Social determinants of health among residential areas with a high tuberculosis incidence in a remote Inuit community

Elaine Kilabuk,[1] Franco Momoli,[2,3,4] Ranjeeta Mallick,[2] Deborah Van Dyk,[2] Christopher Pease,[3,5] Alice Zwerling,[3] Sharon Edmunds Potvin,[6] Gonzalo G Alvarez[2,3,5]

► Additional material is published online only. To view please visit the journal online (http://dx.doi.org/10.1136/jech-2018-211261).

[1]Department of Internal Medicine, University of Ottawa Faculty of Medicine, Ottawa, Ontario, Canada
[2]Ottawa Hospital Research Institute, Ottawa, Ontario, Canada
[3]School of Public Health, University of Ottawa, Ottawa, Ontario, Canada
[4]Children's Hospital of Eastern Ontario Research Institute, Ottawa, Ontario, Canada
[5]The Ottawa Hospital, Division of Respirology, Department of Medicine, Ottawa, Ontario, Canada
[6]Nunavut Tunngavik Inc, Iqaluit, Nunavut, Canada

Correspondence to
Dr Gonzalo G Alvarez, Division of Respirology, Department of Medicine, The Ottawa Hospital, Ottawa, Ontario, Canada; galvarez@ohri.ca

Received 30 June 2018
Revised 22 October 2018
Accepted 9 January 2019

To cite: Kilabuk E, Momoli F, Mallick R, *et al*. *J Epidemiol Community Health* Epub ahead of print: [*please include* Day Month Year]. doi:10.1136/jech-2018-211261

ABSTRACT

Background Tuberculosis (TB) remains a significant health burden among Inuit in Canada. Social determinants of health (SDH) play a key role in TB infection, disease and ongoing transmission in this population. The objective of this research was to estimate the prevalence of social determinants of Inuit health as they relate to latent TB infection (LTBI) among people living in residential areas at high risk for TB in Iqaluit, Nunavut.

Methods Inperson home surveys were conducted among those who lived in predetermined residential areas at high risk for TB identified in a door-to-door TB prevention campaign in Iqaluit, Nunavut in 2011. Risk ratios for SDH and LTBI were estimated, and multiple imputation was used to address missing data.

Results 261 participants completed the questionnaire. Most participants identified as Inuit (82%). Unadjusted risk ratios demonstrated that age, education, smoking tobacco, crowded housing conditions and Inuit ethnicity were associated with LTBI. After adjusting for other SDH, multivariable analysis showed an association between LTBI with increasing age (relative risk, RR 1.07, 95% CI 1.04 to 1.11), crowded housing (RR 1.48, 95% CI 1.10 to 2.00) and ethnicity (RR 2.76, 95% CI 1.33 to 5.73) after imputing missing data.

Conclusion Among high-risk residential areas for TB in a remote Arctic region of Canada, crowded housing and Inuit ethnicity were associated with LTBI after adjusting for other SDH. In addition to strong screening and treatment programmes, alleviating the chronic housing shortage will be a key element in the elimination of TB in the Canadian Inuit Nunangat.

INTRODUCTION

There are 45 000 Inuit that live in the Arctic regions of Canada.[1] The Inuit Nunangat (Inuit homeland) is comprised of four regions: Nunavik (northern Quebec), Nunatsiavut (northern Labrador), Nunavut and the Inuvialuit region of the north-west territories. The Inuit population is young and rapidly growing.[1] Inuit experience significant health disparities with other Canadians including higher rates of infant mortality, suicide and infectious diseases.[2] In 2016, the tuberculosis (TB) incidence among Inuit in Canada was approximately 300 times higher than the Canadian-born non-indigenous population (170 vs 0.5 per 100 000).[3] In their Inuit-specific TB strategy, the national organisation that represents Inuit in Canada, Inuit Tapariit Kanatami, stated that 'a better understanding of the drivers of high rates of TB disease among Inuit' is paramount and 'changes to the approach of TB prevention, control, and care for Inuit should proceed strategically, beginning with an improved understanding of the current state and impact of TB disease and social determinants of health (SDH) in the Inuit regions'.[2]

It is well known that inequities in the distribution of SDH are inextricably linked to poverty.[4–6] Many of these inequities in key SDH, such as level of education attained, income, food security and availability of housing have been noted to be disproportionally represented in Inuit communities. Of Inuit aged 25–64 years living in the Nunangat, only 34% have attained a high school diploma or equivalent.[1] Food insecurity is present in 70% of households across Nunavut.[7] Across the Inuit Nunangat 39% of Inuit have been living in crowded homes.[1] The significant inequities in SDH experienced by Inuit have been linked with the high TB incidence rates in the Nunangat. After a TB outbreak among Inuit in Nunavik (northern Quebec), case-control studies demonstrated associations between latent TB infection (LTBI) and both diet[8] and crowding.[9] Inadequate nutrition was associated with increased susceptibility for TB infection.[8] Crowded housing was also associated with increased odds of newly diagnosed TB infection among people who lived in smear-positive TB households during a TB outbreak.[9] In another case-control study done among Inuit from Greenland, Inuit ethnicity, living in a settlement, unemployment, frequent alcohol intake, and low hygienic standards were associated with active TB disease.[10]

The present study aims to further understand the complex relationships of SDH and TB among Inuit. We set out to estimate the prevalence of inequities in SDH within residential areas at high risk for TB in Iqaluit, Nunavut. We then examined the risk of LTBI associated with different SDH. An understanding of the SDH among Inuit at risk for TB is essential for policy development in this area.

METHODS

Study population

In 2016, the population of the Territory of Nunavut in the Canadian Arctic was estimated at 37 082,[11 12] with Inuit representing 84% of the total population. Iqaluit is the capital and largest community in Nunavut with a population of 7590 people and 55% of the population of Iqaluit is Inuit.[12] Iqaluit can only be accessed by plane or ship.

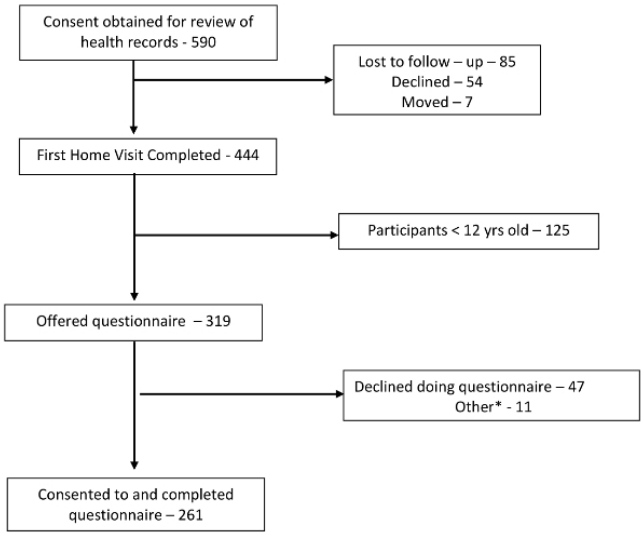

Figure 1 Exclusion of participants for the SDH Questionnaire. *Other includes lost questionnaire or unable to complete due to cognitive disability. SDH, social determinants of health.

An inperson home survey was designed to document SDH in a sample of people in high TB burden zones in Iqaluit, Nunavut in 2011. Our questionnaire was part of a larger study (Taima TB)[13] offering door-to-door screening and treatment for TB in high TB burden zones in Iqaluit. The questionnaire was offered in English and Inuktitut. High-risk residential areas were defined as more than five active TB cases in the previous 4 years, and the areas were determined using addresses of the active TB cases and Google maps. Four high-risk residential areas were identified, from which our data were collected.[13] The premise of the Taima TB study was to offer screening to all eligible individuals based on residence in an identified high-risk geographical area and not individual risk factors for TB. The questionnaire documented self-reported household income for those over 18 years of age, highest education level attained, food security, and lifestyle measures including cigarette/pipe/marijuana smoking and alcohol consumption (see online supplemental material for definitions). The questions that were used in the questionnaire were adapted from previous questionnaires used in other populations[14 15] (see online supplemental material for questionnaire). The crowding variable was calculated by self-reporting of number of people living in household divided by the number of bedrooms (see online supplemental material).

Analysis

Unadjusted risk ratios were derived to provide descriptive associations between SDH and LTBI. Multivariable log binomial regression analysis was performed to estimate risk ratios for the association of each SDH with LTBI while adjusting for other SDH. In both analyses, household was considered as a random effect to account for the correlation among multiple residents in each dwelling. Discordant survey responses within a dwelling for number of people living in the home, number of rooms, average income of the household and food insecurity were resolved by taking the most conservative response (eg, lowest total income). Allowed responses to survey questions included 'don't know' but occasionally residents refused to answer particular questions. To avoid a sizeable loss of respondents due to missing data as a result of not knowing the answer in several survey responses, notably with 54 (21%) of individuals not knowing the household income, we used a combination of simple and multiple imputation.[16] Household income was imputed using the most common response of others in the same household, if possible. Otherwise, we used multiple imputation to create and analyse imputed data sets (m=20). This is thought to be a scientifically sound approach to analyses with missing data[16] if the mechanisms and assumptions are approximately true. Our imputation model included all variables described in the analysis model. Log binomial regression models were fit in each imputed data set separately, and coefficient and variance estimates for SDH were then combined using Rubin's rules. Complete case analyses were also conducted for comparison purposes. We imputed missing values using logistic regression for binary and ordinal variables and discriminant methods function for nominal variables with the SAS procedures Proc MI and proc MiAnalyze. All the analysis was done using SAS V.9 by SAS Institute, Cary, North Carolina, USA.

Ethics approval

The study was approved by the Ottawa Hospital Research Institute Ethics Board. A research license was obtained from the Nunavut Research Institute. Written informed consent was obtained from all of the participants.

RESULTS

Our team visited 162 dwellings located within the high-risk neighbourhoods, where 590 participants provided consent for review of medical records and first home visit[13] (see online supplemental appendix). Of the 590 participants who provided consent, 146 were excluded due to loss to follow-up, declining participation in the Taima TB study or moving after being contacted. Four hundred and forty-four participants received a first visit from a nurse and TB champion who spoke Inuktitut (Inuit language). The TB champions provided TB education and offered the questionnaire in Inuktitut or English. Of those, 183 participants were excluded because they were younger than 12 years old, declined the questionnaire, lost the questionnaire (classified as other) or were unable to complete due to mental disability (classified as other). The final sample of participants who consented and completed the questionnaire was 261 (figure 1).

The prevalence of SDH and descriptive statistics in this population are provided in table 1, stratified by LTBI status. Missing data are noted for each characteristic (eg, 'don't know'). LTBI status was missing for five individuals. Overall, 84 (32%) individuals had incomplete survey data (missing at least one value).

The median age of the participants was 37 years, and most were Inuit. A significant proportion of participants had not completed high school (173 individuals, 67%). Almost half had very low income (115 individuals, 44%), many experienced crowding (167 individuals, 75%) and almost a third experienced hunger (75 individuals, 29%). A significant proportion smoked tobacco (201 individuals, 77%) and marijuana (161 individuals, 62%). No cases of serology-positive HIV were identified among LTBI-positive participants.

Unadjusted analyses demonstrated that age, education, smoking tobacco, crowded housing conditions and Inuit ethnicity had statistically significant associations with LTBI status (table 2).

The relative risk estimates for the complete case analysis and multiple imputation analyses were similar, with the exception of ethnicity. Age and crowding, after covariate adjustment, still showed statistically significant associations with LTBI status. Under the multiple imputation analyses, Inuit ethnicity became positively associated with LTBI status (table 3).

Table 1 Demographics of participants stratified by LTBI status

Characteristics*	All participants† (n=261) (%)	LTBI positive (n=154) (%)	LTBI negative (n=102) (%)
Median age (years) (range)	37 (12–82)	44	31
Sex			
Male	103 (39)	60 (39)	42 (41)
Female	158 (61)	94 (61)	60 (59)
BCG status			
Immunised	148 (58)	94 (61)	
Ethnicity			
Inuit	214 (82)	142 (92)	67 (66)
Canadian—born non-Aboriginal	38 (15)	6 (4)	32 (31)
Other (first Nations and foreign born)	9 (3)	6 (4)	3 (3)
Education level			
No schooling	21 (8)	18 (12)	1 (1)
Elementary school	7 (3)	7 (5)	0 (0)
Middle school (grades 6–9)	68 (26)	44 (29)	24 (23)
Grades 10–11	77 (30)	47 (31)	28 (27)
High school or equivalent	39 (15)	20 (13)	18 (18)
Post high school	45 (17)	15 (10)	30 (29)
Refused	1 (0)	1 (1)	0 (0)
Don't know	3 (1)	2 (1)	1 (1)
Household income (>18 years old)			
<20 000	115 (44)	65 (42)	46 (45)
20 000–40 000	30 (12)	16 (10)	14 (14)
40 001–60 000	24 (9)	14 (9)	10 (10)
60 001–80 000	16 (6)	10 (7)	6 (6)
80 001–100 000	11 (4)	5 (3)	6 (6)
>100 000	11 (4)	4 (3)	7 (7)
Don't know	53 (20)	39 (25)	13 (13)
Refused	1 (1)	1 (1)	0 (0)
Housing			
Crowding (>1 person per room)	167 (75)	101 (84)	65 (65)
Food Insecurity			
Experienced hunger	75 (29)	53 (34)	20 (20)
Reduced food intake	67 (26)	45 (29)	20 (20)
Alcohol intake			
No	82 (31)	53 (34)	26 (25)
Yes	175 (67)	98 (64)	75 (74)
Don't know	1 (1)	1 (1)	0 (0)
Refused	3 (1)	2 (1)	1 (1)
Smoking history (cigarettes/pipes)			
No	59 (23)	24 (16)	33 (33)
Yes	201 (77)	130 (84)	68 (67)
Smoking history (marijuana)			
No	99 (38)	57 (37)	40 (39)
Yes	161 (62)	96 (63)	62 (61)

*Details on the specific questions asked can be found in the questionnaire (online supplemental appendix).
†LTBI status for five patients was missing, three patients with active TB disease who had never been tested for LTBI were excluded from this table.
LTBI, latent TB infection; TB, tuberculosis.

DISCUSSION

Among residential areas at high risk for TB in a remote Arctic region of Canada, a high proportion of residents were Inuit. Many residents had not completed high school, had very low income, lived in crowded housing and/or experienced food insecurity. A substantial proportion smoked tobacco and marijuana. Unadjusted risk ratios showed that increasing age, lower education, smoking, crowding and Inuit ethnicity were associated with

Table 2 Unadjusted associations of social determinants of healthDH with latent tunerculosis infection status, with complete cases (n=261)

Social determinant of health	Relative risk (RR) (95% CI)
Age, years (5-year increase)	**1.07 (1.05 to 1.10)**
Sex	
Female	1.05 (0.86 to 1.27)
Male	1
Income	
<$20 000*	1.25 (0.98 to 1.60)
$20 000–40 000	1.54 (0.63 to 3.69)
$40 000–60 000	1.77 (0.73 to 4.27)
$60 000–100 000	1.65 (0.68 to 3.96)
>$100 000	1
Education	
Grades 0–8	**2.12 (1.44 to 3.13)**
Grades 9–11	**1.76 (1.21 to 2.57)**
High school	1.47 (0.94 to 2.30)
Post high school	1
Food insecurity	
Yes	1.23 (0.99 to 1.53)
No	1
Smoker (cigarette/pipe)	
Yes	**1.41 (1.06 to 1.89)**
No	1
Smoker (marijuana)	
Yes	1.01 (0.82 to 1.25)
No	1
Alcohol intake	
Yes	0.87 (0.71 to 1.07)
No	1
Crowding (†>1)	
Yes	**1.73 (1.19 to 2.53)**
No	1
Ethnicity	
Inuit	**3.85 (1.92 to 7.69)**
Canadian-born non-indigeneous	1

*Income represents household income for those over 18 years of age.
†Persons per room.
Results in bold are those that are statistically significant.

Table 3 Adjusted associations between various social determinants of health and latent tuberculosis infection

Social determinants of health	Adjusted RR (95% CI), n=177	Multiple imputation RR (95% CI), m=20, n=261
Age, years (5-year increase)	**1.12 (1.01 to 1.03)**	**1.07 (1.04 to 1.11)**
Sex		
Female	1.16 (0.88 to 1.53)	1.02 (0.85 to 1.23)
Male	1	
Income		
<$20 000*	0.98 (0.42 to 2.29)	1.09 (0.57 to 2.07)
$20 000–40 000	1. 04 (0.40 to 2.69)	1.11 (0.56 to 2.19)
$40 000–60 000	1.03 (0.42 to 2.53)	1.18 (0.60 to 2.33)
$60 000–100 000	1.37 (0.57 to 3.32)	1.44 (0.73 to 2.84)
>$100 000	1	
Education		
Grades 0–8	1.31 (0.73 to 2.34)	1.22 (0.83 to 1.81)
Grades 9–11	1.49 (0.88 to 2.52)	1.19 (0.80 to 1.76)
High school	1.16 (0.59 to 2.28)	1.13 (0.73 to 1.74)
Post high school	1	
Food insecurity		
Yes	1.22 (0.91 to 1.64)	1.10 (0.89 to 1.35)
No	1	
Smoker (cigarette/pipe)		
Yes	1.18 (0.72 to 1.94)	1.15 (0.85 to 1.54)
No	1	
Smoker (marijuana)		
Yes	1.22 (0.82 to 1.83)	1.10 (0.86 to 1.42)
No	1	
Alcohol intake		
Yes	0.96 (0.72 to 1.28)	0.97 (0.79 to 1.19)
No	1	
Crowding (prersons per room>1)		
Yes	**1.67 (1.00 to 2.81)**	**1.48 (1.10 to 2.00)**
No	1	
Ethnicity		
Inuit	2.00 (0.91 to 4.37)	**2.76 (1.33 to 5.73)**
Canadian-born non-indigenous	1	

m, number of imputations; n, sample size; RR, relative risk.
Results in bold are those that are statistically significant.

higher frequency of LTBI. After adjustment for all measured SDH, age, crowding and Inuit ethnicity remained statistically significant determinants of LTBI status.

The prevalence of the measured SDH underscores the vulnerability of this population to TB. The fact that almost half of the households had less than $20 000 of income per year is striking. This is particularly true given that the median individual total income of tax filers in Nunavut was $29 220 for the year in which the study was done.[12] Our estimate of household income may reflect people who were not tax filers but at the same time may underestimate all incomes as per tax laws. Smoking is a well known risk factor for the acquisition of LTBI,[17] development of active TB disease[18] and death due to TB.[19] The prevalence of smoking is high in this population compared with the rest of Canada. However, it is similar to previous prevalence studies done in Nunavut where 63% of Inuit >12 years of age smoked daily[20]compared with 16% in the rest of Canada[21] during the year our data was collected. Smoking cannabis may increase the risk of acquiring TB.[22] In our study, 62% of participants reported ever smoking cannabis, which is high compared with the rest of Canada.[14 23 24] TB was associated with poor nutrition in a previous case control study among Inuit living in a remote Arctic setting who were in a TB outbreak.[8] In the current study, food insecurity was not independently a strong determinant of LTBI status. The reason may have been that food security alone does not capture nutrient-level data as was done in the previous study.[8]

In our multivariate model, age, crowding and Inuit ethnicity remained in the model after adjusting for all other SDH collected in the data set. The increased risk of LTBI with increasing age was an expected finding since the older the person, the higher the likelihood that they will have been exposed to TB in these high-risk residential areas. Crowding as measured by person per room was associated with LTBI after adjusting for all of the other SDH measured. In addition, the prevalence of crowding

among residential areas at high risk for TB was very high at 74% compared with 35% prevalence in all of Nunavut during the same period of the study.[12] Among First Nations communities in Canada, an increase in 0.1 persons per room was associated with a 40% increase in the risk of two or more cases of TB occurring,[22] however the findings were limited due to the lack of data on other SDH in the models. In the case-control study in Nunavik, crowding was associated with increased odds of newly diagnosed TB infection among people who lived in smear-positive TB households.[9] Our findings provide additional support to these findings by adjusting for several other SDH and highlights that small incremental increases in the persons per room can result in significant increases in TB cases. A possible explanation for crowding being a consistent variable associated with TB in this part of Canada may be related to the severe climate conditions experienced in the Arctic where people cannot live outside as they do in southern urban cities. People use temporary or transient housing (also known as 'couch surfing') which likely increases crowding and also increases the probability of TB transmission. In the most recent housing survey done in Iqaluit, which coincided with the time this study was done, 5% of the population was in immediate need of housing and was living temporarily in another person's dwelling. About 3/10 dwellings housed temporary residents without a usual home elsewhere in the 12 months prior to the survey.[12] Unfortunately, the chronic housing shortage remains a significant challenge among this population but it does not take into account the fact that many houses are also in need of major repairs. Taken together, 49% of houses in Nunavut in the year the study was done, were either crowded or in need of major repairs or a combination of both.[12]

Ethnicity was demonstrably the strongest determinant of LTBI status in our study, with Inuit having two to three times the risk of having had LTBI than Canadian-born non-Indigenous people. Two previous case control studies done among a similar population did not ascertain if ethnicity could be a risk factor for TB infection or disease,[8 9] however they did acknowledge that genetic factors could be contributing to TB incidence among the Inuit.[8] A case control study done in Greenland which has a similar Inuit population and similar Arctic conditions found that Inuit ethnicity was significantly associated with TB disease after adjustment of SDH with large effect size (OR 15.3).[10] The authors used a stringent definition of ethnicity (all four grandparents had to be Inuit) to be considered Inuit in their study. Those tentative findings may suggest a genetic susceptibility to TB among Inuit and may partly help to explain the high rates of TB in these regions. At the turn of the century, some of the highest rates of TB ever recorded were noted among the Inuit.[25] It is possible that because Inuit only came in contact with Europeans in the past century, they have not developed genetic mechanisms necessary to protect them against TB disease. Evidence exists that people may have genetic signatures that predispose them to develop active TB disease.[26] We agree with other researchers[8 10] that further study in this area is warranted.

Our study has several strengths. The study was a prospective cohort that attempted a completed census of residents in high-risk TB areas. We had TB champions who were able to speak Inuktitut (Inuit language) supported by TB nurses. This allowed for more precise questionnaire responses which provided a more precise description of the population at risk for TB disease. It also included several SDH variables to attempt to reduce confounding due to missing SDH. The definition of Inuit ethnicity is also a challenge but in our study it was objectively determined by the health card number.

Our study has several limitations. We conducted our study in only those residential areas that were at high risk for TB in the context of a public health programme. This suggests that interpretation of our results on SDH needs to account for the selective nature of our study population. Our study was limited by sample size which is often the case given that the population in this Arctic region is small compared with the rest of Canada. The results need to be interpreted cautiously due to potential sparse data issues among some of the SDH variables. We also did not explicitly account for the number of wage earners per dwelling, however our cohort did not have many participants that were between the ages of 12–18 years (n=23) that may have had a higher likelihood of not being wage earners. Further, our multivariate analyses adjusted for crowding and income. However, our study has the largest sample size of data collected prospectively used to develop a model to study SDH and TB among this population in the current literature. Our chosen outcome measure of LTBI status at any time in the participant's history may complicate simple interpretations of our results, in that LTBI status may predate changes to some SDH, which can vary throughout a person's lifetime. Although we attempted to document many possible determinants, there are some notable determinants that were not included in our survey, such as mental health, access to care, early childhood development, personal safety and security, culture and language barriers. Future studies should include these determinants for a more robust analysis. Finally, we attempted to address the influence of missing data using multiple imputation under the common assumption of missingness being dependent on measures present in our data set (the 'missing at random' assumption). This is possibly incorrect—for example, missing income may have been more common in the lowest and highest categories of income—but we attempted to address this by including all available variables in our data set in the imputation model, which may have lessened problems due to violations of this assumption.

What is already known on this subject

- Tuberculosis (TB) remains a significant health burden among Inuit in Canada. Social determinants of health play a key role in TB infection, disease and ongoing transmission in this population. Policy makers are faced with difficult decisions when tackling SDH in the Canadian Nunangat given the long list of inequities that are present between the Nunangat and the rest of Canada which can make prioritization a challenge.

What this study adds

- The present study determined that after adjusting for many other key social determinants of health, crowding and Inuit ethnicity were associated with latent TB infection in residential areas at high risk for TB. On World TB day, March 24, 2018, the Federal Government and Inuit Tapariit Kanatami (ITK, National Inuit organization) vowed to eliminate tuberculosis among Inuit communities by 2030. In addition to screening and treatment of TB, the present study offers support to solving the housing crises in the Nunangat as a priority if TB elimination is to be achieved in this remote region of Canada.

Policy makers are faced with difficult decisions when tackling SDH in the Inuit Nunangat in Canada given the long list of inequities that are present between the Inuit Nunangat and the rest of Canada, which can make prioritisation a challenge. The present study offers support to solving the housing crises as a priority in this population if TB elimination is to be achieved in this remote region of Canada. It should also be noted that access to quality diagnosis and treatment of TB needs to go along with action on key SDH.[6]

CONCLUSIONS

Among residential areas in a remote Arctic region of Canada that were at high risk for TB, crowded housing and Inuit ethnicity were associated with LTBI after adjusting for other SDH. On World TB Day, 24 March 2018, the Federal Government and Inuit Tapariit Kanatami (ITK, National Inuit organization) vowed to eliminate TB among Inuit communities by 2030.[27] In addition to screening and treatment of TB, alleviating the chronic housing shortage will be a key element in the elimination of TB in Inuit Nunangat in Canada.

Contributors EK, DVD, SEP and GGA conceived the study. All authors evaluated the data. All authors reviewed the draft, had critical input and reviewed the final submission.

Funding Public Health Agency of Canada, The National Lung Health Framework.

Competing interests None declared.

Patient consent Obtained.

Ethics approval The study was approved by the Ottawa Hospital Research Institute Ethics Board.

Provenance and peer review Not commissioned; externally peer reviewed.

REFERENCES

1 Li S, Smith K. Inuit: fact sheet for inuit nunangat 2016. 2016 http://www.statcan.gc.ca/pub/89-656-x/89-656-x2016014-eng.pdf
2 Inuit Tapiriit Kanatami. Inuit-specific tuberculosis strategy. 2013 https://itk.ca/wp-content/uploads/2013/./20130503-EN-FINAL-Inuit-TB-Strategy.pdf
3 Vachon J, Gallant V, Siu W. Tuberculosis in Canada, 2016. *Can Commun Dis Rep* 2018;44:75–81.
4 Barr RG, Diez-Roux AV, Knirsch CA, *et al*. Neighborhood poverty and the resurgence of tuberculosis in New York City, 1984-1992. *Am J Public Health* 2001;91:1487–93.
5 Lönnroth K, Jaramillo E, Williams BG, *et al*. Drivers of tuberculosis epidemics: the role of risk factors and social determinants. *Soc Sci Med* 2009;68:2240–6.
6 Rasanathan K, Sivasankara Kurup A, Jaramillo E, *et al*. The social determinants of health: key to global tuberculosis control. *Int J Tuberc Lung Dis* 2011;15:30–6.
7 Rosol R, Huet C, Wood M, *et al*. Prevalence of affirmative responses to questions of food insecurity: international polar year inuit health survey, 2007-2008. *Int J Circumpolar Health* 2011;70:488–97.
8 Fox GJ, Lee RS, Lucas M, *et al*. Inadequate Diet Is Associated with Acquiring Mycobacterium tuberculosis Infection in an Inuit Community. A Case-Control Study. *Ann Am Thorac Soc* 2015;12:1153–62.
9 Khan FA, Fox GJ, Lee RS, *et al*. Housing and tuberculosis in an Inuit village in northern Quebec: a case-control study. *CMAJ Open* 2016;4:E496–506.
10 Ladefoged K, Rendal T, Skifte T, *et al*. Risk factors for tuberculosis in Greenland: case-control study. *Int J Tuberc Lung Dis* 2011;15:44–9.
11 Statistics Canada. Canada's population estimates. 2017 http://www.stats.gov.nu.ca/Publications/Popest/Population/Nunavut%20and%20Canada%20Population%20Estimates%20StatsUpdate,%20Third%20Quarter%202017.pdf
12 Government of Nunavut. Nunavut bureau of statistics. http://www.stats.gov.nu.ca/en/home.aspx
13 Alvarez GG, VanDyk DD, Aaron SD, *et al*. Taima (stop) TB: the impact of a multifaceted TB awareness and door-to-door campaign in residential areas of high risk for TB in Iqaluit, Nunavut. *PLoS One* 2014;9:e100975.
14 Tan WC, Lo C, Jong A, *et al*. Marijuana and chronic obstructive lung disease: a population-based study. *CMAJ* 2009;180:814–20.
15 Tait H, Survey AP. *Inuit health and social conditions*. Ottawa: Statistics CanadaOntario, Canada, 2006.
16 Pedersen AB, Mikkelsen EM, Cronin-Fenton D, *et al*. Missing data and multiple imputation in clinical epidemiological research. *Clin Epidemiol* 2017;9:157–66.
17 Godoy P, Caylà JA, Carmona G, *et al*. Smoking in tuberculosis patients increases the risk of infection in their contacts. *Int J Tuberc Lung Dis* 2013;17:771–6.
18 Bates MN, Khalakdina A, Pai M, *et al*. Risk of tuberculosis from exposure to tobacco smoke: a systematic review and meta-analysis. *Arch Intern Med* 2007;167:335–42.
19 Wen CP, Chan TC, Chan HT, *et al*. The reduction of tuberculosis risks by smoking cessation. *BMC Infect Dis* 2010;10:156.
20 Statistics Canada. *Prevalence of daily, occasional and non-smoking, by Inuit region, Inuit population aged 15 or older*: Statistics Canada: Canada, 2012.
21 Statistics Canada. Special tabulation based on 2001 and 2012 Canadian community health survey. 2016 http://www.statcan.gc.ca/pub/82-003-x/2017002/article/14773-eng.htm
22 Oeltmann JE, Oren E, Haddad MB, *et al*. Tuberculosis outbreak in marijuana users, Seattle, Washington, 2004. *Emerg Infect Dis* 2006;12:1156–9.
23 Government of Canada. Canadian Tobacco Alcohol and Drugs (CTADS): 2013 summary. 2013.
24 Leos-Toro C, Rynard V, Hammond D. Prevalence of problematic cannabis use in Canada: cross-sectional findings from the 2013 canadian tobacco, alcohol and drugs survey. *Can J Public Health* 2018;108:e516–22.
25 Grzybowski S, Styblo K, Dorken E. Tuberculosis in eskimos. *Tubercle* 1976;57:S1–58.
26 Zak DE, Penn-Nicholson A, Scriba TJ, *et al*. A blood RNA signature for tuberculosis disease risk: a prospective cohort study. *Lancet* 2016;387:2312–22.
27 Canadian Broadcasting Corporation. *Ottawa vows to eliminate tuberculosis in Inuit communities by 2030*. Ottawa: CBC, 2018.