoples in Canada was approximately 1.4 million (22-24). Of those who completed the survey, 60.8% self-identified as a First Nations person, 32.3% identified as a Métis person and 4.2% identified as an Inuit person (22, 21). The NHS has limitations with respect to non-response bias and being underpowered (25). The response rate of the 2011 NHS was 68.6% compared to 93.5 % for the 2006 Long-Form census (25). There were also issues with data quality arising from an underestimation of health and social disadvantage among Indigenous peoples, such as missing homeless individuals or the highly transient (25). The use of data suppression also raised concerns, as there was no Indigenous profile for small Indigenous populations, such as those with an "Aboriginal identity" population of less than 250 people. Another limitation was that 36 reserves were incompletely enumerated in the 2011 NHS survey, which may have impacted the total population estimate (22, 25).

Health data on urban Indigenous peoples is scarce, out-of date, and often not longitudinal (2). There exists valid sampling frames for surveying populations on reserves, such as for the First Nations Regional Longitudinal Health Survey (RHS), but sampling frames for Indigenous

[1]The Constitution act uses the term "Indians" to refer to First Nations and non-status Indians.

peoples living in urban areas are not as well established (26). The RHS is notable for being a national-level survey coordinated and governed by regional and national First Nations organizations and representatives (27).

One of the main sources of data on social and economic conditions, and health status, among off-reserve Indigenous peoples is the Aboriginal Peoples Survey (APS) (2, 26). It has been administered by Statistics Canada in 1991, 2001, 2006, and 2012. The Canadian Community Health Survey (CCHS) is another commonly used source for identifying urban Indigenous peoples, as it captures information on the health status of Canadians, excluding residents living on reserves and in certain remote areas (26). Unlike the APS, the CCHS did not make distinctions between the three types of Indigenous peoples of Canada. Another challenge of the CCHS is that estimates based on the Indigenous sample are vastly underpowered, which reduces the researcher's ability for meaningful city specific disaggregation (25, 26). A limitation of both surveys was that the term "off-reserve" did not distinguish between Indigenous people living in rural and remote areas from urban areas (26). A further challenge of Indigenous data is that the operational definition for identifying as an Indigenous person may differ between surveys, such as between the APS and the CCHS (2, 26).

2.2 Urbanization of Indigenous Peoples in Canada

The Indigenous population in Canada, which includes First Nations peoples, has become increasingly urbanized in recent years (2, 14). Newhouse (11) reported that 49% of self-identified Indigenous people lived in urban areas in 2001, up from 7% as was reported in the 1951 Census of Canada. This increase has been echoed by multiple studies, which have reported that more than half of self-identifying Indigenous people in Canada now live in urban cities and

towns (2, 12-15, 22, 28). A). The 2011 NHS survey (22) reported that the largest First Nations population (23.6%) resided in Ontario. However, as mentioned earlier, this may have been an underestimate as the NHS survey has suffered problems from non-response bias and being underpowered (22, 25).

The rapid growth of the urban Indigenous population has been attributed to natural increase, migration, and especially ethnic mobility (11, 12, 28). Natural increase cannot solely explain the explosive growth observed in this population. From 1996 to 2001, the fertility rate for all First Nations women in Canada was 2.9 children, as compared to 1.5 children among non-First Nations women (29). However, the Canadian Census of Population reported that, between 1996 and 2006, the growth rate for urban Indigenous peoples occasionally exceeded that of 5.5% per year, which is considered the theoretical maximum growth rate of populations subject only to births and deaths (30). Urban migration of Indigenous peoples is often driven by familial factors, education and employment opportunities, and housing options (11,12). However, this does not adequately address this population's growth, as the 1996 and 2001 census found that more people were moving to rather than from reserves (30). This movement to reserves may have been influenced by the prospect of increased social and family support, and the availability of culturally appropriate activities (4, 11). In addition, city housing was often very expensive, forcing Indigenous peoples to live in impoverished areas (4, 11). Further challenges faced by Indigenous peoples in urban areas have included substance abuse, discrimination, theft, poverty, difficulty finding support services to help with the transition, and challenges to establishing and practicing their culture in this new environment (4, 11, 14).

Another potential contributor to this is "ethnic mobility", which is defined by changes in self-identified ethnic origin and identity from one census to another. This occurs in two primary ways (11, 30). The first, intergenerational ethnic mobility, occurs when children of at least one Indigenous parent are identified as being part of the ethnic group in question. The second, intragenerational ethnic mobility, results from an individual's change in ethnic self-identity over time. Between 1986 and 1996, the second type was responsible for 41% of First Nations peoples' population growth (11). In addition, 59,000 more individuals self-identified as a First Nations person living off reserve in the 2006 census as compared to the 1996 census (30). Factors influencing ethnic mobility may have included children with multi-cultural backgrounds having their choice of ethnicity, increased social awareness, and positive public perceptions of Indigenous peoples (11, 30). Another contributing factor is legislative action such as Bill C-31, which amended the Indian act in 1985, facilitating the reinstatement of Indigenous Status to those who lost it (10, 31).

2.3 A Summary of Health Inequities Endured by Indigenous Peoples in Canada

The underlying causes of health disparities among Indigenous peoples in Canada are colonization and historically poor relations with the nation-state (7, 11). The creation of reserves in remote regions, the resettlement of Indigenous children into residential schools, and other discriminatory practices have contributed to the marginalization of this group (7). Over time, this has resulted in social, economic, and political inequities for Indigenous peoples (7). These inequities have contributed to current health disparities in this group, such as higher rates of suicide, injury, substance abuse, and even chronic diseases such as diabetes and hypertension (7). Shah (32) reported that hospitalization rates among Ontario First Nations peoples were similar to

other groups known to have inadequate primary care access. Resettlement and urban migration has had an effect on the preservation of and access to traditional health practises viewed as important by the Indigenous community (2, 33). Cultural assimilation has had farther reaching health effects, such as the adoption of a westernized lifestyle among First Nations children, including higher rates of smoking and caloric-rich diets (34, 35). A history of physical and mental abuse in residential schools continues to take a toll in the Indigenous population even today (36).

Indigenous peoples who migrate to cities have continued to experience similar health problems to those living on reserves and in rural areas (14, 18). Transitioning from a community-based approach as seen on reserves to an urban health care system has posed additional challenges. An early report by Shah (18) cited experiencing low socioeconomic status, cultural incompatibility and discrimination in cities to be primary obstructions to accessing adequate healthcare in this group. Shah (18) also reported that the rate of hospital admissions among urban First Nations peoples was four times that of the general population in a sample of First Nations peoples in British Colombia. In a report on health services available to First Nations peoples in Manitoba, Lavoie (17) noted that Indigenous people who moved to cities often faced other challenges including lack of financial and transportation support, finding suitable housing near medical services, and isolation from their social and cultural support networks.

Indigenous peoples migrating to urban areas have also experienced trouble interfacing with the health care system, which has led to inefficient service use such as the use of emergency room visits for non-emergent care (2, 18). This was also supported by a study of Indigenous peoples living in downtown Vancouver, which found that Indigenous people were making inadequate use

of the available services, other than emergency departments, even when requisite information was available (18). A Survey by the Ontario Task Force found that, although Indigenous peoples were active users of the health care system, half of the respondents of the survey were unaware of supplementary government and private insurance plans (18). In another study comparing health habits between on and off-reserve First Nations peoples, it was reported that First Nations peoples on-reserve used specialty arthritis services more frequently than those in urban areas, despite having a greater distance to travel to access these services (2). These challenges may be affected by difficulties interfacing with the health care system in an urban setting (2, 26).

Another issue faced by the urban Indigenous community is appropriateness of care, which can be influenced by discrimination when receiving care, poverty, social exclusion, and lack of access to traditional and culturally appropriate health practices (14, 26). As mentioned previously, the Urban Indigenous People's Survey (UAPS), which captures data on urban Indigenous peoples throughout Canada, reported that 72% of Indigenous residents of urban areas considered access to traditional healing practices to be as important, or more important than mainstream care, but only 30% had "very easy" access to it (2). Statistics Canada reported that, in a 2001 APS survey capturing data on Indigenous people living in "non-reserve" areas across Canada, it was found that 34% of urban Indigenous peoples were unaware if traditional health care was available in their community (2).

Waldram (37) aimed to address access to and incorporation of traditional medical care for urban Indigenous peoples. He reported that most who migrated to urban areas were not motivated to acculturate, and in terms of health care were likely to seek both conventional and traditional care. Waldram (37) further cited that the most significant barrier to the delivery of traditional health

care was the biased attitude of health care providers toward any form of alternative treatment without scientific merit. In his study, 142 Indigenous People living in Saskatoon, Saskatchewan, were interviewed. Of those, 67.7% of respondents stated that they would consult with a traditional healer if one were available, although only 5.1% indicated knowing one. Waldram (37) found that 60.8% of respondents believed that certain health problems could be handled better by traditional healers than biomedical practitioners. Respondents also indicated that finding a traditional healer was an informal affair, involving tapping into the Indigenous social network. The belief of employing "dual use", that is to say employing traditional healthcare alongside conventional care, was widely-held among respondents. Though this was a small sample, it provided insight on the important role of traditional care, and the need for improvements in access to this type of care.

Benoit (33) studied how the demands of Indigenous women in Downtown East Vancouver were being met with the implementation of Urban Aboriginal Health Centers (UAHCs). These centers aimed to address unmet health care needs and increase access to culturally appropriate care in the urban Indigenous population. Data was gathered from three focus groups, each composed of 12 Indigenous women, as well as from semi-structured interviews by local UAHC staff, health providers, government representatives, and community leaders in health care. Many of the Indigenous women voiced concerns over the practice style of clinic physicians, citing a lack of compassion and respect, which could result in their reluctance to follow up for check-ups, even when in pain. Concern was also cited for the lack of integration of traditional models of healing with bio-medical models across all programs and services, such as healing circles, as well as a lack of private waiting room spaces. Indigenous women are a particularly vulnerable group, owing to isolation, poor social support, and abuse (33). Health officials at one of the UAHCs

said that there was inadequate government funding, and a lack of health professionals of Indigenous backgrounds. Moreover, few traditional healers were willing to work in an urban clinical setting, due to inadequate remuneration, and government regulation of traditional practices. This study was limited in terms of making generalizations, owing to a small, exclusively female sample, accessing the services. However, it did provide an in-depth look at many of the challenges of receiving culturally appropriate care, both at the level of Indigenous clients, and health care providers.

Tjepkema (8) used data from the 2000/01 CCHS (Canadian Community Health Survey) to compare the health status, health care utilization, and health behaviours of off-reserve First Nations peoples as well as Metis and Inuit individuals residing in urban areas across Canada to the general Canadian population. With respect to social-determinants of health, the urban Indigenous population exhibited lower levels of education and household income and were less likely to have worked the entire year. These socio-economic findings have been echoed by other studies (2, 14). In the Indigenous group, the prevalence of smoking was 1.9 times higher than the non-Indigenous population. Tjepkema (8) also reported that Indigenous peoples had higher rates of heavy drinking, but in contrast lower rates of weekly drinking. Moreover, 23.1% of urban Indigenous people living in urban areas rated their health as either fair or poor, which was 1.9 times higher than the non-Indigenous population (8). A comparatively higher prevalence of chronic disease was reported for urban Indigenous peoples, notably hypertension and diabetes, which are risk factors for heart disease (5, 8, 38). It should be noted that the disparity observed between both self-perceived health and the prevalence of chronic conditions was non-significant when comparing individuals with higher household incomes (8). In terms of health care access, Tjepkema (8) reported that more off-reserve First Nations people as well as Metis and Inuit

individuals residing in urban areas than non-Indigenous people cited an unmet health care need (19.6% of individuals vs. 12.7% respectively). This specifically pertained to the area of acceptability, which was defined as "responses concerned with attitudes and competing responsibilities" (51.3% of unmet needs), and availability (47.5% of unmet needs) of services. In addition, the number of urban Indigenous people who reported seeing a regular doctor was lower than that for other provincial residents.

There were several limitations in Tjepkema's (8) study, including recall bias associated with the self-reported nature of the CCHS. In addition, the CCHS surveys the general Canadian population across all provinces and territories, but does not cover those living in reserves. There may also be cultural differences between Indigenous and non-Indigenous people in terms of reporting various health conditions and service utilization (8). Furthermore, the study only included those from the CCHS who identified as an Indigenous person. Individuals may have been hesitant to disclose this information, for fear of being stigmatized. The CCHS may have also underestimated the number of low-income Indigenous households, given that household size and income were used to determine income adequacy. The largest household size was 5 or more persons, and Indigenous people are more likely than non-Indigenous people to live in households with 5 more or people. A greater proportion of Indigenous respondents were found at the lower end within each household income category (low, middle, and high), especially the high-income group. This meant that the effects of income did not entirely control for data presented by income level and for the multiple logistic regression models used in the study. Finally, data from the CCHS was cross-sectional, and therefore no temporal or causal relationships among variables could be inferred.

A follow up study by Tjepkema (4) compared the mortality of urban Indigenous adults to their non-Indigenous counterparts using the 1991-2001 Canadian Census Mortality follow-up study. The study found that mortality rates of Indigenous adults were significantly higher than those of non-Indigenous adults, as the Indigenous group had a shorter life expectancy by 4.7 and 6.5 years for men and women, respectively. Mortality rate ratios for Indigenous men and women were particularly elevated for digestive system diseases, motor vehicle collisions, alcohol and drug-related diseases, and HIV/Aids. In the case of HIV/Aids, risk ratios were more than twice as much for urban Indigenous men, and more than ten times for urban Indigenous women. Consistent with other studies, socio-economic variables played an important role in the disparities observed. For example, the all-cause mortality hazard ratios comparing Indigenous to non-Indigenous adults (1.60 and 2.00 for men and women respectively), were reduced to 1.22 and 1.68 for men and women respectively when controlling for community size, lone parenthood, educational attainment, income adequacy, occupation skill level, work status, and immigration. Circulatory system diseases (ischemic heart disease in particular) were the primary contributor in mortality among Indigenous people. The study was limited in that it only included place of residence and demographic variables measured at baseline. The former is particularly important for Indigenous people due to their high rate of mobility (12, 14).

Literature on Indigenous health care in urban areas is scarce and often out-of-date (2). As a result of the lack of adequate sampling frames and the high mobility exhibited by this group, there is insufficient long-term data on health, demographic, and socio-economic variables (2, 39). In a medline search of journal articles published between 1992 and 2001, Young (40) determined that there were few research articles on the health of Indigenous peoples in Canada, notably those living in an urban environment. The National Collaborating Centre For Aboriginal Health (2)

reported that, though there are health services available for Indigenous peoples, they remain inadequate and inconsistent in terms of availability and acceptability. Place (2) further argued that as many of the current services offered were charitable endeavours, it demonstrated a lack of funding. Place (2) also suggested that services focusing on increased education attainment, employment rates, and socio-economic factors may need to be prioritized over those that largely rely on physical risk factors. This would reflect the role SES variables have been shown to play in urban Indigenous health (2, 7).

2.4 Government Policy

Public policy on Indigenous peoples has not caught up with the current demographic situation of this group. It focuses primarily on the population living on-reserve, without taking into account the massive urbanization that has occurred with Indigenous peoples (41). This is problematic, as it does not reflect the realities faced by those living in urban areas, such as finding adequate housing and a lack of access to traditional services and practices (2, 41). Given that the disparities in socio-economic conditions observed among Indigenous people compared to the general Canadian population are well-documented, Hanselmann (41) argued that it is imperative that policy makers address urban challenges faced by this group sooner rather than later. One of the challenges policy makers face is the disagreement over who has legislative authority over Indigenous people living in urban areas. The Canadian Constitution states that the federal government is legislatively responsible for those living on reserves and remote communities, while governance of those living in urban areas is unclear. The federal government's position has been that the provinces bear primary, but not exclusive responsibility for Indigenous peoples living in urban areas, while the provinces have historically responded that all Indigenous people

are the primary responsibility of the federal government. This lack of consensus has led to "inconclusive activity", leaving municipalities to create their own policies. The Royal Commission on Aboriginal Peoples (42) stated that urban Indigenous peoples do not receive the same level of services and benefits as First Nations people living on-reserve or Inuit populations receiving aid from the federal government, and that Indigenous peoples experienced difficulties accessing provincial programs. Official consensus of responsibilities between legislative branches may be necessary to deal with some of the health, financial, and other issues faced by this group.

2.5 Hypertension and Cardiovascular Disease (CVD) in Indigenous Peoples

In recent years, Indigenous peoples in Canada have been disproportionately affected by cardiovascular conditions (5, 6, 8), a disparity that is on the rise. According to the Heart Research Institute (9), Indigenous peoples are 1.5 to 2 times more likely to develop heart disease than the general Canadian population. A 2008/10 report by the RHS found that the most commonly reported chronic condition among Indigenous peoples living on reserves and in northern areas was high blood pressure, with a prevalence of 21.8% (27). Shah (39) analyzed data from the 1991 census of Canada on 41 Indigenous communities in Ontario and found that hospitalizations for ishchemic heart disease for self-identified Indigenous people had doubled from 1981 to 1997. This was higher than that of the general Canadian population. The Indigenous communities observed in these two reports were primarily located in rural areas.

In examining risk factors of obesity in a community of First Nations adults in Manitoba, Bruce (43) found that 43% of the sample had hypertension. With respect to burden, Reading (1) reported that, although the risk of cardiovascular disease (CVD) has been decreasing worldwide,

the Indigenous population in Canada was actually experiencing a higher burden of morbidity and mortality attributed to CVD. This was echoed by Tjepkema (4), who found that circulatory system diseases, such as hypertension, and CVD, were the leading cause of death among urban Indigenous adults in Canada aged 25 years and older.

Tjepkema's study was limited as it only captured data on individuals with registered Indian status. In a review paper on cardiovascular health in Indigenous peoples in Canada, Young (3) reported that, in the first decade of the 21st century, the age-standardized mortality rate for First Nations peoples had overtaken that of the general Canadian population. Furthermore, Kmetic (6) reported that in 2000, circulatory diseases accounted for 30% of deaths in the First Nations population in Canada. Tjepkema (8) found that off-reserve First Nations peoples, as well as Metis and Inuit individuals living in rural areas, suffered from a higher prevalence of hypertension than non-Indigenous Canadians. Most of the Indigenous individuals observed in the above study, however, were found at the lower end of each household income category (44, 45).

There are a number of factors which may have affected the rise in prevalence of CVD and hypertension among this population. High rates of Obesity have been observed among the First Nations population. This may have been influenced by the rapid adoption of a westernized lifestyle which has resulted in decreased food security, less nutritious meals, and a loss of certain traditional activities, such as hunting and fishing, which are associated with better perceived health among urban Indigenous peoples (1, 14, 43, 46, 47). Indigenous peoples in Canada have also demonstrated higher rates of smoking and alcohol consumption than their non-Indigenous counterparts (2, 48, 49). Diabetes, which is considered a risk factor for heart disease (5, 38), has also been reported as higher among off-reserve First Nations peoples as compared to their non-

Indigenous counterparts (2, 8, 34, 50, 51). Another contributing factor to CVD and hypertension may be depression (52, 53). Indigenous peoples have experienced higher rates of mental disorders among both adults and children than the general population (2, 54). Anand (55) found that the Indigenous population in Canada had elevated rates and risk factors for CVD regardless of the income level as compared to Canadians of European ancestry. Some of these included significantly higher rates of smoking, glucose intolerance, obesity, substantially higher concentrations of fibrinogen, and plasminogen activator inhibitor-1, higher rates of unemployment, and lower household annual income.

A growing body of research has documented both the prevalence and burden of CVD, hypertension, and associated risk factors among the Indigenous population. Much of the research, however, has not focused on urban areas or included non-status Indians. Using the OHC dataset, the primary objective of this study was to explore the impact of barriers to access to health services on the prevalence of both CVD and hypertension in an urban First Nations population. In a previous analysis of baseline health data using the OHC dataset, Firestone *et al.* (56) reported that the estimate of the prevalence of hypertension and heart disease in the Hamilton population was 25.8% and 8.4% respectively.

2.6 Literature Review Summary

Research into First Nations health must reflect the modern-day challenges faced by this group, such as the continual effects of marginalization, and the challenges of accessing adequate and culturally-appropriate health care in an urban environment. To examine barriers to access to health services, it is important to include access to both conventional and traditional health care. Much of the current literature on health services among Indigenous peoples in Canada is out of

date, is often based on small sample sizes, or does not reflect the migration of this population to urban areas. The results of this study could assist policy-makers in the implementation of initiatives aimed at efficiently combating the burden of hypertension and CVD in an urban Indigenous population, as well as guide future research in improving urban First Nations health. Furthermore, though there has been previous research investigating the prevalence of hypertension and CVD in the OHC dataset (56), this thesis was an opportunity to build on previous work (19, 56, 57) and perform multivariable statistics to gain more insight on associations with the prevalence of these cardiovascular conditions in an urban Indigenous population.

Chapter 3: Methods

3.1 Data Source

In partnership with the *De dwa da dehs nye>s* Aboriginal Health Access Centre in Hamilton, data were obtained from the OHC survey, which recorded health and demographic variables of urban First Nations peoples. The OHC survey collected from a total of 790 respondents, including 554 adults and 236 children, over a period of 2.5 years from December 2009 to April 2010. Only adults (18 years or older) were used in this study. To be included, all respondents had to be residents of the city of Hamilton, and self-identify as a First Nations person. As missing data were minimal, a complete-case analysis of 538 participants was used for the prevalence of hypertension, while 548 participants were analyzed for CVD. For reference, all data used in this study, including the outcomes, exposure variables, and other covariates, were self-reported by the respondents in an individual interview. The OHC survey employed a community-based participatory research approach, involving the Indigenous community in Hamilton in both study design and implementation to ensure the study was culturally appropriate and adhered to community-based participatory research principles (58).

3.2 Ethics Approval

Ethics approval was obtained from the ethics board at the Centre for Research on Inner City health at St. Michael's Hospital, in partnership with the Ontario Federation of Indian Friendship Centres and the De dwa da dehs ney>s Aboriginal Health Access Centre. In addition, data analysis is governed by the data sharing agreement outlined in Appendix A of the Our Health

Counts Community Report (19). Any future publications or release of information involving the OHC dataset need to be approved by the Indigenous Stakeholders.

The study conformed to the four principles of Ownership, Control, Access, and Possession (OCAP®), which are established standards for how First Nations research should be collected, protected, used, or shared (59). The Ownership, Control, Access and Possession principles each relate to: the collective ownership of group information, control of research directions and information throughout all stages of a project, management of dissemination of the data and results, and physical ownership of the data (59). In compliance with OCAP®, the Indigenous Stakeholders and First Nations community have access to and collective ownership over the data and results of this study, as well as control over their dissemination. Permission was required from the Indigenous stakeholders in order to use the OHC dataset for this thesis as they have official claim over the data (19). In addition, Indigenous stakeholders and community members played an integral role in developing and administering the survey, and determined which exposure and outcome variables would be investigated in this study (19).

3.3 Sampling

All data in the study were obtained using Respondent-Driven Sampling (RDS), a chain-referral sampling method used to obtain data from hidden populations (20, 60). Hidden populations, as defined by Heckathorn (20), are those where "no sampling frame exists and where public acknowledgement of membership in the population is potentially threatening". The latter part of the definition refers to potential legal ramifications or social persecution for members of these populations who engage in research (20, 60). RDS has facilitated the successful sampling of many such populations, such as injection drug users (20), transgendered individuals (61), or men

who have sex with men (62). Urban Indigenous populations would also fall into this category, due to both the marginalization they've experienced and the high degree of population mobility they exhibit (12). Conventional approaches to accessing these populations, such as snowball sampling, are statistically inefficient as selection bias is introduced at each successive level of respondents. Snowball sampling also does not account for bias that may have been introduced by the initial selection of individuals. RDS is distinct from conventional snowball sampling in that it employs mathematical models that adjust for correlations between respondents within their social networks, and includes incentives for peer recruitment and recruitment quotas (20). In RDS, sampling starts with a set of non-randomly selected initial respondents, or "seeds", who refer their peers from their social network into the sample. Those new recruits could then recruit their peers into the sample, and so on, with respondents from each wave recruiting peers of the subsequent wave. With RDS, it has been shown that as a recruitment chain grows longer and the sample expands, so does the composition of individuals (20, 60). This eventually results in a composition that is representative of the target population, independent of the selection of initial study members and limiting selection bias (20, 60). It is estimated that this process will achieve an equilibrium state (which in this case represents a composition representative of the target population) in 4-6 waves of respondents.

In the OHC survey, ten individuals were identified through the *De dwa da dehs nye>s* Aboriginal Health Access Centre as potential seeds. Of these potential candidates, six volunteered to take part in the study, and were each given three coupons. These "seeds" could then recruit their peers, who were given a numbered coupon by the person who informed them of the study, which they then presented to the researchers before participating, thereby allowing network referral patterns to be mapped out as recruitment trees. These recruits could in turn

recruit others to the study, increasing the amount of levels in a tree, and expanding the sample exponentially until a predetermined sample size was reached. Due to the non-traditional nature of this sample design, traditional sample size approaches are not valid. In an investigation on sample size calculations for RDS, Salganik (63), recommended that the sample size for an RDS study should be twice that which would be needed under simple random sampling, to account for this loss of statistical efficiency.

Another advantage of RDS is that it employs a dual-incentive system, where participants are rewarded both for participation in the study and for recruiting others. This system standardized the rewards involved for participants, and reduced bias associated with volunteerism, where a certain number of people participate more readily than others, as well as masking, where participants are hesitant to reveal personal identity information about their peers to researchers (60). In the OHC study, monetary rewards were offered for both participating in the study, and recruiting others.

RDS can provide asymptotically unbiased estimates if the referral chains are long enough (60). Furthermore, individuals within the RDS sample are inversely weighted in accordance to the size of their social network, to adjust for the increased likelihood of recruiting people with larger networks (20). This is important to account for the non-random recruitment of peers who have social-ties to a respondent, and the potential bias this may introduce.

In light of these methodological complications, improved statistical techniques are required for the application of regression models for data obtained through RDS. The models utilized in this thesis were developed by Dr. Michael Rotondi for data that were collected through the Respondent-Driven Sampling method. RDS remains a great potential option for sampling hidden

populations which lack a sampling frame, yet analysis of data obtained through it is still a developing area of research.

3.4 Exposure Variables: Barriers to Access to Health Services

Four barriers to access to health services were explored individually: Access to health services, access to food and nutrition, housing and mobility, and socioeconomic status. Each barrier, with the exception of socioeconomic status, was comprised of multiple individual variables. A comprehensive list of the four barriers to access to health services and their corresponding individual variables is shown in Table 1.

Exposure Variable: Barriers in Access to Health Services

First Nations peoples living on reserves in Canada have experienced difficulty accessing healthcare (13). This has been a contributing factor to the large influx of Indigenous peoples into urban centers (13). A 2008/10 RHS report, which captured data on Indigenous peoples living on reserves and in northern areas, found that 38.6% of First Nations adults felt they had less access to health care services than the rest of the general Canadian population (27). This was an increase from 35.6%, which was reported in 2002/3 (27). Hospitalization rates among Ontario First Nations peoples were similar to other groups known to have inadequate primary care access (32). In spite of an increased urban migration, access to primary health care in Canada remains limited for urban Indigenous peoples (2, 13). In a report by Tjepkema (8), more off-reserve First Nations as well as Metis and Inuit individuals residing in rural areas than non-Indigenous people cited an unmet health care need. It has also been suggested that 'mainstream' models of primary health care are insufficient in serving Indigenous peoples (26). Furthermore, being in an urban

center has made it difficult for Indigenous peoples to access traditional, culturally appropriate healthcare (14). As previously mentioned, the UAPS reported that 72% of urban Indigenous residents considered access to traditional healing practices to be as or more important, than mainstream care, but only 30% had "very easy" access to it (2). Statistics Canada found that 34% of urban Indigenous peoples were unaware if traditional health care was available in their community (2). This emphasizes another issue with respect to health care access: lack of interface. Despite being close to health care resources, the urban First Nations population may not have the sufficient support or interface required to access these services (26). Many of the difficulties with health care access may be related to issues of poverty, social exclusion, discrimination and other barriers to receiving adequate healthcare. These and other factors may leave the Indigenous population feeling excluded from the benefits of the health care system in Canada (26, 64).

There were several questions on the OHC survey concerning barriers to accessing health services. They addressed issues such as: Insufficient doctor availability, difficulty with direct medical costs, insufficient access to traditional care, lack of cultural sensitivity among services offered, and being dissatisfied with the available health care services. Each barrier was recorded according to its presence in the past 12 months and was examined individually in this study. These variables were binary and not mutually exclusive, with a respondent indicating either the presence or absence of an issue.

Exposure Variable: Barriers in Access to Food and Nutrition in the Last 12 Months

The recent development of unhealthy dietary practices among the Indigenous population in Canada is a driving factor behind the prevalence of adverse health outcomes such as diabetes and

heart disease (2, 47). Traditional Indigenous diets, which involved foods high in animal protein, nutrient-rich, and low in fat or high in marine sources of fat, have been replaced by more processed foods which are more likely to be associated with the development of obesity, metabolic disorders and other risk factors for cardiovascular disorders (1, 47). From a cross-sectional survey, Ho (35) found that First Nations adults in Northwestern Ontario were more likely to eat foods with a higher caloric value and fat content up to 30 times more often than healthier alternatives. In the aforementioned study, over 80% of the respondents were overweight or obese. Reading (64) found that off-reserve First Nations individuals as well as Metis and Inuit individuals residing in rural areas were almost 3 times more likely to be living in households with food insecurities than the non-Indigenous population. Only 22% of respondents from the OHC survey reported having control over their food choices, which is significant as nutrition and food security are considered important factors in the maintenance of good health (2).

Food access and the nutritional value of food choices were both measured as separate variables. The food access variable in the OHC survey, which is divided into four categories, focuses on food security. The four categories on the OHC survey, which were used as such in this study, included "You and others always had enough of the kinds of food you wanted to eat," "You and others had enough to eat, but not always the kinds of food you wanted," "Sometimes you or others did not have enough to eat," and "Often you or others did not have enough to eat". The Nutrition Quality variable, adapted from the OHC survey question "Do you eat a nutritious, balance diet", was coded as "Almost Always", "Sometimes", "Rarely", and "Never".

Exposure Variable: Barriers in Access to Housing and Population Mobility

Adequate, affordable housing and living conditions are associated with health and well-being (65). Poor quality housing and overcrowding have been associated with adverse health outcomes in relation to an increased risk of communicable diseases, accidents and injuries, mental health disorders and social dysfunction (66). Urban Indigenous renters have presented higher rates of core housing needs and overcrowding as compared to non-Indigenous renters (65). Indigenous peoples also tend to live in poorer, more crowded, and underserviced (less likely to have no piped water supply, more likely to be in need of repairs, more likely to have no bathroom facility etc.) living conditions than non-Indigenous Canadians (7). The Indigenous population is also uniquely affected by high rates of population mobility both between rural and urban areas, and within urban areas (11, 67). Graham and Peters (67) reported that, between 1991 and 1996, 70% of Indigenous peoples lived in large, urban centers, of which 45% were moving within the same community, as compared to 20% for their non-Indigenous counterparts. High rates of mobility can be disruptive for individuals, families and communities, especially from a social perspective (68). It may also affect the continuity of health service delivery, and the ability of health service providers to maintain consistent care (2). Residential mobility (changing residences within a city) is often driven by negative circumstances, such as violence and financial difficulties, and has been linked to stressors such as lack of neighborhood security, which can contribute to negative health outcomes (12). Within the OHC dataset used for this study, 54% of respondents reported moving at least three times in the past five years.

The mobility variable in this study was categorical, and defined as either stable (no moves within the past 5 years), relatively stable (2 or fewer moves in the past 5 years) or unstable (3 or more

times in the past 5 years). Housing quality was assessed as a categorical variable by an OHC question concerning to what extent individuals' dwellings were in need of repairs. The responses used were: "No, only regular maintenance is needed," "Yes, minor repairs are needed," and "Yes, major repairs are needed". A crowding variable was derived by calculating the number of persons per room by combining two OHC questions concerning both the number of people currently living in a household and the number of rooms in a home (not counting bathrooms, hallways, and rooms used solely for business). The crowding variable was continuous.

Exposure Variable: Socioeconomic Status (Measured by Income)

Socioeconomic status (SES), as measured by both income and education, is often judged as a health indicator for a variety of outcomes (44, 45). With respect to income, Indigenous peoples have been found to be disproportionately affected by poverty and are more likely to live in low-income neighborhoods, which can act as a barrier to food security and obtaining health services, and may influence other health-limiting factors (2). In a population of "non-reserve" Indigenous peoples in Canada, Tjepkema (8) reported that the proportion of individuals experiencing a poor health outcome decreased as SES status improved. In terms of other indicators of SES, inadequate education can have significant effects later in life, such as providing insufficient skills for the competitive labour market, resulting in lower paying jobs and higher rates of unemployment (64). It can also act as a barrier to accessing or developing health promoting behaviours (64). Reading (64) further reported a high rate of dropping out of high school among Indigenous children, which could result in diminished literacy and employment, as well as increased poverty in future generations.

In this study, income was the primary indicator of SES. Education had insufficient variability to be considered as a reliable indicator, as 57% of the OHC survey sample population had not completed high school. Income, with its relatively larger variability in the dataset, was more viable in this study as an indicator of SES. Respondents were asked for their income in the year ending at December 31, 2008, before deductions, and from all sources. The variable was separated into multiple annual income categories, each by intervals of $5000. The lowest category was "No personal income" ($0), followed by $1-$4999, $5000-$9999 and ending at $80,000+.

Note that we recognize that low SES is strongly associated with housing instability, food insecurity as well as many of our other barriers to accessing health care. In this way, low SES may be on the causal pathway in these associations and not an independent variable in the traditional sense. However, in consultation with our community partners, they were keenly interested in the role of low SES as an exposure variable to examine its own impact on CVD and hypertension.

3.5 Outcome Variables

This study examined two separate binary outcomes: the presence of hypertension and the presence of CVD, as diagnosed by a health professional, respectively. Given that CVD was not specifically measured on the OHC survey, respondents were considered to have a positive outcome for this variable if they had reported being diagnosed with heart disease or stroke.

3.6 Adjusted Analyses: Variable Definitions and Coding

In the multivariable analyses, statistical models will be adjusted for the following covariates in an effort to reduce confounding and bias in the estimation of the role of barriers to access to health services on the prevalence of CVD and hypertension respectively. These variables and their coding are described below:

Age and Sex

Age and sex have been associated with cardiovascular health both among Indigenous peoples and the general population (1, 3, 69). In this study, age was included as a continuous variable while sex was binary (Table 2).

BMI and obesity

A high BMI is a common risk factor for hypertension and CVD (46, 70). Within the Indigenous population in Canada, rates of obesity have been increasing faster than that of the general population (43, 46). High rates of obesity have been reported in both remote and semi-remote First Nations communities in Canada (35). This has serious implications for the future burden of CVD and hypertension among this population (70). BMI was coded as a continuous variable, which provided increased statistical power (Table 2).

Physical Activity

Physical activity is one of the prime modifiable risk factors associated with CVD (2, 47). Among First Nations peoples in Canada, the rapid adoption of a westernized lifestyle has resulted in a loss of certain traditional activities, such as hunting and fishing, which are associated with better perceived health among urban Indigenous peoples (1, 14, 47).

On the OHC survey, participants reported the number of days per week that they completed at least 30 minutes of moderate to vigorous physical activity. The physical activity guidelines established by the Public Health Agency of Canada recommended that individuals engage in at least 4 of the above 30-minute sessions per week (71). Physical activity was categorized as a binary variable depending on whether or not individuals met these recommended guidelines (Table 2).

Smoking Status

Smoking is a well-known modifiable risk factor for CVD (47, 48). Indigenous peoples in Canada have demonstrated higher rates of smoking than their non-Indigenous counterparts, as well as higher rates among adolescents (48, 49). In this study, respondents were categorized as a current smoker, former smoker, or non-smoker (Table 2).

Alcohol Consumption

Heavy drinking is a risk factor for both CVD and hypertension (72, 73). Indigenous populations in urban and rural areas are reported to have similar rates of heavy drinking, though both are higher than the non-Indigenous urban population (2). A report by Tjepkema (8) on urban

Indigenous peoples supported this finding, but also found that Indigenous peoples living in urban areas had lower rates of weekly drinking as compared to the general Canadian population.

The OHC survey included data on drinking behaviours for the 12 months preceding a survey response. The frequency at which a binge drinking episode occurred in that time frame (number of times an individual had 5 or more drinks on one occasion) was recorded as a categorical variable. The responses included: "Never", "less than once per month", "once per month", "2-3 times per month", "once per week", "more than once per week", and "every day" (Table 2).

Diabetes

Diabetes is considered a risk factor for heart disease (5, 38). Elevated rates of type 2 diabetes and its associated risk factors, such as obesity and a westernized, caloric-rich lifestyle, are reported within off-reserve First Nations peoples as compared to their non-Indigenous counterparts (2, 8, 34, 50, 51). In particular, Indigenous women face a disproportionately higher rate of gestational diabetes than the non-Indigenous population (50). In this study, diabetes (both types 1 and 2) was coded as a binary variable with a positive code indicating the presence of the disorder as diagnosed by a health care provider. There was no distinction between diabetes type 1 and 2 on the OHC survey (Table 2).

Presence of a Mental Disorder

Depression has been associated with hypertension in previous studies (52, 53). Among youth, it has also been identified as a predisposing risk factor for atherosclerosis and early CVD (52). Both rural and urban Indigenous peoples have experienced higher rates of mental disorders among both adults and children than the general population (2, 54). In this study, the presence or

absence of a mental disorder, as diagnosed by a health professional, was coded as a binary variable (Table 2).

3.7 Statistical Models

Multivariable logistic regression models were the primary method of analysis in this study. As there was no universally accepted method for the multivariable analysis of RDS data, two competing statistical models were used to understand the sensitivity of results to different analysis strategies: weighted generalized linear mixed models and survey-based procedures. All statistical analyses were performed in SAS 9.4 (74).

3.7.1 Weighted Generalized Linear Mixed Models

One of the challenges of using RDS in this study was accounting for respondents with different network sizes and the tendency of individuals to recruit participants who are like themselves. Because individuals sampled from their own network, it could be assumed that there was clustering in the data (20, 60). In this context, there are two main forms of clustering: 1. Fixed effects (whose quantities are non-random), such as if the participant resided in Hamilton, or outside of that metropolitan area; and 2. Random effects such as the random correlation that occurs within individual recruitment trees, and within participants who were recruited by a shared recruiter level. For this reason, a generalized linear model (GLM) was inappropriate. "Fixed effect models", such as GLM's, assume that all observations are independent of each other, and are therefore unsuited for analyzing correlated data structures.

Generalized linear mixed models (GLMM) can be considered an extension of the above concept as it can model both random and fixed effects (75, 76). In addition, GLMM can be used for

dichotomous outcomes with non-normal distributions, and is therefore commonly used for logistic regression (75, 76). In clustered designs, subjects may be nested within larger units (such as having a shared-recruiter or being in the same recruitment tree), which is referred to as "multi-level data" (75). GLMM's allow random cluster and/or subject effects to be added directly into a regression model, allowing the analysis of multilevel data where cross level interactions can occur between subjects at different levels (76). Adjusting only for fixed effects and ignoring the possibility of correlation that arises in multi-level data can lead to biased estimates and inflated error terms (75, 76).

In addition to including random and fixed effects, the analysis of correlated data requires the proper covariance structure, which describes the form of the correlation among data points within clusters (77). This is important as covariance may impact overall model fit, the parameter estimates and their standard errors (77). Covariance attempts to model all variability in the data that cannot be explained by fixed effects, but sometimes fails to converge, yielding no results (odds ratios and confidence intervals in this case) (77). In these situations, covariance is given a more simplifying structure, which reduces the number of parameters and can improve model convergence (77). It should be noted, however, that simplifying a model too much can lead to inflated type 1 error rates (78). The correlation structure used in this study, as specified by SAS, was the first-order autoregressive moving average structure ARMA(1,1) (autoregressive moving-average error processes) (79). The ARMA structure accounts for the exponential decrease in correlation that is observed over time as distance increases between observations (79). This is what would be observed each time an individual is recruited, as successive respondents are further and further away from the initial seed in a growing recruitment tree (Figure 1). In some cases where ARMA failed to converge, the first order autoregressive correlation AR(1) was used

(79). Unlike ARMA, which accounts for correlation across an entire recruitment chain, AR(1) only accounts for correlation with respect to the value immediately preceding an observation (79).

For this study, a traditional GLMM was used. The representative equation is $g(E(Y)) = X\beta$ (79). Y is the outcome, while the link function, g, specifies the relationship between the distribution of the mean of the data to the linear predictor (Xß) (76, 80). In a logistic regression model, g would be "logit", to the formula $g=\log_e (p/(1-p))$ where p is the probability of the outcome (prevalence of hypertension or CVD) (76, 80). GLMM's follow the equation $y = X\beta + Zv + e$, where y is the outcome variable, X is a matrix of predictor OR exposure variables, ß represents fixed effects regression coefficients, Z is a matrix of random effects associated with X, and v is a matrix of the random components associated with Z. e, also known as the "error term", represents the residuals, which are the remaining parts of v that have not yet been accounted for by the other parts of the model. The variance in the outcome variable is represented by the equation $Vay(Y)=A^{1/2}VA^{1/2}$ where A is a diagonal matrix of variance functions which corresponds to g, and V is a block diagonal matrix of variance components, specified for the correlation structure (76, 80).

The second major challenge in the analysis of RDS data is the unequal sampling probabilities. Individuals who have larger social networks are more likely to be recruited into the study, and this unequal sampling probability must be accounted for in the analysis of RDS data.

To address these issues, weighted generalized linear mixed models were used, which allow for the analysis of variables that correlate in time or space. The function in SAS used to create these models is the GLIMMIX procedure. These models allow for the inclusion of both random effects

to adjust for correlations between subjects, and fixed effects to determine the effect of each variable on the outcome of interest, while the weights adjust for the unequal sampling probabilities. The primary difference between GLIMMIX and the survey analysis procedures presented in the next section, is that the former adjusts for correlations using random effects, while the latter utilizes survey-sampling techniques to adjust for the correlation between study participants.

3.7.2 Survey Analysis Procedures

In addition to the weighted generalized linear mixed models approach, survey procedures in SAS were also be used to examine these relationships in the OHC database. These were represented by the SURVEYFREQ and SURVEYLOGISTIC functions. Complex survey designs that recruit through peer social networks are useful to obtain data on populations where obtaining a single, unbiased representative sample is difficult. These designs can account for weighting and adjust for stratification. Unlike in simple random sampling, which is difficult to use with hidden populations, complex survey designs, such as RDS, are used. The issue arises in that this type of sampling is non-random, and often relies on respondents recruiting their peers through social networks. This would mean that individuals with larger social networks have a larger probability of being chosen than those with smaller ones, violating the assumptions of each individual having an equal probability of being chosen. This often results in respondents being drawn from clusters, in which respondents' characteristics are not independent of one another. Correlations may arise from respondents sharing the same seed (being in the same tree), and from having a shared recruiter. In the OHC dataset, this means that individuals who shared recruiters and/or seeds may have been clustered. The effects of clustering between participants and social network

size was accounted for in the SAS 9.4 Survey Procedures.

The SURVEYFREQ procedure in SAS computes frequency distributions of survey based data, which can generate odds ratios and confidence intervals for potential health outcomes (81). SURVEYFREQ was used to look at the weighted, unadjusted bivariate associations between barriers to access to health services and the prevalence of both hypertension and CVD through the use of 2x2 tables. PROC SURVEYLOGISTIC in SAS is used to perform logistic regression models on survey data (82). It can incorporate sample design information into its analysis, such as weighting and stratification, and fits a linear logistic regression model using maximum likelihood. The CLASS statement identifies categorical variables in the analysis. The STRATA statement identifies non-overlapping data that share a single strata. In this study, this would represent a single tree-cluster, and is SURVEYLOGISTIC's way of accounting for correlations that may arise between individuals who share a seed. The CLUSTER statement accounts for correlations that arise from respondents having the same recruiter, and is nested within strata. The WEIGHT statement is used to adjust for the unequal probability of being selected due to the size of a respondent's social network (20). The generalized logit function (logit) was used for this study.

3.7.3 General Analysis Strategies

Multivariable logistic regression models were used to analyze the data in this study, and yielded results in terms of odds ratios and 95% confidence intervals (CI). Separate analyses were done for each of the two outcomes: the prevalence of hypertension and the prevalence CVD, respectively. Multiple analyses with different levels of adjustment were also done for each outcome. In addition, each individual analysis was conducted using both types of statistical

models. This allowed the weighted generalized linear mixed modeling approach to be compared with the survey-based procedures so as to ensure robustness of study conclusions.

The association between an outcome and barriers to access to health services was initially analyzed in a bivariate manner using first the SURVEYFREQ, and then the GLIMMIX procedure. All subsequent analyses were performed using the SURVEYLOGISTIC procedure followed by the GLIMMIX procedure in SAS. Weighted sex and age-controlled analyses were performed for each exposure variable on each outcome. Following this, a fully adjusted model was performed, controlling for sex, age, BMI, physical activity, smoking status, alcohol consumption, diabetes, and the presence of a mental disorder. Though there is still a lack of clear methodology for regression modelling of RDS data, preliminary statistical simulations performed by Dr. Rotondi suggest that the weighted linear mixed models approach is more conservative, and therefore more robust against type 1 errors than survey-procedures.

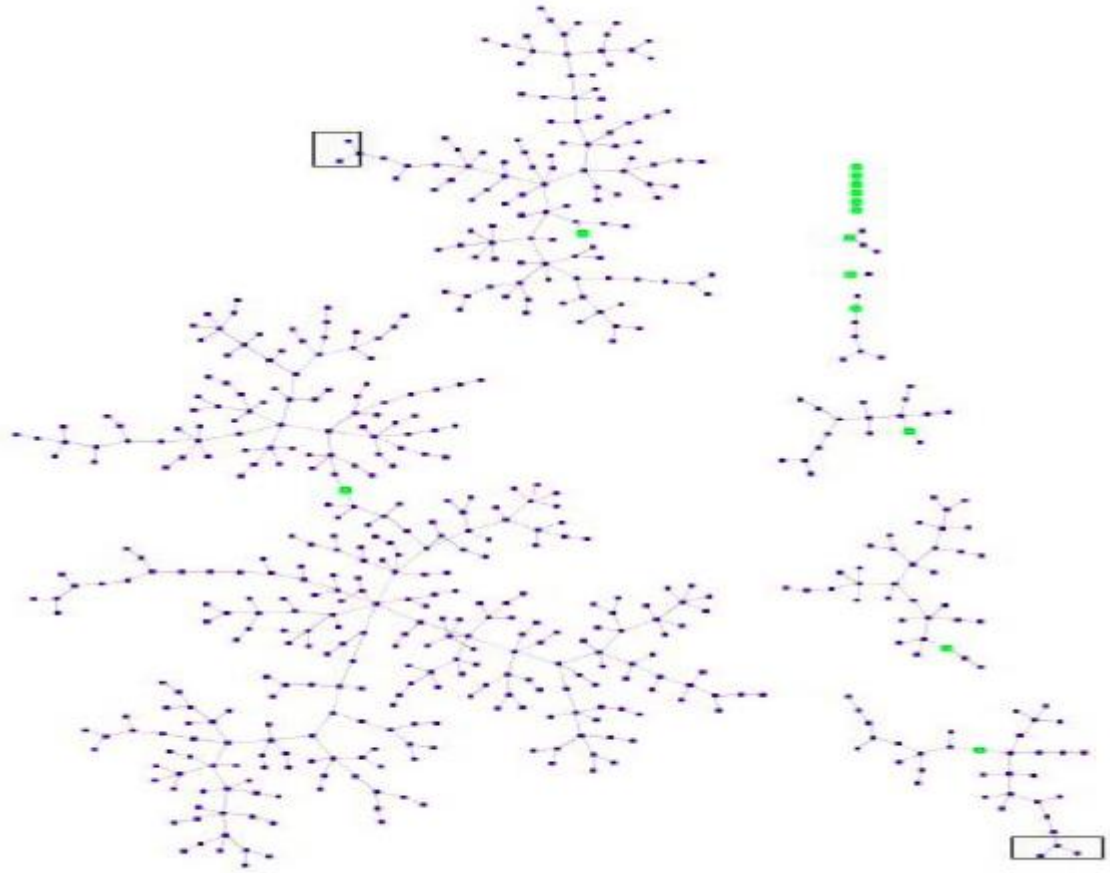

Figure 1: Recruitment trees from the OHC study, sampled using RDS. Seeds are identified in green.

Table 1: Barriers to access to health services adapted from the Our Health Counts (OHC) survey (19, 56).

Barrier	Question	Answer
Access to Health Services	During the past 12 months, have you experienced any of the following barriers to receiving health care?	1. Doctor not available in my area 2. Nurse not available 3. Lack of trust in healthcare provider 4. Waiting list too long 5. Unable to arrange transportation 6. Difficulty getting traditional care 7. Not covered by non-insured health benefits (service, medication, equipment) 8. Prior approval for services under non-insured health benefits (NIHB) was denied 9. Could not afford cost of care/service 10. Could not afford transportation costs 11. Could not afford childcare costs 12. Felt health care provided was inadequate 13. Felt service was culturally appropriate 14. Chose not to see health professional 15. Service was not available in my area
Access to Food and Nutrition	Do you eat a nutritious, balanced diet?	1. Almost Always 2. Sometimes 3. Rarely 4. Never 5. Don't know 6. No response
	Which of the following statements best describes the food eaten in your household in the past 12 months?	1. You and others always had enough of the kinds of food you wanted to eat 2. You and others had enough to eat, but not always the kinds of food you wanted 3. Sometimes you or others did not have enough to eat 4. Don't know 5. No response

Housing and Population Mobility	How many times have you moved in the past 5 years?	1. Less than 3 times 2. 3 to 4 times 3. 5 times or more 4. Don't know 5. No response
	How many people reside per room in your house?	1. Number of people per room 2. Don't know 3. No response
	Is your dwelling in need of any repairs?	1. No, only regular maintenance is needed (painting, furnace cleaning, etc.) 2. Yes, minor repairs are needed (missing or loose floor tiles, bricks or shingles, defective steps, railing or siding, etc.) 3. Yes, major repairs are needed (defective plumbing or electrical wiring, structural repairs to walls, floors or ceilings, etc.) 4. Don't know 5. No response
Income	For the year ending December 31, 2008, please think of your total personal income, before deductions, from all sources. Please look at these categories and tell me which range it falls into?	1. No personal income 2. $1-$4999 3. $5000-$9999 4. $10-14999 5. $15000-$19999 6. $20000-$24999 7. $25000-$29000 8. $30000-$39999 9. $40000-$49999 10. $50000-$59999 11. $60000-$69999 12. $70000-$79999 13. $80+ 14. Don't Know 15. No Response

Table 2: Covariates used for adjusted analyses in multivariable models.	
Variable	**Responses**
Age	Continuous
Sex	1. Male 2. Female
BMI	Continuous
Completed at least 4 sessions of at least 30 minutes of moderate to vigorous physical activity a week?	1. Yes 2. No 3. Don't Know 4. No Response
Smoking Status	1. Current smoker 2. Former smoker 3. Non-smoker
During the past 12 months, how often have you had 5 or more drinks on one occasion?	1. Never 2. Less than once per month 3. Once per month 4. 2-3 times per month 5. Once per week 6. More than once per week 7. Every day 8. Don't Know 9. No Response
Do you have diabetes (as diagnosed by a health care provider)?	1. Yes 2. No 3. Don't Know 4. No Response
Have you ever been told by a health care worker that you have a psychological and/or mental health disorder (i.e. Depression, anxiety)?	1. Yes 2. No 3. Don't Know 4. No Response

Chapter 4: Results

Demographic characteristics, prevalence of outcomes, prevalence of exposure variables and each of their associated RDS-adjusted proportions and confidence intervals are presented in Tables 3 and 4. This chapter begins with a detailed discussion of bivariate, and adjusted analyses for hypertension, followed by bivariate and adjusted analyses for CVD:

Hypertension

Of the 537 respondents analyzed for hypertension, 150 (27.93%) reported the presence of the outcome (19, 56). The weighted bivariate associations between the exposure variables and the prevalence of hypertension are shown in Table 5. Table 6 shows the weighted association between barriers to access to health services and the prevalence of hypertension, adjusted for age and sex. In the SURVEYLOGISTIC model, significant results for the prevalence of hypertension were found with the unavailability of a doctor in a participant's area (OR = 2.78, 95% CI: 1.16-6.65), feeling nurses weren't available (OR = 4.98, 95% CI: 1.80-13.78), not being covered by non-insured health benefits (NIHB) (OR = 2.96, 95% CI: 1.16-7.58), prior approval for coverage of services under NIHB being denied (OR=3.56, 95% CI: 1.39-9.11), being unable to afford the cost of care/services (OR= 2.87, 95% CI: 1.28-6.45), and feeling that services offered were not culturally appropriate (OR = 2.29, 95% CI 1.09-4.81). The GLIMMIX model for Table 6 showed significant associations for the prevalence of hypertension with the unavailability of a doctor in a participant's area (OR = 2.36, 95% CI: 1.34-4.15), feeling nurses weren't available (OR= 3.55, 95% CI: 1.85-6.80), the waiting list to access services being too long (OR = 1.80, 95% CI: 1.08-3.01), difficulty getting traditional care (OR = 2.06, 95% CI: 1.06-3.99), not being covered by NIHB (OR = 3.47, 95% CI: 1.78-6.74), prior approval for coverage of services under NIHB

being denied (OR = 4.10, 95% CI: 2.00-8.39), being unable to afford the cost of care/services, (OR = 3.84, 95% CI: 2.20-6.71), being unable to afford transportation costs (OR = 1.75, 95% CI: 1.03-2.98), feeling that health care provided was inadequate (OR = 2.38, 95% CI: 1.34-4.21), and feeling that services offered were not culturally appropriate (OR = 2.63, 95% CI: 1.41-4.88). In the GLIMMIX model, the variables "Waiting list too long", "Prior approval for services under non-insured health benefits (NIHB) was denied", and "Felt service was culturally not appropriate" needed AR(1) in order to converge.

Table 7 shows the weighted relationship between the prevalence of hypertension and potential barriers to access to health services, adjusted for age, sex, BMI, physical activity, smoking status, alcohol consumption, diabetes, and the presence of a mental disorder. In the SURVEYLOGISTIC model, significant results for the prevalence of hypertension were observed with the unavailability of a doctor in a participant's area (OR = 3.67, 95% CI: 1.30-10.39), feeling nurses weren't available (OR = 7.51, 95% CI: 2.27-24.85), not being covered by NIHB (OR = 5.49, 95% CI: 1.97-15.30), prior approval for coverage of services under NIHB being denied (OR=5.48, 95% CI: 1.81-16.61), and being unable to afford the cost of care/services (OR= 4.53, 95% CI: 1.79-11.47). The GLIMMIX model for Table 7 showed significant associations for the prevalence of hypertension with the unavailability of a doctor in a participant's area (OR = 2.73, 95% CI: 1.20-6.21), feeling nurses weren't available (OR= 4.19, 95% CI: 1.62-10.85), difficulty getting traditional care (OR = 4.00, 95% CI: 1.48-10.81), not being covered by NIHB (OR = 6.30, 95% CI: 1.98-20.06), prior approval for coverage of services under NIHB being denied (OR = 4.21, 95% CI: 1.26-14.05), and being unable to afford the cost of care/services (OR = 3.48, 95% CI: 1.60-7.57). In the GLIMMIX model, the "waiting list is too long" variable had to be run with AR(1) in order for it to converge. "How many people

reside per room in your house?", and "Is your dwelling in need of any repairs?", did not converge due to sparse cell counts.

Cardiovascular Disease

Of the 548 respondents analyzed for CVD, 64 (11.68%) reported the presence of the outcome (19, 56). The weighted and adjusted bivariate associations between the exposure variables and the prevalence of CVD are shown in Table 8. Table 9 shows the weighted association between barriers to access to health services and the prevalence of CVD, adjusted for age and sex. In the SURVEYLOGISTIC model, significant results for the prevalence of CVD were observed with the waiting list to access services being too long (OR = 4.17, 95% CI: 1.50-11.60), not being covered by NIHB (OR = 3.83, 95% CI: 1.30-11.32), prior approval for coverage of services under NIHB being denied (OR=4.47, 95% CI: 1.49-13.42), being unable to afford the cost of care/services (OR = 2.87, 95% CI: 1.12-7.36), and being in a higher household income group (OR = 1.32, 95% CI: 1.11-1.56). The GLIMMIX model for Table 9 showed significant associations for the prevalence of CVD with having a lack of trust in the health care provider (OR= 2.08, 95% CI: 1.05-4.12), the waiting list to access services being too long (OR = 3.72, 95% CI: 1.97-7.04), not being covered by NIHB (OR = 3.39, 95% CI: 1.70-6.77), prior approval for coverage of services under NIHB being denied (OR = 4.24, 95% CI: 2.01-8.94), being unable to afford the cost of care/services, (OR = 2.59, 95% CI: 1.40-4.80), feeling that health care provided was inadequate (OR = 2.56, 95% CI: 1.38-4.75), feeling that services offered were not culturally appropriate (OR = 2.12, 95% CI: 1.08-4.16), choosing not to see a health professional (OR = 1.98, 95% CI: 1.05-3.71), and the number of people per room (OR = 1.24, 95% CI: 1.02-1.50). In the GLIMMIX model, the "Lack of trust in healthcare provider", and "Could not afford

cost of care/services" variables had to be run with AR(1) in order for them to converge. Income did not converge due to insufficient data points in some of the income groups.

Table 10 shows the weighted relationship between the prevalence of CVD and potential barriers to access to health services, adjusted for age, sex, BMI, physical activity, smoking status, alcohol consumption, diabetes, and the presence of a mental disorder. In the SURVEYLOGISTIC model, significant results for the prevalence CVD were observed with eating a more unbalanced, less nutritious diet (OR = 2.13, 95% CI: 1.11-4.08), and the number of people per room in a household (OR = 1.98, 95% CI: 1.20-3.30). The GLIMMIX model for Table 10 showed significant associations for the prevalence of CVD with eating a more unbalanced, less nutritious diet (OR = 1.96, 95% CI: 1.19-3.25), the number of people per room in a household (OR = 2.32, 95% CI: 1.21-4.46), and the amount of repairs required by a participant's dwelling (OR = 2.14, 95% CI: 1.00-4.57). "Unable to arrange transportation" did not converge due to sparse cell counts.

Table 3: RDS-adjusted estimates of demographic characteristics and outcome variables in the Hamilton First Nations population (19, 56).	
Demographic Variable	**Estimated Population Proportion % (95% CI)**
Outcomes	
Prevalence of Hypertension	24.9% (18.5-32.7%)
Prevalence of CVD	13.1% (7.5-18.3%)
Sex	
Male	59.7% (51.1-69.3%)
Female	40.3% (30.7-48.9%)
Have you completed at least 4 sessions of at least 30 minutes of moderate to vigorous physical activity a week?	
Yes	83.3% (75.5-88.1%)
No	16.7% (11.9-24.5%)
Smoking Status	
Current smoker	82.1% (75.8-87.9%)
Former smoker	13.8% (8.3-19.4%)
Non-smoker	4.1% (2.3-6.8%)
During the past 12 months, how often have you had 5 or more drinks on one occasion?	
Never	24.3% (17.6-31.1%)
Less than once per month	17.4% (11.6-23.4%)
Once per month	16.5% (10.6-23.6%)
2-3 times per month	17.7% (12.3-26.6%)
Once per week	6.1% (3.3-8.9%)
More than once per week	14.4% (7.7-20.5%)
Every day	3.7% (13.0-7.4%)
Do you have diabetes (as diagnosed by a health care provider)?	
Yes	15.9% (10.0-22.5%)
No	84.1% (77.5-90.0%)

Have you ever been told by a health care worker that you have a psychological and/or mental health disorder? (i.e. Depression, anxiety) Yes No	 45.4% (36.6-54.8) 54.6% (45.2-63.4)
BMI, mean (STDEV)	28.6 (6.9)
Age (years), mean (STDEV)	40.2 (13.1)

Table 4: RDS-adjusted estimates of exposure variables in the Hamilton First Nations population	
Exposure Variable	**Estimated Population Proportion % (95% CI)**
Access to Health Services	
Doctor not available in my area	29.3% (22.6-38.7%)
Nurse not available	18.0% (11.8-26.6%)
Lack of trust in healthcare provider	22.7% (15.8-28.6%)
Waiting list too long	48.3% (40.7-57.9%)
Unable to arrange transportation	37.4% (28.6-45.9%)
Difficulty getting traditional care	19.2% (13.3-27.0%)
Not covered by non-insured health benefits (service, medication, equipment)	25.8% (15.4-33.0%)
Prior approval for services under non-insured health benefits (NIHB) was denied	19.8% (11.8-28.1%)
Could not afford cost of care/service	27.3% (19.0-34.7%)
Could not afford transportation costs	31.1% (23.1-37.4%)
Could not afford childcare costs	5.9% (3.0-8.7%)
Felt health care provided was inadequate	23.9% (18.1-31.6%)
Felt service was culturally not appropriate	18.3% (13.2-23.9%)
Chose not to see health professional	29.1% (22.1-36.6%)
Service was not available in my area	18.8% (12.6-26.1%)
Access to Food and Nutrition	
Do you eat a nutritious balanced diet?	
Almost Always	36.4% (28.2-44.3%)
Sometimes	36.8% (29.0-44.7%)
Rarely	17.5% (11.9-24.6%)
Never	9.3% (4.1-15.7%)
Which best describes the food eaten in your household in the past 12 months	
Always enough and kinds	25.4% (19.7-33.3%)
Enough but not always kinds	53.0% (44.6-60.8%)
Sometiems Not enough	14.8% (8.4-19.7%)
Often not enough	6.7% (3.9-11.5%)

Housing and Population Mobility	
How many times have you moved in the past 5 years?	
Stable	10.0% (5.2-16.9%)
Relatively Stable	34.7% (27.2-44.7%)
Unstable	55.3% (44.9-63.5%)
Is your dwelling in need of any repairs?	
Reg	66.6% (56.1-73.6%)
Minor	27.9% (20.8-38.1%)
Major	5.6% (3.7-8.2%)
Socio-Economic Status	
Income	
No personal income	1.4% (0.4-2.3%)
$1 to $4,999	19.5% (11.0%-29.1%)
$5000 to $9,999	22.8% (16.7-32.8%)
$10,000 to $14,999	20.5% (14.2-26.8%)
$15,000 to $19,000	11.2% (7.6-17.9%)
$20,000 to $24,999	7.9% (3.3-13.5%)
$25,000 to $29,999	5.6% (1.9-8.8%)
$30,000 to $39,000	4.5% (0.9-9.4%)
$40,000 to $49,000	2.2% (0.5-4.5%)
$50,000 to $59,000	2.8% (0.7-4.7%)
$60,000 to $69,000	0.2% (0.0-0.5%)
$70,000 to $79,000	0.1% (0.0-0.3%)
$80,000 and over	1.2% (0.0-3.0%)
How many people reside per room in your house? **mean (STDEV)**	0.74 (0.94)

Table 5: Weighted bivariate logistic regression analysis of barriers to access to health services and their association with the prevalence of hypertension in an adult urban First Nations population (n=537).

Barrier to Access to Health Services	Surveyfreq	Glimmix
Access to Health Services	**Odds Ratio (95% CI)**	**Odds Ratio (95% CI)**
Doctor not available in my area	2.21 (0.97-5.04)	**1.97 (1.21-3.22)**
Nurse not available	**3.30 (1.30-8.39)**	**2.63 (1.49-4.65)**
Lack of trust in healthcare provider	1.01 (0.50-2.04)	0.92 (0.54-1.58)
Waiting list too long	1.96 (0.98-3.94)	**1.92 (1.21-3.04)**
Unable to arrange transportation	0.95 (0.43-2.08)	1.03 (0.62-1.69)
Difficulty getting traditional care	1.51 (0.64-3.54)	**1.89 (1.06-3.38)**
Not covered by non-insured health benefits (service, medication, equipment)	**2.73 (1.03-7.21)**	**3.09 (1.70-5.62)**
Prior approval for services under non-insured health benefits (NIHB) was denied	**4.18 (1.55-11.23)**	**5.16 (2.67-9.97)***
Could not afford cost of care/service	**2.93 (1.33-6.48)**	**3.77 (2.28-6.26)**
Could not afford transportation costs	1.60 (0.78-3.28)	**1.74 (1.07-2.82)**
Could not afford childcare costs	1.49 (0.50-4.51)	1.54 (0.58-4.05)
Felt health care provided was inadequate	2.01 (0.97-4.17)	**2.14 (1.29-3.55)**
Felt service was culturally not appropriate	**2.43 (1.18-4.97)**	**2.83 (1.66-4.83)**
Chose not to see health professional	1.02 (0.46-2.26)	0.95 (0.56-1.62)
Service was not available in my area	1.12 (0.52-2.39)	1.34 (0.75-2.41)
Access to Food and Nutrition		
Do you eat a nutritious balanced diet?	1.18 (0.83-1.68)	1.15 (0.89-1.47)
Which best describes the food eaten in your household in the past 12 months	0.95 (0.63-1.43)	0.85 (0.65-1.13)
Housing and Population Mobility		
How many times have you moved in the past 5 years?	0.96 (0.57-1.60)	0.76 (0.54-1.07)
How many people reside per room in your house?	0.62 (0.25-1.58)	0.69 (0.43-1.13)
Is your dwelling in need of any repairs?	1.44 (0.86-2.42)	1.20 (0.83-1.75)
Socio-Economic Status		
Income	1.14 (0.98-1.32)	**1.18 (1.07-1.30)**

*Required the AR(1) function to converge
**Did not converge, even with the AR(1) function

Table 6: Weighted logistic regression analysis of barriers to access to health services and their association with the prevalence of hypertension in an adult urban First Nations population, adjusted for age and sex (n=537).		
Barrier to Access to Health Services	**SurveyLogistic**	**Glimmix**
Access to Health Services	**Odds Ratio (95% CI)**	**Odds Ratio (95% CI)**
Doctor not available in my area	**2.78 (1.16-6.65)**	**2.36 (1.34-4.15)**
Nurse not available	**4.98 (1.80-13.78)**	**3.55 (1.85-6.80)**
Lack of trust in healthcare provider	1.42 (0.66-3.06)	1.54 (0.84-2.85)
Waiting list too long	2.10 (1.00-4.43)	**1.80 (1.08-3.01)***
Unable to arrange transportation	1.05 (0.46-2.38)	1.17 (0.66-2.05)
Difficulty getting traditional care	1.50 (0.58-3.92)	**2.06 (1.06-3.99)**
Not covered by non-insured health benefits (service, medication, equipment)	**2.96 (1.16-7.58)**	3.47 (1.78-6.74)
Prior approval for services under non-insured health benefits (NIHB) was denied	**3.56 (1.39-9.11)**	**4.10 (2.00-8.39)***
Could not afford cost of care/service	**2.87 (1.28-6.45)**	**3.84 (2.20-6.71)**
Could not afford transportation costs	1.67 (0.76-3.70)	**1.75 (1.03-2.98)**
Could not afford childcare costs	1.49 (0.47-4.73)	1.59 (0.54-4.66)
Felt health care provided was inadequate	1.89 (0.91-3.95)	**2.38 (1.34-4.21)**
Felt service was culturally not appropriate	**2.29 (1.09-4.81)**	**2.63 (1.41-4.88)***
Chose not to see health professional	1.15 (0.47-2.80)	1.01 (0.57-1.81)*
Service was not available in my area	1.25 (0.57-2.73)	1.72 (0.89-3.34)
Access to Food and Nutrition		
Do you eat a nutritious balanced diet?	1.27 (0.86-1.87)	1.26 (0.95-1.68)
Which best describes the food eaten in your household in the past 12 months	0.90 (0.60-1.34)	0.79 (0.58-1.08)*
Housing and Population Mobility		
How many times have you moved in the past 5 years?	1.24 (0.72-2.13)	1.03 (0.70-1.52)
How many people reside per room in your house?	0.62 (0.24-1.59)	0.73 (0.49-1.09)
Is your dwelling in need of any repairs?	1.64 (0.95-2.83)	1.25 (0.82-1.90)
Socio-Economic Status		
Income	1.11 (0.96-1.28)	**1.13 (1.10-1.26)**
*Required the AR(1) function to converge **Did not converge, even with the AR(1) function		

Table 7: Weighted logistic regression analysis of barriers to access to health services and their association with the prevalence of hypertension in an adult urban First Nations population, adjusted for age, sex, BMI and obesity, physical activity, smoking status, alcohol consumption, diabetes, and the presence of a mental disorder (n=537).

Barrier to Access to Health Services	**SurveyLogistic**	**Glimmix**
Access to Health Services	**Odds Ratio (95% CI)**	**Odds Ratio (95% CI)**
Doctor not available in my area	**3.67 (1.30-10.39)**	**2.73 (1.20-6.21)**
Nurse not available	**7.51 (2.27-24.85)**	**4.19 (1.62-10.85)**
Lack of trust in healthcare provider	1.16 (0.48-2.81)	1.07 (0.44-2.64)
Waiting list too long	1.22 (0.51-2.91)	1.22 (0.55-2.67)
Unable to arrange transportation	0.60 (0.23-1.57)	0.83 (0.37-1.86)
Difficulty getting traditional care	2.76 (0.79-9.63)	**4.00 (1.48-10.81)***
Not covered by non-insured health benefits (service, medication, equipment)	**5.49 (1.97-15.30)**	**6.30 (1.98-20.06)**
Prior approval for services under non-insured health benefits (NIHB) was denied	**5.48 (1.81-16.61)**	**4.21 (1.26-14.05)**
Could not afford cost of care/service	**4.53 (1.79-11.47)**	**3.48 (1.60-7.57)**
Could not afford transportation costs	1.54 (0.54-4.41)	1.33 (0.62-2.86)
Could not afford childcare costs	2.51 (0.56-11.22)	1.29 (0.32-5.21)
Felt health care provided was inadequate	1.45 (0.55-3.86)	1.64 (0.72-3.71)
Felt service was culturally not appropriate	1.74 (0.62-4.90)	1.86 (0.78-4.44)
Chose not to see health professional	1.05 (0.34-3.26)	0.90 (0.39-2.08)
Service was not available in my area	1.61 (0.55-4.72)	1.85 (0.70-4.91)
Access to Food and Nutrition		
Do you eat a nutritious balanced diet?	1.33 (0.75-2.34)	1.25 (0.83-1.89)
Which best describes the food eaten in your household in the past 12 months	0.85 (0.52-1.40)	0.81 (0.52-1.27)
Housing and Population Mobility		
How many times have you moved in the past 5 years?	1.41 (0.72-2.76)	**
How many people reside per room in your house?	0.50 (0.16-1.55)	**
Is your dwelling in need of any repairs?	1.60 (0.89-2.88)	**
Socio-Economic Status		
Income	1.09 (0.93-1.28)	1.08 (0.91-1.27)

*Required the AR(1) function to converge
**Did not converge, even with the AR(1) function

Table 8: Weighted bivariate logistic regression analysis of barriers to access to health services and their association with the prevalence of CVD in an adult urban First Nations population (n=548).

Barrier to Access to Health Services	Surveyfreq	Glimmix
Access to Health Services	**Odds Ratio (95% CI)**	**Odds Ratio (95% CI)**
Doctor not available in my area	1.14 (0.43-3.03)	1.11 (0.62-1.98)*
Nurse not available	1.19 (0.44-3.26)	1.20 (0.61-2.36)*
Lack of trust in healthcare provider	1.47 (0.58-3.69)	1.42 (0.77-2.61)
Waiting list too long	**3.11 (1.27-7.60)**	**3.09 (1.74-5.50)***
Unable to arrange transportation	0.96 (0.37-2.47)	1.04 (0.59-1.82)
Difficulty getting traditional care	1.22 (0.49-3.07)	1.13 (0.55-2.30)
Not covered by non-insured health benefits (service, medication, equipment)	**3.84 (1.29-11.46)**	**4.00 (2.11-7.57)**
Prior approval for services under non-insured health benefits (NIHB) was denied	**5.85 (1.93-17.71)**	**6.01 (3.02-11.99)***
Could not afford cost of care/service	**3.27 (1.28-8.34)**	**3.44 (1.99-5.93)**
Could not afford transportation costs	1.43 (0.57-3.61)	1.31 (0.75-2.29)
Could not afford childcare costs	0.37 (0.09-1.52)	**
Felt health care provided was inadequate	**2.97 (1.19-7.41)**	**3.21 (1.83-5.60)**
Felt service was culturally not appropriate	**3.55 (1.44-8.77)**	**3.48 (1.97-6.17)**
Chose not to see health professional	1.60 (0.63-4.07)	**
Service was not available in my area	1.65 (0.65-4.23)	1.67 (0.90-3.09)
Access to Food and Nutrition		
Do you eat a nutritious balanced diet?	1.16 (0.78-1.72)	1.14 (0.86-1.52)
Which best describes the food eaten in your household in the past 12 months	1.02 (0.53-1.98)	1.03 (0.75-1.42)
Housing and Population Mobility		
How many times have you moved in the past 5 years?	1.21 (0.55-2.65)	1.15 (0.75-1.76)
How many people reside per room in your house?	1.22 (0.90-1.66)	**1.22 (1.01-1.47)**
Is your dwelling in need of any repairs?	1.30 (0.67-2.55)	1.33 (0.85-2.06)
Socio-Economic Status		
Income	**1.30 (1.12-1.52)**	**1.31 (1.17-1.46)**

*Required the AR(1) function to converge

**Did not converge, even with the AR(1) function

Table 9: Weighted logistic regression analysis of barriers to access to health services and their association with the prevalence of CVD in an adult urban First Nations population, adjusted for age and sex (n=548).

Barrier to Access to Health Services	**SurveyLogistic**	**Glimmix**
Access to Health Services	**Odds Ratio (95% CI)**	**Odds Ratio (95% CI)**
Doctor not available in my area	1.49 (0.55-4.00)	1.26 (0.66-2.41)
Nurse not available	1.55 (0.55-4.39)	1.36 (0.65-2.86)
Lack of trust in healthcare provider	2.18 (0.88-5.43)	**2.08 (1.05-4.12)***
Waiting list too long	**4.17 (1.50-11.60**)	**3.72 (1.97-7.04)**
Unable to arrange transportation	0.98 (0.38-2.53)	0.99 (0.53-1.87)
Difficulty getting traditional care	1.28 (0.50-3.30)	1.26 (0.58-2.71)
Not covered by non-insured health benefits (service, medication, equipment)	**3.83 (1.30-11.32)**	**3.39 (1.70-6.77)**
Prior approval for services under non-insured health benefits (NIHB) was denied	**4.47 (1.49-13.42)**	**4.24 (2.01-8.94)**
Could not afford cost of care/service	**2.87 (1.12-7.36)**	**2.59 (1.40-4.79)***
Could not afford transportation costs	1.19 (0.42-3.38)	1.03 (0.56-1.90)
Could not afford childcare costs	0.43 (0.10-1.86)	0.40 (0.07-2.32)*
Felt health care provided was inadequate	2.39 (0.92-6.21)	**2.56 (1.38-4.75)**
Felt service was culturally not appropriate	2.39 (0.93-6.15)	**2.12 (1.08-4.16)**
Chose not to see health professional	1.82 (0.73-4.54)	**1.98 (1.05-3.71)**
Service was not available in my area	1.86 (0.72-4.80)	1.90 (0.96-3.78)
Access to Food and Nutrition		
Do you eat a nutritious balanced diet?	1.28 (0.82-2.00)	1.25 (0.90-1.74)
Which best describes the food eaten in your household in the past 12 months	1.05 (0.53-2.09)	1.11 (0.78-1.57)
Housing and Population Mobility		
How many times have you moved in the past 5 years?	1.84 (0.68-5.01)	1.57 (0.98-2.53)*
How many people reside per room in your house?	1.24 (0.71-2.18)	**1.24 (1.02-1.50)**
Is your dwelling in need of any repairs?	1.39 (0.66-2.90)	1.26 (0.77-2.07)
Socio-Economic Status		
Income	**1.32 (1.11-1.56)**	**

*Required the AR(1) function to converge
**Did not converge, even with the AR(1) function

Table 10: Weighted logistic regression analysis of barriers to access to health services and their association with the prevalence of CVD in an adult urban First Nations population, adjusted for age, sex, BMI and obesity, physical activity, smoking status, alcohol consumption, diabetes, and the presence of a mental disorder (n=548).

Barrier to Access to Health Services	**SurveyLogistic**	**Glimmix**
Access to Health Services	**Odds Ratio (95% CI)**	**Odds Ratio (95% CI)**
Doctor not available in my area	1.30 (0.34-4.98)	1.03 (0.33-3.23)
Nurse not available	1.25 (0.24-6.43)	0.93 (0.28-3.13)
Lack of trust in healthcare provider	1.11 (0.23-5.45)	0.87 (0.25-3.10)
Waiting list too long	2.12 (0.62-7.28)	2.59 (0.95-7.11)
Unable to arrange transportation	1.44 (0.41-5.13)	1.37 (0.46-4.12)
Difficulty getting traditional care	1.10 (0.28-4.39)	**
Not covered by non-insured health benefits (service, medication, equipment)	2.91 (0.84-10.08)	2.95 (0.72-12.07)
Prior approval for services under non-insured health benefits (NIHB) was denied	2.22 (0.52-9.60)	2.98 (0.67-13.34)
Could not afford cost of care/service	1.88 (0.66-5.36)	1.43 (0.54-3.79)
Could not afford transportation costs	1.80 (0.35-9.19)	1.43 (0.54-3.81)
Could not afford childcare costs	0.23 (0.03-1.71)	0.08 (0-1.90)*
Felt health care provided was inadequate	3.11 (0.94-10.36)	2.50 (0.87-7.15)
Felt service was culturally not appropriate	1.95 (0.54-6.97)	1.21 (0.40-3.67)
Chose not to see health professional	1.38 (0.41-4.70)	1.38 (0.50-3.83)
Service was not available in my area	0.80 (0.16-4.13)	0.77 (0.22-2.70)
Access to Food and Nutrition		
Do you eat a nutritious balanced diet?	**2.13 (1.11-4.08)**	**1.96 (1.19-3.25)**
Which best describes the food eaten in your household in the past 12 months	1.35 (0.61-3.01)	1.21 (0.72-2.02)
Housing and Population Mobility		
How many times have you moved in the past 5 years?	1.20 (0.34-4.21)	1.15 (0.57-2.29)
How many people reside per room in your house?	**1.98 (1.20-3.30)**	**2.32 (1.21-4.46)**
Is your dwelling in need of any repairs?	2.09 (0.86-5.11)	**2.14 (1.01-4.57)**
Socio-Economic Status		
Income	1.16 (0.88-1.53)	1.16 (0.92-1.46)

*Required the AR(1) function to converge
**Did not converge, even with the AR(1) function

Chapter 5: Discussion

The results of this study show an association between access to health services variables, living conditions, and diet on the prevalence of hypertension and CVD in an urban First Nations population. Furthermore, the findings make an important contribution to the sparse data on urban Indigenous peoples. The study also provides examples of multivariable regression analyses of RDS data.

Significant associations for the prevalence of hypertension were the unavailability of a doctor in a participant's area, and feeling nurses weren't available. Respondents already diagnosed with hypertension who have difficulty accessing health care professionals may not have access to consistent blood pressure monitoring, education and preventative measures of modifiable risk factors of high blood pressure (83). Continuous adherence to pharmacological treatment and a healthy lifestyle are important for blood pressure control (84, 85). Lack of compliance to prescribed anti-hypertensive medications is a major contributor to uncontrolled blood pressure and has been associated with biomarkers for a higher cardiac workload (84, 85, 86). This is relevant, as previous research has shown that regular interaction and recommendations by primary care providers (PCP's) can influence the adoption of healthy behaviours among patients (87, 88, 89, 90). Access to health care professionals is particularly important as hypertension is often asymptomatic, and its treatment is an ongoing process (83). Due to the cross-sectional nature of this study, it's possible that having hypertension may have unmasked these unmet needs rather than the variables themselves influencing the prevalence of the disorder.

It is well documented Indigenous peoples consider traditional healing practises to be important (2, 33, 37). A significant association was found between difficulty accessing traditional care, and

the prevalence of hypertension. In a study on data collected through the APS, Wilson and Caldwell (14) noted that urban Indigenous People who contacted a traditional healer were less likely to self-report fair/poor health versus excellent/very good/good health on the single-item global measure of self-assessed health, in contrast to those who consulted a nurse or doctor. The authors also suggested that perhaps conventional treatment was used for illness, whereas traditional healers were used for maintaining health (14). This potential explanation would be in keeping with the holistic and spiritual view of traditional Indigenous health practises (14). This may be relevant to chronic conditions, such as hypertension, given that prevention and stress management are key parts of treatment (83). Another possible reason for the importance of traditional care is that it may be a protective factor against depression, which can contribute to cardiovascular disorders (8, 52, 53). This is relevant, as Tjepkema (8) found that Indigenous people living off reserve exhibited high rates of depression. Bellamy (91) noted that Indigenous individuals were less likely to respond to western-based mental health treatment, and had a high risk of dropping out. However, as this study is cross-sectional we cannot rule out that those with hypertension were seeking more access to traditional healers and hence experienced more barriers to accessing traditional care.

The positive effect of traditional care may also be connected to the relationship between a health care provider and patient (92). Through a set of interviews with primary care providers and some of their hand-selected patients, Scott (92), identified factors fostering a relationship that facilitated healing. Three factors that appeared to foster a "healing relationship" between primary care provider and patient were: valuing/creating a nonjudgmental emotional bond, appreciating power/consciously managing clinician power in ways that would most benefit the patient, and abiding/displaying a commitment to caring for patients over time (92). Health care providers

who respect an Indigenous person's culture and individuality may be able to foster a relationship more conducive to healing (92). This is supported by Waldram (37), who found that a biased attitude of a health care provider towards alternate treatment was a significant barrier to health care delivery to Indigenous peoples. Culturally trained therapists could help fulfill the specific needs of this group (37, 91).

The following three factors were significantly associated with the prevalence of hypertension: services under NIHB being previously denied, not being covered by NIHB, and not being able to afford the costs of care/services. Potentially, a participant's inability to afford anti-hypertensive medications, either by lack of NIHB coverage or financial means, may impede their ability to treat hypertension (84, 85, 93). Indigenous peoples rely heavily on these benefits, especially for pharmacy costs. In a 2010 report by Health Canada, that captured NIHB pharmacy claim data from 2000-2009, the percentage of Indigenous peoples in Canada using cardiac drugs, including antihypertensive agents, had increased by 50% over the studies' time period (94). The increase in drug usage was highest among the younger generations (67%, 32% and 26% amongst those aged 20-39, 40-64 and 65+, respectively) (94).

The significant association between a more unbalanced, less nutritious diet, and the prevalence of CVD, is consistent with literature on diet as a modifiable risk factor for CVD (95). A diet high in saturated fats can increase risk factors for CVD and its associated risk factors, such as obesity, diabetes, hypertension, and elevated lipid levels (2, 95, 46). This is relevant to Indigenous peoples as their traditional diet, which involved nutrient-rich food, high in animal protein and low in fat, may have been replaced by a diet high in processed foods which is associated with the onset of obesity, metabolic disorders and other CVD risk factors (1, 47).

Poor housing conditions and overcrowding have been associated with detriments in both physical and mental wellbeing (65, 66). Living in a dwelling in need of repairs, and living in more crowded housing conditions, were both significantly associated with the prevalence of CVD. A review article by Cooper (96) on the effects of the physical environment and its effect on mental health corroborated these findings. It highlighted that poor housing quality has been associated with poorer mental health outcomes, such as depression, and anxiety (96). Weich and Lewis (97), noted that individuals living in dwellings with 2 or more minor or major structural problems were 1.4 times more likely to have mental disorders. Other studies also reported positive associations between housing quality with mental disorders and psychological distress (98, 99). Wells (98) observed that psychological distress among women who relocated to lower quality households was diminished following basic household improvements.

The significant association of crowding with the prevalence of CVD was consistent with Cooper's (96) review, that crowding had detrimental effects on social relations, mental fatigue, and stress. A study by Fuller, which examined the impact of housing conditions and household crowding in Thailand, found that a lack of privacy was associated with increased psychological stress (100). Wells (98) further reported that there were improvements in psychological distress in response to decreased crowding. It is also possible that crowding could contribute to communicable diseases, such as rheumatic fever, which, if left untreated, can lead to rheumatic heart disease (101).

Strengths and Limitations

To our knowledge, this was one of the most comprehension examinations of barriers to access to health services on the prevalence of hypertension and CVD in an urban Indigenous population.

The use of RDS afforded a larger, more representative sample size than regular snowball sampling, while reducing selection bias. Methodological complications arising from the use of this sampling technique were minimized by the improved multivariable models developed by Dr. Rotondi. In addition, a community-based participatory framework was employed to develop the OHC study, which involved the Indigenous community in survey design and study priorities, making the study more culturally appropriate and reflective of the community's needs (58).

In terms of limitations, the data analyzed in this study was cross-sectional, so it was not possible to ascertain causality between the outcome and other variables. Specifically, we cannot say for certain whether the observed barriers to access health care caused hypertension or CVD, or if the presence of hypertension or CVD led to study participants experiencing more barriers in their use of health care services. In addition, the OHC study only collected data from the city of Hamilton. However, future OHC studies are currently underway in Toronto, Ontario and London, Ontario and may further validate these findings. This should be taken into account when generalizing the results of the study to the greater Indigenous population. It was also possible that the degree of household crowding was underreported, as the maximum option on the survey for the number of individuals residing in a household was "10 or more". However, only six respondents reported this option. Nonetheless, the rate of overcrowding was 19 times the national average, further demonstrating the importance of this factor in Hamilton's Indigenous community (19). Another limitation was that a positive diagnosis for hypertension and CVD required an official diagnosis by a health professional. There is also the possibility that hypertension and CVD were underreported in this study, as Tjepkema (8) reported that the number of Indigenous people who reported regularly seeing a doctor was lower than for provincial residents. This may be a particular issue for hypertension, which is often asymptomatic, and requires several blood

pressure tests at different time intervals for diagnosis (93). Finally, the barriers to access to health services captured only those that respondents had experienced in the past 12 months. This meant that it could not account for any other contributing factors to the outcome that may have occurred prior to that time frame.

Study Implications

This study has implications with respect to potential targeting of effective measures for hypertension and CVD in an urban Indigenous population. It also helps to fill the gap in health research in this group. The significant findings with hypertension may highlight the importance of exploring factors that contribute to improving regular access to both conventional and traditional health care providers among First Nations peoples. It also encourages more exploration into the specific effects of traditional care on hypertension in an urban environment. Alternatively, given that the data are cross-sectional the observed associations may be reversed, and the results would thus show a significant portion of urban Indigenous participants who have hypertension or CVD have unmet health care needs. The significant findings of the variables involving lack of access to NIHB may highlight the importance of extra coverage in hypertension and CVD treatment, however future analyses will explore this as a function of NIHB eligibility. The significant results of this study suggest avenues to mitigate the rapidly increasing burden of cardiac conditions among urban First Nations peoples in terms of mortality, quality of life and cost to the healthcare system.

The weighted RDS framework used in the OHC survey also provides a potential sampling frame that can produce asymptotically unbiased estimates for future research in urban First Nations populations and other hidden populations. The study also has implications for future research in

the application of regression models for data obtained through RDS, particularly with respect to linear mixed models and survey-based procedures.

The next step of this study is consulting with the involved Indigenous stakeholders to finalize the interpretation of results, as well as its dissemination, to ensure accessibility of these results to all members of this population. To reiterate, the Indigenous community maintains ownership of this data, and oversees all aspects of interpretation and dissemination in accordance with the research agreement in the OHC community report (Appendix A) (19).

Conclusion

This study found that the prevalence of hypertension in an urban First Nations population was associated with barriers to access to health services, while the prevalence of CVD was associated with inadequate housing factors, and having a more unbalanced, less nutritious diet. The findings suggest potential mechanisms to target the burden posed by CVD and hypertension in this group. Future research and interventions in this group could focus on the importance of NIHB benefits and other coverage, better access to health care providers, both traditional and biomedical, and improved housing conditions. The results of this study highlight areas where resources and funding could be allocated to effectively handle hypertension and CVD among urban First Nations peoples, and potentially among Indigenous peoples in general.

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