

# BMJ Open Unmasking health determinants and health outcomes for urban First Nations using respondent-driven sampling

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## ABSTRACT

**Objective:** Population-based health information on urban Aboriginal populations in Canada is limited due to challenges with the identification of Aboriginal persons in existing health data sets. The main objective of the Our Health Counts (OHC) project was to work in partnership with Aboriginal stakeholders to generate a culturally relevant, representative baseline health data set for three urban Aboriginal communities in Ontario, Canada.

**Design:** Respondent-driven sampling (RDS).

**Setting:** Hamilton, Ontario, Canada.

**Participants:** The OHC study, in partnership with the De dwa da dehs ney >s Aboriginal Health Access Centre (DAHC), recruited 554 First Nations adults living in Hamilton using RDS.

**Results:** Among First Nations adults living in Hamilton, 78% earned less than \$20 000 per year and 70% lived in the lowest income quartile neighbourhoods. Mobility and crowded living conditions were also highly prevalent. Common chronic diseases included arthritis, hypertension, diabetes and chronic obstructive pulmonary disease and rates of emergency room access were elevated.

**Conclusions:** RDS is an effective sampling method in urban Aboriginal contexts as it builds on existing social networks and successfully identified a population-based cohort. The findings illustrate striking disparities in health determinants and health outcomes between urban First Nations individuals and the general population which have important implications for health services delivery, programming and policy development.

## INTRODUCTION

According to the 2006 Census, over 60% (150 570 people) of Aboriginal<sup>1</sup> people living

<sup>1</sup>“Aboriginal people” is a collective name for all of the original peoples of Canada and their descendants. The *Constitution Act* of 1982 specifies that the Aboriginal Peoples in Canada consist of three groups: Indians, Inuit and Métis. The term First Nations came into common use in the 1970s to replace Indian, which some people found offensive. Despite its widespread use, there is no legal definition for this term in Canada. In the United

## Strengths and limitations of this study

- Our study is the first respondent-driven sampling (RDS) of self-identified First Nations people residing in an urban setting in Canada.
- This study models best practices in academic-Aboriginal community research partnerships.
- RDS has been demonstrated to be a promising tool for generating Aboriginal health assessment measures in urban areas where there are limited existing sampling frame options.
- At present, multivariable regression analyses using RDS samples have not appropriately addressed the co-relation between observations and the unequal sampling probabilities inherent in RDS; therefore, we present prevalence estimates for which methods are better established.

in Ontario live in urban areas.<sup>1</sup> Nearly 7 of 10 Métis live in urban areas, and about 3 of every 4 people in the off-reserve First Nations population live in urban areas.<sup>1</sup> First Nations people have historically been dislocated from their original homelands and may constitute diasporic, heterogeneous communities in urban areas.<sup>2</sup> Specifically, an increasing number of First Nations individuals are moving to urban centres to seek better housing, employment and education opportunities and for the services and amenities available.<sup>3–5</sup> There is a growing body of literature exploring the complexities of urban indigeneity,<sup>6</sup> and some of the elements which distinguish urban Aboriginal identity are social and economic marginalisation, a growing middle class and population diversity in terms of cultural origins and legal status.<sup>7</sup>

States, the term “Native American” is used to represent Indigenous peoples from North America, including Mexico. For alignment with the US Constitution and to ensure policy implications, the term “American Indian” is still used for Indigenous populations living within US borders, particularly the lower 48 states and parts of Alaska. “Indigenous” is a term used in the international context.

According to the Canadian Census, First Nations, Inuit and Métis populations experience ongoing disparities in social determinants of health such as income insecurity, unemployment, low levels of education, decreased food availability and inadequate housing compared with non-Aboriginal Canadians, and these disparities are exacerbated with urban residence.<sup>1 8 9</sup>

Despite the growing size of the urban Aboriginal population in Canada, accessible and culturally relevant population health data for this population are almost non-existent.<sup>10–13</sup> While census data do exist, there are serious deficits in population health measures.<sup>13</sup> Some of the reasons behind this deficiency are limitations in the current health information system and data collection processes with respect to Aboriginal peoples.<sup>14 15</sup> Sampling frames are often biased and comprise non-random subpopulations such as lists of members or clients of particular programmes and services in the community. When urban Aboriginal people have been included in census-based national surveys, these surveys were underpowered and often First Nations, Inuit and Métis data could not be successfully disaggregated.<sup>14 16</sup> Additionally, studies based on census data show that a significant number of Aboriginal people move from rural and reserve areas to cities, and back and forth as well as within and among cities.<sup>4 17</sup> These factors make it difficult to get reliable counts of the Aboriginal population of a city.

At the national level, the continued inability to identify Aboriginal peoples in healthcare databases leads to very poor coverage of Aboriginal populations in Canada, with a specific paucity of health information for First Nations, Métis and Inuit populations living in urban areas. Provincial and territorial systems generally do not collect ethnic-specific utilisation data, and their ethnic flags for vital statistics are inconsistent or absent.<sup>18</sup> The federal government's decision to cancel the long form of the Canadian national census will further challenge the ability of researchers and communities to identify and address social inequities across and within populations that experience racialisation and the negative effects of structural discrimination in healthcare and other sectors, thus widening the existing health and social policy vacuum.<sup>19 20</sup>

In the absence of an accessible and accurate population-based sampling frame for urban Aboriginal people, we implemented respondent-driven sampling (RDS) for the Our Health Counts (OHC) study. RDS, like other chain-referral approaches, relies on members of a population to recruit their peers.<sup>21 22</sup> However, RDS differs from other methods because of estimation procedures that adjust for the participants' different probabilities of being sampled.<sup>22</sup> RDS also differs from other chain-referral methods because the number of recruitments any participant can make is limited, and it employs a dual incentive structure where participants are rewarded for participating and for recruiting their peers.<sup>23</sup>

There is limited literature on RDS in Indigenous contexts;<sup>24</sup> however, there is evidence that links the success of RDS to the strength of social networks and relationships.<sup>25</sup> Indigenous knowledge is wholistic, relational and embraces a fluidity that allows for constant growth and change.<sup>26 27</sup> Aboriginal identities tend to value the group over the individual, thereby establishing models of kinship where everyone has the right to give and receive according to their own choices.<sup>26</sup> Therefore, we hypothesised that RDS would be an appropriate and effective sampling methodology as it builds on social networks and would draw on existing kinship systems known to be present in Indigenous communities.<sup>28</sup>

The main objective of the OHC project was to work in partnership with Aboriginal stakeholders to generate a culturally relevant, representative baseline health data set for three urban Aboriginal communities in Ontario, Canada. The results presented here pertain specifically to the urban First Nations population in Hamilton where the organisational project lead was the Ontario Federation of Indian Friendship Centres (OFIFC) and the community partner was the De dwa da dehs ney >s Aboriginal Health Access Centre (DAHC).

## METHODS

### Community-based participatory research

This study upheld current ethical and scientific standards in Indigenous health research<sup>29–32</sup> through a community-based participatory research partnership between the academic research team, OFIFC and DAHC. We ensured that our Aboriginal decision-making partners were active in all aspects of the research through the following mechanisms: Aboriginal leadership; research agreements which explicitly addressed issues of project governance, community expectations, benefits, ownership, control, access and possession of information, and dissemination of project results; capacity building through staffing at community sites, data workshops and awareness building; respect for the individual and collective rights of Aboriginal peoples with respect to their health information; cultural relevance through the development and application of culturally appropriate measures; representation of the urban Aboriginal population of Ontario; and sustainability of the project to ensure expansion of the database. In addition, a governing council, comprised of representatives from the core partner urban Aboriginal provincial organisations, was established to oversee all stages of the research process. Specifically, this body adhered to governance protocols and ensured that individual and collective community rights were respected, were kept informed about the project's progress and led the project towards meaningful results, acted as a resource to the community on questions related to various portions of the research project and controlled the release of all data generated by the study.

All members of the Hamilton study team were from the Aboriginal community, living in the general vicinity of the City of Hamilton. Formal ethics approval was provided by the Research Ethics Board of St. Michael's Hospital in Toronto.

### Study site

The City of Hamilton is located in southern Ontario on what was traditionally Haudenosaunee (Iroquoian) territory and is near two First Nations reserves: Six Nations of the Grand River and Mississaugas of the New Credit. According to the 2006 Census, the total Aboriginal population in Hamilton was 13 735 people, comprising 2.8% of the total population of the city.<sup>33</sup> The OFIFC identified the City of Hamilton as a promising community site based on its significant Aboriginal population and strong infrastructure of Aboriginal community services.

### Recruitment

The RDS process was initiated through the purposive selection of individuals to begin recruitment, also called 'seeds'. Inclusion criteria for participation in the study included 18 years of age, residence within the geographic boundaries of the City of Hamilton and self-identified as having First Nations identity. First Nations identity was determined through open dialogue around family, experiences and location while also explaining the overall study goals and additional study sites in Ottawa. Questions such as: "What words best describe you?" and "How do you see yourself?" were useful. With the help of community partners, six seeds were identified and agreed to participate. In order for seeds to reflect a diverse demographic of First Nations people living in Hamilton, factors such as gender, age, family size and occupations were considered in their selection. For example, seeds were identified in the student population, among the steel workers union, among artists, elders, housing and social assistance providers as well as members of local Aboriginal organisations and boards. Five of the six seeds produced referrals within the 2 weeks leading up to the December 2009 holiday closure at DAHC. In February and March 2010, three additional seeds were added.

Study participants, including seeds, provided informed consent and then completed a health assessment survey after which they received 3–5 coded coupons to refer a member of their social network into the study. Following the holiday closure of DAHC, the number of distributed coupons per recruit was increased from 3 to 5 in order to increase the rate of recruitment. Participants received a monetary reimbursement of \$20 for their time and participation. They also received an additional \$10 for every eligible person they recruited into the study. Study recruitment and interviews took place in an Aboriginal community centre.

For sample size calculation, we assumed 95% CI, survey item prevalence ranges from 10% to 75% and a

design effect of two.<sup>34</sup> Based on this formula, the OHC study aimed to recruit 500 First Nations adults and 250 children.

### Sources of data

Community concept mapping was implemented to develop a community-specific survey for First Nations in Hamilton,<sup>35</sup> which was comprised of eight domains covering areas such as sociodemographics, physical, mental and emotional health, First Nations identity and impacts of colonisation (ie, questions about residential school attendance, involvement of child protection agencies, dislocation from traditional lands and discrimination), and access and barriers to care. The survey tool was piloted with First Nations community members, and minor modifications were made to improve face validity. Data were collected and compiled by computer-assisted personal interviewing with a computer-based version of the survey tool developed by the research team using the SPSS Data Collection Author and Collector.<sup>36</sup>

On completion of recruitment and survey, our sample of First Nations adults was linked to data holdings at the Institute of Clinical Evaluative Sciences (ICES) including provincial records of emergency room and hospital visits (Canadian Institutes of Health Information—Discharge Abstract Database and National Ambulatory Care Reporting System: Emergency), and neighbourhood income quintiles (derived from census data). Using healthcare system identification numbers (ie, Ontario Health Card) provided by participants, we successfully linked 92% (N=725) of First Nations adults to the ICES database.

### Analysis

Recruitment dynamics, adjusted population-based estimates and CIs were calculated using the RDS-I enhanced data smoothing estimator in the custom RDSAT software (V.7.1).<sup>37</sup> The RDS methodology anticipates that personal networks are not randomly distributed, and therefore adjusts for small-to-moderate levels of network clustering (people who have ties to others like them), in the form of postsampling weights.

### RESULTS

Among First Nations adults in Hamilton, 78.9% of participants were recruited via referral trees originating from two seeds. With 19 and 32 waves, respectively, the lengths of both of these recruitment chains were long enough to overcome the original sampling bias, which usually happens after 6 or 7 waves of recruitment.<sup>38</sup> The statistical theory is that if the chain-referral process consists of enough waves or cycles of recruitment, the composition of the final sample with respect to key characteristics and behaviours will become independent of the seeds from which it began. The point at which the sample composition becomes stable is termed

'equilibrium' and is an indication that RDS has been implemented successfully.<sup>21</sup>

Over a period of 4.5 months (November 2009–March 2010), a total of 790 persons were recruited, including 554 adults and 236 children. Overall, a high-response rate for survey questions was observed. Specifically, non-response rates ranged from 2.5% to less than 0.5%, including sensitive questions around income, food security and impacts of colonisation, which had non-response rates under 2%. Such high-response rates can be attributed to the survey tool itself, which reflected the health priorities of the community<sup>39</sup> and which was administered in a safe and culturally secure context. Demographic and social characteristics are presented in table 1.

The data presented in table 2 for age, gender and income quintiles compare the OHC population estimates with the total Hamilton population and a random subset of 10% of the Ontario provincial population. The three populations were very similar with respect to the gender breakdown; however, the OHC sample was younger than the general Hamilton and Ontario populations, which is consistent with the census data.<sup>41</sup> Over 70% of the First Nations population fell into the lowest income quartile compared with 25% of the general Hamilton population and 20% of the Ontario population. At the higher end of the income scale, we observed that while 15% of Hamilton residents and 20% of the Ontario population fell into the highest income quartile, only 3% of the study population was earning in this category.

The most common self-reported chronic conditions that had been diagnosed by a healthcare provider among First Nations adults (n=554) in Hamilton included arthritis (30.7%; 95% CI 25.4% to 36.8%), hypertension (25.8%; 95% CI 20.3% to 31.6%), asthma (19%; 95% CI 14.9% to 24.6%), diabetes (15.6%; 95% CI 11.2% to 21.1%), heart disease (8.4%; 95% CI 4.8% to 12.5%) and chronic obstructive pulmonary disease (8.4%; 95% CI 5.3% to 11.8%). The prevalence of self-reported Hepatitis C was 8.7% (95% CI 4.3% to 11.7%). Twenty-five per cent reported having been injured over the past 12 months. Self-reported upper respiratory tract infection (URTI) was common, with 73% (95% CI 67.9% to 79.9%) of adults reporting URTI in the past 12 months.

Among First Nations adults (n=554), 16.7% (95% CI 11.4% to 22.1%) felt that availability of health services in their community was excellent, 43.3% (95% CI 36.1% to 49.6%) felt it was good, 28.9% (95% CI 23.3% to 35.2%) felt it was fair and 11.1% (95% CI 7.9% to 15.6%) felt it was poor. The fact that 40% of the population felt their level of access to healthcare was fair or poor, despite the geographic proximity to extensive health and social services that the City of Hamilton provides, substantiates the idea that just because the services are geographically proximate does not mean that they are accessible to First Nations people. Close to half

**Table 1** Demographic and social characteristics of First Nations adults (total N=554)

Characteristic	Prevalence % (95% CI)
Sex	
Male	59.9 (53.3 to 67.2)
Age	
18–34	40.2 (33.3 to 48)
35–49	35.4 (28.7 to 41.6)
50+	24.4 (18.4 to 30.8)
Education	
Some high school or less	57.3 (51.1 to 64)
Completed high school	19.5 (14.5 to 24.7)
Some or completed college	18.3 (13.3 to 23.3)
Some or completed University	5 (2.4 to 8)
Income sources for household	
Provincial or municipal social assistance or welfare (eg, Ontario Disability Support Program (ODSP), Ontario Works)	69.2 (63.1 to 75)
Wages and salaries	28.2 (22.1 to 34.2)
Child tax benefit	17 (12.4 to 21.8)
Any other income support	13.3 (9.2 to 17.6)
Employment insurance	9.6 (5.4 to 14.3)
Income from self-employment	7.7 (4.3 to 11.7)
Child support payments	3 (1.1 to 4.6)
Individual annual income	
\$0–4999	18.3 (13.4 to 24.8)
\$5000–5999	23.1 (17.1 to 28.5)
\$10 000–14 999	21.9 (16.3 to 27.6)
\$15 000–19 999	14.8 (10.7 to 20)
\$20 000+	21.8 (16 to 27.6)
Mobility (moves in past 5 years)	
No	10.2 (6.2 to 14.8)
1	15.5 (10.5 to 20.6)
2	20.2 (15.4 to 26.4)
3–5	41.1 (35 to 48.6)
6–10	10.4 (5.7 to 13.4)
Overcrowding (persons/room)*	
≤1	27.7 (21.6 to 33.8)
1–2	46 (40.5 to 54.3)
>2	26.3 (19.7 to 30.8)
Food security	
You and others always had enough of the kinds of food you wanted to eat	26.7 (21.1 to 32.8)
You and others had enough to eat, but not always the kinds of food you wanted	51.5 (45.3 to 58)
Sometimes or often you did not have enough to eat†	21.8 (16.5 to 27)

\*Following statistics Canada standards: calculated by dividing the number of rooms in each household (excluding the bathroom) by the number of people residing in the home, where a higher value of 'persons per room' indicates a higher level of crowding.<sup>40</sup>

†Collapsed sometimes and often you did not have enough food to eat.

(47.9%) of First Nations adults living in Hamilton reported that long waiting lists to see a specialist were a barrier (95% CI 41.9% to 55.4%). Other common

**Table 2** Gender, age and income quintile for First Nations adults, City of Hamilton and Ontario—10%

Variable	Sample			
	OHC (total N=725*) Prevalence, %	OHC RDS-adjusted Prevalence, % (95% CI)	Hamilton (total N=536 253) Prevalence, %	Ontario-10% (total N=1 324 241) Prevalence, %
Sex				
Female	49.4	37.6 (29.6 to 43.6)	50.9	51.2
Male	50.6	62.4 (56.4 to 70.4)	49.1	48.7
Age†				
18–34	37.4	41.9 (34.4 to 49.9)	28.2	28.2
35–49	37.6	36.6 (29.9 to 43.1)	28.1	29.5
50–64	22.9	20.7 (14.7 to 26.9)	24.8	24.8
65+	2.1	0.8 (0.3 to 1.6)	18.9	17.6
Income quintile				
1-low	71.76	73 (66.5 to 79.2)	25.1	19.5
2	16.22	11.8 (7.7 to 16)	22.8	19.8
3	6.3	7.4 (3.6 to 10.5)	20.3	19.8
4	2.48	4.9 (2.5 to 9.8)	17	20.4
5-high	1.34	3 (1.1 to 5.4)	14.7	20.2

\*Total N reflects the number of participants linked to the ICES database.

†Age of participants on 01-04-2010.

OHC, Our Health Counts; RDS, respondent-driven sampling.

barriers included: not being able to arrange transportation; doctor not being available; not being able to afford direct costs and/or transportation; services not covered by NonInsured Health Benefits (NIHB) and lack of trust in healthcare provider.

Acute and non-acute emergency room visits were much more frequent among First Nations in Hamilton compared with the general Hamilton and Ontario populations. According to data linkages with ICES, a striking 10.6% of the First Nations adult population in Hamilton made six or more emergency room visits in the previous

2 years compared with 1.6% and 1.9%, respectively, of the Hamilton and Ontario adult populations (table 3).

On the basis of ICES data linkages, the rates of hospitalisation were found to be slightly higher among the First Nations population compared with the Hamilton and Ontario populations. This may partly be explained by a higher birth rate among First Nations populations compared with the general Canadian population,<sup>42</sup> which is reflected by higher rates of obstetrics hospitalisation compared with the general Hamilton and Ontario populations: 7.3% (95% CI 3.9% to 10.9%) of

**Table 3** Number of ER visits in the previous 2 years for adults (18–64 years), First Nations, City of Hamilton and Ontario-10%

Frequency of ER visits	Sample			
	OHC (total N=514*) Prevalence, %	OHC RDS-adjusted Prevalence, % (95% CI)	Hamilton (total N=360 378) Prevalence, %	Ontario-10% (total N=901 509) Prevalence, %
None	35.2	31.5 (25.8 to 37.5)	66.3	69.1
1	23	26.2 (20.7 to 32.8)	18.7	16.8
2–5	32.5	31.7 (25.9 to 37.8)	13.4	12.3
6+	9.3	10.6 (6.2 to 14.5)	1.6	1.9
ER visits (acute)				
None	51	50.2 (43.9 to 57.5)	78.4	80.1
1	24.3	24.7 (18.7 to 30.1)	14.2	13.1
2–5	21.6	20.7 (15.3 to 26.1)	6.8	6.3
6+	3.14	4 (1.6 to 6.9)	0.6	0.6
ER visits (non-acute)				
None	56.8	54.3 (47.6 to 61.2)	79.4	81.2
1	20.8	22.4 (17.3 to 28.5)	14	12.2
2–5	19.8	20.4 (14.5 to 25.4)	6.3	6
6+	2.5	2.9 (1 to 5.6)	0.4	0.6

\*Total N reflects the number of adults aged 28–64 linked to the ICES database.

ER, emergency room; ICES, Institute of Clinical Evaluative Sciences; OHC, Our Health Counts; RDS, respondent-driven sampling.



the Hamilton First Nations population between the ages of 18 and 64 years had been hospitalised at least once in the past 5 years for obstetrical reasons compared with 4% of the general Hamilton and Ontario populations in the same age group and over the same time period. However, given the high rates of chronic diseases such as diabetes and heart disease and the much higher rates of emergency room use among the First Nations population, these findings were unexpected and therefore require further investigation.

## DISCUSSION

The OHC project generated a representative, urban Aboriginal health database. Through the successful application of RDS, a sample of urban First Nations individuals who might otherwise not have participated in mainstream surveys or the census was captured. In addition, given the current deficiency in public health information on urban First Nations populations, the statistically rigorous RDS sample allowed us to produce population-based estimates that can be utilised by local, regional, provincial and federal policymakers as well as urban Aboriginal stakeholders to address social inequities and health disparities facing this community.

Striking levels of poverty were identified in this study. The income data presented here may be a more representative income profile of the First Nations population in Hamilton than the 2006 Census. Specifically, the OHC data were adjusted for the sampling procedure using an RDS estimator and captured more 'hidden' populations such as persons who are homeless, transient or have low-literacy skills, who are known to be under-represented in the Census.<sup>11 13</sup> Further evidence of low incomes among this population is provided by the RDS-adjusted ICES income quintile data, which revealed that over 70% of the OHC cohort was in the lowest income quartile compared with 25% of the general Hamilton population and 20% of the Ontario population.

Accompanying high levels of poverty, housing and food insecurity were also highly prevalent among First Nations persons living in Hamilton. Over half of the study population had moved at least three times in the past 5 years compared with 60% of the general Hamilton population who had not moved at all for the past 5 years.<sup>33</sup> Compared with an overcrowding rate of 3% for the general Canadian population in the 2006 Census,<sup>1</sup> 74% of First Nations persons in Hamilton live in crowded conditions. These findings echo those presented in the 2007 Urban Aboriginal Task Force (UATF) final report, which documented persistent obstacles with finding affordable housing, obtaining stable and secure employment and accessing appropriate services and resources among urban Aboriginal people.<sup>43</sup> Similarly, the Toronto Aboriginal Research Project (TARP) found that Aboriginal people in Toronto tend to concentrate in lower income neighbourhoods where a significant

proportion, particularly men, live in poverty.<sup>44</sup> Similar experiences have been reported in other urban jurisdictions across Canada.<sup>45 46</sup> While a growing proportion of urban Aboriginal people in Canada are achieving varying degrees of economic success in a number of occupations,<sup>5 44</sup> there remains a significant amount of unmet basic needs among this population.

The burden of chronic conditions experienced by First Nations adults in Hamilton is disproportionately high. For example, 19% of the OHC Hamilton population reported having been told by a healthcare provider that they have asthma, which is more than twice the self-reported asthma rate (9.3%) for the overall Hamilton population in the 2007 Canadian Community Health Survey (CCHS).<sup>47</sup> Likewise, rates of arthritis and high blood pressure were 30.7% and 25.8%, respectively, among First Nations adults in Hamilton compared with 19.9% and 19.7%, respectively, among all adults in Hamilton as reported in the 2007 CCHS.<sup>47</sup> For First Nations adults in Hamilton, the rate of diabetes diagnosed by a healthcare provider was approximately three times the rate among the general Hamilton population.<sup>47</sup> These findings are particularly disconcerting given the much younger age demographic of the First Nations Hamilton population and the documented barriers to receiving healthcare services including long wait lists, challenges with accessing and affording transportation and the unavailability of primary care providers including physicians, nurses and other healthcare providers in the area. Furthermore, 45.8% (95% CI 38.9% to 52.4%) of First Nations adults believed that their ability to engage in preventative health activities (ie, regular exercise, going to the doctor or nurse for health screening tests and accessing preventative dental care) had been affected by financial hardship.

High rates of emergency usage by First Nations persons living in Hamilton are most likely linked to problems in accessing non-emergency healthcare, as revealed by 40% of the population who rated their access to healthcare as fair or poor and 48% who indicated that wait lists are too long. In addition, as a result of primary healthcare reforms,<sup>48</sup> patients may be told by their primary care providers to go to the emergency department rather than a walk-in clinic when their primary care team is not available.<sup>49</sup> High rates of emergency room visits may also reflect a perceived lack of access to community-based or primary care settings and the extent to which high proportions of First Nations people continue to be dismissed or disregarded when attempting to access healthcare, despite geographic proximity.<sup>50-52</sup> Further examination is required to explore potential bias in hospital admission practices and to differentiate between types of hospitalisations (ie, mental health, surgical and medical hospitalisations).

There were a number of limitations to the study. First, it should be noted that we may have under sampled the elderly First Nations population living in nursing homes or residences for senior citizens in Hamilton.

During our initial seed selection, we did not select any seeds from this population, and this population may have fewer network ties than other population groups, which may have resulted in an under-representation of First Nations individuals over 65 years of age. Second, RDS cannot guarantee a random sample of network members;<sup>53</sup> therefore, estimates are unbiased to the degree that the assumptions of the RDS estimator are met. There is an active literature on RDS and estimation using RDS data,<sup>54 55</sup> and there is debate regarding the true design effects of RDS surveys.<sup>56 57</sup> Existing multivariable regression analyses using RDS samples have not appropriately addressed the co-relation between observations and the unequal sampling probabilities inherent in RDS; therefore, we have focused on reporting prevalence estimates for which methods are better established. Despite these limitations, RDS was used to effectively recruit an urban Aboriginal population and allowed for the derivation of rigorous population estimates and data linkages that have previously not been possible.

Given the near absence of population health information for urban Aboriginal people in Canada, this research is able to provide, for the first time, First Nations data that clearly demonstrate alarming socio-economic inequities, a significant burden of chronic disease, multiple barriers in access to healthcare and elevated emergency room use. This newly established health database represents a significant contribution to public health that will directly inform strategic directions for the improvement of health and social status of urban Aboriginal people in Ontario. For example, this research will support the development of RDS as a tool to effectively recruit a larger cohort for longitudinal research with Aboriginal families in Ontario.

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**Contributors** MF contributed substantially to the study conception and design, co-led the data interpretation and analysis and drafted multiple versions of the manuscript. JS co-led the study conception and design, data analysis and interpretation and made important contributions to the draft and final manuscript. SM contributed substantially to the study conception and design, was a member of the governing council that guided each stage of research, represented the Aboriginal organisational lead of the research and made important revisions to the draft manuscript. MS provided important technical support during data collection, co-led the data analysis and interpretation and provided important revisions to the manuscript. PO contributed substantially to the study conception and design, analysis and interpretation of data and made important revisions to the draft manuscript.

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**Competing interests** None.

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**Data sharing statement** No additional data are available.

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