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ORIGINAL ARTICLE

Housing conditions in 2 Canadian First Nations communities

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ABSTRACT

Objectives. Housing conditions were assessed in 2 Canadian First Nations communities. Possible associations with tuberculosis (TB) were explored.

Study design. Participatory community-based survey.

Methods. Qualitative and quantitative data on housing and health were collected in the northern Dene community at Lac Brochet (LB), which has experienced endemic and epidemic TB, and the southern Ojibwa community at Valley River (VR), which has not.

Results. 72 of 135 (53%) houses at LB and 57 of 95 (60%) houses at VR were enrolled. Houses in both communities were small (mean 882 and 970 sq. ft., respectively) compared to the Manitoba average (1,200 sq. ft.). Crowding was evident at LB (mean persons per room [ppr] 1.1) and VR (mean ppr 0.9). The provincial mean ppr is 0.5. However, only 49% of householders at LB and 19% at VR felt “crowded” in their homes. More than two-thirds of houses had absent or non-functional heat recovery ventilation systems. Mould was observed in 44% of LB houses and 19% of VR houses. At LB a significant association was found between the number of permanent residents in the house and the presence of self-reported latent or active TB, either currently or during residence in that house ($p=0.001$).

Conclusions. Houses that were studied in these 2 First Nations communities were predominantly small, crowded and in poor repair. An association was found between the number of persons in a house and self-reported TB. Improved housing conditions in First Nations communities are indicated to promote and sustain health as well as human and Indigenous rights.

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Keywords: housing, First Nation, Indigenous, tuberculosis, determinants of health, human rights

INTRODUCTION

Housing and health are inextricably interconnected. Poor housing quality and overcrowded housing are associated both directly (causally) and indirectly with communicable diseases, illness due to accidents and injuries, psychological ill health and social dysfunction (1–4).

In Canada, the link between housing, health and justice is critically apparent in the First Nations (FN) population. Fifty percent of FN on-reserve housing falls below Canadian Mortgage and Housing Corporation (CMHC) qualitative and/or quantitative standards (5). The average number of persons per room is 20% higher for FN people living on-reserve than for the rest of the Canadian population (6). The incidence of tuberculosis (TB) is 34 times higher among FN people living on-reserve compared to the rest of Canadians (7). A direct linear association has been demonstrated between overcrowding of houses on-reserve and the incidence of TB (8). Similar associations have been noted for other respiratory, diarrheal and skin and soft tissue infections in Canadian and other Aboriginal populations (9–14).

In 2006, the Chiefs from 2 Manitoba First Nations communities, Northlands Denesuline First Nation (Lac Brochet) and Tootinaowaziibeeng Treaty Reserve 292 (Valley River), requested the formation of a partnership with researchers from the University of Manitoba in order to document on-reserve housing conditions. The request was made in the context of concerns that many of their people did not have access to adequate shelter for their needs. They defined these needs as housing that would protect them from the harsh climate, that would foster human dignity and emotional

well-being and that would support (rather than undermine) health. Housing was viewed in the communities as an issue of health, justice, human rights and Indigenous rights (15–17).

Prior to this request, the authors had established a relationship with both communities over the previous decade that had focused on social and biological research on historical and current health concerns, including TB. The community of Lac Brochet has experienced ongoing, endemic TB, interspersed with periodic epidemics, in the previous as well as the current century.

From 1999 to 2004, the average annual incidence of active TB in Lac Brochet was 636 cases per 100,000 people (18). The epidemiology in this community is characterized by a unique strain of *Mycobacterium tuberculosis* and by a higher incidence of central nervous system disease in adults (18). Lac Brochet expressed particular concern regarding the role of crowded and poorly ventilated houses in their community in the transmission of *Mycobacterium tuberculosis*. Valley River experienced TB epidemics in the early and mid-twentieth century but had not experienced any recent cases (19). Valley River expressed concern regarding the potential for crowded housing to promote possible future epidemics of infectious diseases, including TB and influenza.

In a research context, it is difficult to demonstrate a direct causal relationship between select illnesses, such as tuberculosis, and inadequate housing. This is primarily because of the prevalence and interdependence, in many populations, of numerous determinants; including but not limited to low socio-economic status, food insecurity, barriers to health care, discrimination and social disruption. Understanding the limitations of the scientific method – and with

¹In the context of this paper, First Nations is a term that refers to the Aboriginal peoples of Canada who are not Métis or Inuit.

the understanding that in the Indigenous context research may be considered a form of “ceremony” that builds relationships and fosters insight (20) – the communities requested that the authors undertake a survey with the primary objective of documenting quantitative and qualitative aspects of First Nation housing. As a secondary objective, community members requested that a brief health questionnaire be administered to complement and inform the housing survey. Issues of concern to the community included TB, tobacco use and the consumption of traditional (“country”) foods.

Conducting a study of 2 communities that are distinct from a cultural, geographical and health (TB) point of view offered the opportunity to demonstrate a range of conditions. Although the communities were not randomly selected, comparisons could be made between them in order to highlight similarities and differences among Aboriginal people who share common concerns regarding their individual and communal well-being.

MATERIALS AND METHODS

The 2 communities involved in this community participatory research study are linked through political, cultural and health organizations and activities, but are culturally distinct and geographically separate. The northern Dené community of Lac Brochet, located at 58° latitude in Manitoba, Canada, is remote and accessible only by air (weather permitting) or by an ice road that is only open in the winter. The Ojibwa community of Valley River is located in southern Manitoba at 51° latitude; it has road access to major centres.

This research project was proposed by these 2 communities and was designed, conducted,

analysed and shared in a partnership that existed between the communities and the University of Manitoba, incorporating the Aboriginal research principles of ownership, control, access and possession (OCAP) (21). The study was approved by the University of Manitoba Ethics Board and the Chiefs and Councils of the communities. In accordance with their wishes, the communities are named in this report.

A survey was designed to collect both qualitative and quantitative data from First Nation community households. A household was defined as a group of people who live in a private dwelling. At the time of the survey no apartments existed in the 2 communities; all the dwellings that were surveyed were single-detached houses. A permanent resident was an individual who considered the house their primary residence and who lived more than 6 months per year in that house at the time of the survey. In order to also capture data on the phenomenon of extra crowding in houses due to the influx of visitors during holidays or festival occasions, the surveyors questioned householders regarding the maximum number, if any, of visitors (defined as temporary residents) that had simultaneously stayed in the house for a period of time less than 2 months during the most recent holiday/festival (the March 2007 winter festival in the case of Lac Brochet, and the current 2008 summer holiday in the case of Valley River).

The study’s aim was to enroll as many households as possible from each First Nation community, although it was anticipated that some householders might choose not to participate or might not be available at the time of the survey. It was not acceptable to the community to use a research methodology that involves random sampling.

Enrollment criteria were as follows: that the house was located on the respective First Nation land; informed consent of an adult household

member; and that the house sheltered 1 or more community members. Houses rented by non-community members (such as transient teachers) were not included in the survey, in accordance with the expressed community desire to describe a people rather than a geographical location. In Lac Brochet there are 17 houses rented by transient residents who are not band members. In Valley River there are no such transient residents.

The survey was conducted door-to-door during a 4-week period in the summers of 2007 at Lac Brochet and 2008 at Valley River. An adult member of each participating household self-identified as the key informant. Translation into Dené or Ojibwa languages in the communities was available for all components of the study. Local community members and university researchers worked together to administer the survey, which consisted of 2 parts.

Part 1 of the survey collected data on the physical structure of the houses, including size, type of heat, ventilation, insulation, plumbing and interior and exterior conditions. Specific attention was directed in each house to the presence or absence of a heat recovery ventilation (HRV) system, which is currently recommended in all new homes in Canada (2). HRV systems provide fresh air, improved climate control and energy savings by facilitating the exchange of inbound and outbound airflow from the house (22). By regulating ventilation according to household requirements, air quality is improved and the growth of mould is retarded (2).

Two measures of crowding were calculated. The average square foot per person in a home was calculated by dividing the total area of the house by the number of persons who permanently resided therein. The number of persons per room (ppr) was defined as the number of persons living in a dwelling divided by the number of rooms in the

dwelling, excluding bathrooms or storage areas.

Part 2 of the study involved an interview with the key informant to collect data about the number of people in the house, how the space in the house was used and the general health of residents. The participants were asked if anyone had been diagnosed with TB (latent or disease) while living in the house. Detailed questions were asked about the number of people in each house who had been infected with TB (that is, those diagnosed with infection but not disease) while living in that house.

The researchers did not have access to the medical records of the participants. However, there was a high degree of awareness about TB in both communities due to active education, prevention, diagnostic, therapeutic and research programs locally and in the region, and because of increasing community activism and media exposure regarding endemic and epidemic TB in Aboriginal populations in Manitoba (18,23–25). The study participants were aware of their personal clinical test results from the previous decade of testing and treatment. The participants self-reported their TB status as “latent,” “disease” or “negative.” Latency was defined as current or past infection (with or without treatment) without a history of progression to disease. Disease was defined as a history of current or previously diagnosed disease requiring therapy. Negative was defined as absence of current or past infection or disease. Questions were asked to clarify what tests and/or treatments the participant had undergone and whether the participant understood the difference between latent and active disease. The survey was designed to ensure that if TB was determined to be present, it had been diagnosed while the person was living in that house. Not all householders were able or willing to provide this information, in which case the answer was coded as “no response.”

The communities were also interested in surveying other health conditions and behaviour, including asthma, atopic eczema, diet and tobacco use. We report these results here. Although they do not constitute the focus of the study, they may to some extent provide further insight into the general health status of the population.

Information was recorded onto datasheets and compiled into Excel spreadsheets for analysis using SAS 9.1 and Hierarchical Linear and Non-linear Modeling (HLM) for Windows V6.06 statistical software (SAS Institute, Cary, NC, USA). Student's t-test was used to analyse continuous data pertaining to housing and measures of crowding. Chi-square was used to assess the statistical significance of differences in proportions pertaining to health conditions and food consumption.

RESULTS

In the Dené community of Lac Brochet, 605 people live in 135 houses. Seventy-two of the 135 houses (53%) in this community were enrolled in the study over a 6-week period in the summer of 2007. The remaining 63 houses were not recruited for reasons that include the researchers' inability to contact the householders (who were out of town or unavailable to meet), the residents' desire for privacy or a refusal without an expressed explanation. In the Ojibwa community of Valley River, 302 people live in 95 houses. Fifty-seven (60%) of the 95 households completed the survey and the remaining 38 were not enrolled for the reasons noted above.

The houses that were surveyed in both communities were small: 882 square feet (range 196–1,974, standard deviation 232.7) at Lac Brochet and 970 (range 60–2,270, SD 401.0) in

Tootinaowaziibeeng ($p=0.15$). These houses are considerably smaller than the average house in Manitoba, which is estimated to be 1,200 square feet (26).

At Lac Brochet, 357 permanent residents lived in the 72 participating houses (5.2 persons per house), indicating a greater degree of crowding ($p=0.004$) than in Valley River where 227 residents lived in the 57 participating houses (3.9 persons per house). However, in both communities there were significantly more permanent residents per house than the Manitoban average of 2.9 (27).

Crowding was exacerbated by the frequency of overnight temporary visitation from family and friends, which is common in First Nations communities. Data were collected on the maximum number of temporary residents that simultaneously stayed in the participating houses during recent holidays. Lac Brochet households reported an average additional 4.7 persons in each house during their recent winter festival. Valley River does not have a winter festival, but visiting is common in the summer; households indicated that an average of 1.0 extra person slept in the house at the time of the survey.

Measurements of house size and number of rooms per resident revealed evidence of crowding in both communities, particularly at Lac Brochet. The mean square feet per (permanent) resident in participating Lac Brochet houses was 212 (range 77–224, SD 134.4), compared to 300 square feet (range 60–1376, SD 225.9) per resident in Valley River ($p=0.012$). By comparison, in Manitoba as a whole the average house comprises 413 square feet per person (calculated from estimated average house size and Statistics Canada average number of persons per house [2.9]). Analysis of participating houses according to the number of persons per room (ppr) also revealed differences

between the 2 communities (Lac Brochet: mean 1.1, range 0.2–2.4, SD 0.5; Valley River: mean 0.9, range 0.2–2.3, SD 0.5; $p=0.02$). Both communities significantly exceed the mean Canadian ppr of 0.5 (27).

The houses at Lac Brochet conform to a basic structural style—a 2-door, wood-sided, 3-bedroom bungalow with aluminum windows, a crawlspace and an asphalt roof. One house enrolled in the survey was a “bi-level” (comprising 2 levels, of which the lower one forms a partial basement). At Valley River the majority of houses were bungalows with crawlspaces; 20 of the 57 enrolled houses had basements and 5 were “bi-levels.” The average age of the houses at Lac Brochet was 19 years compared to 23 years at Valley River.

At Lac Brochet a variety of heating sources were used in the houses: 46% used oil/diesel furnaces; 47% used a wood stove; 6% used a wood stove and an oil/diesel furnace; 1% had no heat source. At Valley River the primary source of heating in 54 (95%) of the 57 enrolled houses was electric heat, while 3 (5%) used a wood stove and electric heat. Adequate ventilation is necessary to maintain optimal air quality in a house and to manage humidity. Passive (windows and doors)

and mechanical (fans, HRV) systems are used to promote ventilation. In the 2 participating communities, damaged (broken or covered by plastic sheeting) windows and entry doors were prevalent (Table I). Absent or non-functioning kitchen or bathroom fans were present in 54% of surveyed houses at Lac Brochet and 40% of those in Valley River (Table II). Heat recovery ventilation (HRV) systems were either absent or non-functional in 88% of surveyed houses at Lac Brochet and 58% of those in Valley River (Table II). These numbers are particularly worrisome in light of the amount of humidity generated (through respiration, cooking, bathing, laundry and other activities of living) by the large number of people living in these houses.

Structural damage to houses may result in excessive moisture within them and may adversely affect air quality. Damaged eavestroughs, gutters, downspouts, roofs, chimneys and exterior walls, and landscaping that permits water to drain towards (rather than away from) the house foundation were documented in the majority of surveyed houses at Lac Brochet (Table III) and in many of the houses in Valley River. These structural problems contribute to moisture and

Table I. Passive ventilation in participating Lac Brochet and Valley River houses.

Passive ventilation	Lac Brochet (n=72) Mean number per house (range, SD)	Valley River (n=57) Mean number per house (range, SD)
Windows	5.9 (1–15, 1.8)	7.7 (6–18, 2.2)
Damaged windows	1.2 (0–5, 1.3)	1.42 (0–13, 3.1)
Doors to outside*	1.9 (1–2, 0.2)	1.9 (1–4, 0.4)
Damaged doors to outside	1.4 (1–2, 0.2)	1.9 (0–2, 0.6)

* Exit doors are sources of passive ventilation and markers of adherence to building and fire codes (49).

Table II. Mechanical ventilation in participating Lac Brochet and Valley River houses.

Mechanical ventilation	Lac Brochet (n=72) number (%)	Valley River (n=57) number (%)
Houses without, or with non-functioning, kitchen fan	39 (54.1%)	17 (29.8%)
Houses without, or with non-functioning, bathroom fan	37 (51.3%)	23 (40.3%)
Houses without, or with non-functioning, HRV system	63 (87.5%)	33 (57.8%)

damage in crawlspaces. At Lac Brochet, 34% of the houses had visible mould in the crawlspaces and 44% had mould on the walls, ceilings or floors of the rooms on the main floor of the house

(Fig. 1). At Valley River we documented mould in the crawlspaces in 12% of surveyed houses and mould on the main floor walls, ceilings or floors in 19% of houses (Table III).

Table III. Structural condition of the participating Lac Brochet and Valley River houses.

	Lac Brochet (n=72) number (%)	Valley River (n=57) number (%)
Houses with missing or damaged gutters	63 (88%)	27 (47%)
Houses with missing or damaged downspouts	68 (94%)	42 (74%)
Houses with lot upgrading that slopes towards house or is flat	42 (58%)	19 (33%)
Houses with damaged exterior walls	51 (71%)	34 (60%)
Houses with exterior foundation walls with wood-soil contact	68 (94%)	16 (28%)
Houses with a crawspace foundation	46 (64%)	23 (40%)
Houses with visible mould in foundation	25 (35%)	7 (12%)
Houses with damaged foundation interior walls	38 (53%)	12 (21%)
Houses with damaged air vapour barriers in crawspace	12 (17%)	2 (4%)
Houses with visible mould in ceiling, walls or floors	32 (44%)	11 (19%)
Houses with damaged roofs	61 (85%)	26 (46%)
Houses with missing or damaged roof vents	55 (76%)	32 (56%)
Houses with damaged chimneys	28 (39%)	2 (4%)
Houses with damaged toilets	27 (38%)	5 (9%)
Houses reporting inadequate water supply or water quality	44 (62%)	40 (70%)



Figure 1. Mould growth around a non-operational ceiling fan.

In the qualitative component of the study, we explored the perceptions and experiences of householders that pertained to their houses and their personal health. Some householders told us that they had recently cleaned mould off surfaces in their house, so the observations made by the surveyors may underestimate the true prevalence of mould in homes. Seventy-one percent of householders at Lac Brochet and 42% of those at Valley River reported the presence of visible mould on surfaces in the living areas of their homes. Ninety-three percent of householders at Lac Brochet and 65% of those at Valley River reported the perception that the air quality in their homes was “not healthy.”

An Elder at Lac Brochet reported that “mushrooms” frequently grew through the kitchen

floorboards of her house. Large fungi were found in the crawlspace underneath the house and were indeed pressing upwards through the floorboards of the kitchen (Fig. 2). Participants in 71% of the houses reported cleaning and/or painting over mould and/or smelling mould in their houses.

Thirty-five of the 72 (49%) of household participants at Lac Brochet indicated that they felt “crowded” in their current home, compared to 11 (19%) of the 57 householders in Valley River ($p=0.001$).

Questions about TB in household members were answered by 63 (88%) of the 72 households surveyed at Lac Brochet and 55 (96%) of the 57 households at Valley River. In 9 households at Lac Brochet, and in 2 households at Valley



Figure 2. Fungi growing in the crawlspace of a bungalow in a Dené house in early June.

River, the residents declined to respond. Latent TB, current disease or past disease that had occurred while the person was resident in the house was reported in 37 (59%) of the 63 houses at Lac Brochet that responded to this question, and in none of the responding households at Valley River. For the Lac Brochet houses where data was collected (n=63) the average number of residents that reported TB (latent, current disease or previous disease while living in the house) was 1.2.

The reporting of TB (latent, current disease or previous disease while living in the house) among household members was not significantly associated with house size, but was associated with the number of permanent household residents (5.9) compared to the number in households where TB was not reported (4.1) ($p < 0.0001$). The houses that reported TB in 1 or more household members also had a higher number of persons per room (ppr=1.2) than houses reporting an absence of TB (ppr=0.9; $p = 0.001$).

Questions focusing on other health issues revealed that households at Valley River were significantly more likely to report the presence of asthma and/or eczema (VR: 43/57, 76%; versus LB: 39/72, 40%; $p = 0.02$) in household members, and smoking in the house (VR: 33/57, 58%; versus LB: 17/72, 24%; $p < 0.0001$). The majority (41/72, 57%) of householders in Lac Brochet consumed a traditional diet of “country food” (caribou in Lac Brochet, moose or deer meat at Valley River) on a daily basis, compared to those in the latter community (6/57, 11%; $p < 0.0001$).

DISCUSSION

There are a number of limitations to this study. In terms of external validity, the communities described in this study were not randomly selected. The results are therefore not generalizable to all First Nations communities in the province of Manitoba, and the comparisons between the 2 communities is relevant only to highlight that First Nations living conditions are not homogeneous.

The study is also limited by possible sample and information bias. Enrollment was 53–60% in the 2 communities. While this degree of participation is not surprising in the context of research performed in Canadian Aboriginal populations (20) and in remote communities, we must be cautious in generalizing the results to the entire communities of Lac Brochet and Valley River, or to other First Nations communities in the province or in Canada.

Performance of the study in the summer months maximized the surveyor’s ability to view the exterior and crawl spaces of the houses. However, it is also a time of very busy outdoor activity such that many families are absent from their homes and/or the community for a prolonged period. Issues of trust, privacy and hope also affect participation rates in research studies, particularly among Indigenous populations (20,28). The original proposal for this study came from the Chiefs and Councils of the communities, and was confirmed in a series of community meetings. The research adhered to the community request for open enrollment, rather than use a random sampling method. The community leadership planned to use the data generated by this study in their discussions with the government about housing needs. The

data collection tools required the sharing of personal health information, feelings and opinions about housing and health, as well as close inspection of the houses involved. It is possible that the households that agreed to participate may represent a biased sample of houses or of householders' health statuses (including experience and memory of TB). Participating houses or householders may represent a higher or lower standard compared to non-participants. Participation may depend to some extent on the degree to which individuals believed, or hoped, that taking part in the study had or would have individual or collective meaning (20,28).

The researchers did not have access to health records and therefore relied on personal recollection. The health data collected from the household informants may therefore be subject to information bias if the respondents have an imperfect understanding of their current or past medical history. However, the experience with TB and the level of education about TB in the Lac Brochet community has been vigorous over the past decade, suggesting that memory of these health-related issues may be accurate and widespread.

We have described several possible limitations to the external and internal validity of the study. We can say that, although the study results do not convey "the truth" of conditions in all First Nations communities, or even conditions within the geographical limits of the communities themselves, the results do represent "a truth." In meetings to share and discuss the results of the study, the response of community members has been that the numbers, words and images presented in this paper convey in some small way their "lived reality," and that documentation and communication of this reality is important (17). The houses that we studied

were crowded and in poor repair. Variation can be seen within communities (expressed through data ranges) and between the 2 communities. However, comparisons with provincial statistics reveal substantial inequality.

In contrast to the empirical evidence, only 49% of those surveyed in Lac Brochet and 20% of those at Valley River indicated that they felt "crowded" in their homes. An exploration of the cause of this apparent disparity between what numbers "show" and what participants "feel" was not conducted in this study. The questions that emerge from this study include the following: "To what extent does the state of the structural 'health' of the house or the householders influence the perception of being crowded?"; "How do traditional communal living patterns affect perception of space within homes?"; and "Have past and current difficulties in securing basic needs resulted in altered expectations regarding housing?" (29,30).

Crowding and lack of adequate ventilation have been identified as potential risk factors for the transmission of TB and other respiratory infections (2). In this study the number of permanent residents in Lac Brochet houses was associated with the presence of latent, currently active or previously (during residence in that house) active TB (odds ratio 1.21). These findings are in keeping with a Canadian study in which an increase of 0.1 ppr in First Nations communities was associated with a 40% increased risk of the occurrence of 2 or more cases of TB (8).

This study does not demonstrate causation in the relationship between crowded housing and TB. The determinants of TB, some causal and others not, are interlinked and are prevalent in many Manitoba First Nations communities. They may be thought of in terms of the

epidemiologic triangle of host, environment and agent, but many of the determinants of TB show interplay between these categories.

As an environmental determinant of TB transmission, poor quantity and quality housing not only facilitates the spread of *Mycobacterium tuberculosis*, but also the growth of mould and fungi. While there is no evidence to suggest that mould causes tuberculosis, there is evidence that mould can affect the immune response among those who are chronically exposed, causing an imbalance between pro- and anti-inflammatory cytokines (31–35). An individual exposed to mould and fungi allergens will typically mount a strong Th2 immune response, whereas a Th1 response is primarily required for resistance to TB disease (31,36). Previous studies have suggested that the Dené from this region have a cytokine and chemokine immunogenetic profile which is skewed to favour a Th2 immune response (37,38). The mechanisms of environment-gene interaction in this population are not currently understood, but would likely shed light on our attempts to assess new diagnostic (e.g., interferon gamma release assays) and old control (e.g., approach to outbreaks) measures in this population (39). Agent-host interactions are also relevant, given evidence of the increased incidence of central nervous system tuberculosis in Lac Brochet, as well as evidence of hyper-virulence of the predominant strain of *Mycobacterium tuberculosis* affecting the Aboriginal people of Manitoba (18,40,41).

Housing conditions that are insufficient to sustain health, or which are directly deleterious to health, are found in many circumpolar countries (42–45). In the context of epidemic and endemic infectious disease experienced by many Aboriginal people in Canada, the provi-

sion of culturally appropriate and adequate housing should be supported in order to promote the same level of protection from infections (and other illnesses) that is afforded to the majority of Canadians. As health care is considered a treaty right for the First Nations communities involved in this study (and for other Canadian First Nations), and given that housing is an important determinant of health, government action to address housing inadequacies is required, such action would represent effective health and social policy, fulfillment of a fiduciary (treaty) obligation and fulfillment of Canada's obligations under the United Nations Declaration on Human Rights and the United Nations Declaration on the Rights of Indigenous Peoples (15–17,46–48).

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