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The association of household food security, household characteristics and school environment with obesity status among off-reserve first nations and métis children and youth in Canada: Results from the 2012 aboriginal peoples survey

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The association of household food security, household characteristics and school environment with obesity status among off-reserve First Nations and Métis children and youth in Canada: results from the 2012 Aboriginal Peoples Survey

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Abstract

Introduction: Indigenous children are twice as likely to be classified as obese and three times as likely to experience household food insecurity when compared with non-Indigenous Canadian children. The purpose of this study was to explore the relationship between food insecurity and weight status among Métis and off-reserve First Nations children and youth across Canada.

Methods: We obtained data on children and youth aged 6 to 17 years (n = 6900) from the 2012 Aboriginal Peoples Survey. We tested bivariate relationships using Pearson chi-square tests and used nested binary logistic regressions to examine the food insecurity – weight status relationship, after controlling for geography, household and school characteristics and cultural factors.

Results: Approximately 22% of Métis and First Nations children and youth were overweight, and 15% were classified as obese. Over 80% of the sample was reported as food secure, 9% experienced low food security and 7% were severely food insecure. Off-reserve Indigenous children and youth from households with very low food security were at higher risk of overweight or obese status; however, this excess risk was not independent of household socioeconomic status, and was reduced by controlling for household income, adjusted for household size. Negative school environment was also a significant predictor of obesity risk, independent of demographic, household and geographic factors.

Conclusion: Both food insecurity and obesity were prevalent among the Indigenous groups studied, and our results suggest that a large proportion of children and youth who are food insecure are also overweight or obese. This study reinforces the importance of including social determinants of health, such as income, school environment and geography, in programs or policies targeting child obesity.

Keywords: *child obesity, food insecurity, Indigenous peoples, First Nations, Métis, school environment*

Highlights

- Off-reserve Indigenous children and youth from households with very low food security were at higher risk of being overweight or obese.
- Children and youth whose school environments were rated the most negative (e.g. exposure to racism, bullying and drugs) were the most likely to be overweight or obese relative to those who rated their school environments the least negatively.
- There was no difference in weight status between Indigenous children and youth living in rural, small, medium or large cities.

Introduction

Indigenous children in Canada (including First Nations, Métis and Inuit) are at a disproportionately higher risk for overweight and obesity compared to their non-Aboriginal Canadian counterparts.[1,2] Defined as the accumulation of excess body fat, obesity is associated with poor health outcomes including compromised immune function, mental health disorders, type 2 diabetes, cardiovascular disease, sleep apnea and decreased quality of life.[3-7]

According to the 2009-2011 Canadian Health Measures Survey, approximately one-third of Canadian children and youth between 5 and 17 years of age are classified as overweight (body mass index [BMI] ≥ 25kg/m^2– < 30kg/m^2) or obese (BMI ≥ 30kg/m^2), with Indigenous children and youth being twice as likely to be classified as obese in comparison.[4] Corroborating this pattern, the Public Health Agency of Canada reports that 20% of First Nations children living outside of First Nations reserves and 16.9% of Métis children have a BMI ≥ 30, compared to 11.7% of non-Indigenous Canadian children.[2,4]

While the etiology of obesity is multifactorial and complex, a social determinants of health framework provides a starting point for unpacking the distal* causes of

* Based on social and ecological frameworks of health, proximal determinants include individual-level (e.g. behaviour, early life events) and interpersonal factors (e.g. family practices, physical environment). Distal factors (e.g. household characteristics, community, built environment, society, historical factors) are located further in a causal chain or ecological framework and impact individual health through proximal or intermediary factors.

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child obesity, as well as identifying targets for prevention and treatment.[8,9] However, the health disparities experienced by Indigenous peoples highlight the fact that these social determinants are experienced differently by Indigenous populations and must be explored alongside more culturally relevant factors. Several Indigenous-specific social determinants of health models have been developed as a result, including an ecological model by Willows et al.[8] that includes causal factors related to households, schools, communities and the macrosocial context. Greenwood and de Leeuw[9] use a web diagram to demonstrate that there are multiple interrelated relevant social determinants of Aboriginal peoples' health operating at various socio-ecological levels.

One factor noted in these models that has been gaining increased attention in obesity research is the importance of food security for weight status. Food insecurity is defined as a situation in which availability or access to nutritionally adequate and culturally acceptable food is limited or uncertain.[10,11] While the relationship between food insecurity and obesity may seem paradoxical, research is increasingly linking the two, as food insecurity results in a lack of affordable nutritious food choices, which then may result in obesity.[12-16]

Adults and children have distinct experiences of food insecurity, as children are more vulnerable to resultant behavioural problems, such as decreased school attendance and performance, and poorer overall health and nutrition, despite parents' efforts to minimize food insecurity's impact.[13,17,18] A possible relationship between food insecurity and obesity may be especially relevant for Indigenous children, as Indigenous households are three times more likely to experience food insecurity than non-Indigenous Canadians.[19,20] The 2007/2008 Canadian Community Health Survey found that 20.9% of Indigenous households were food insecure, with 8.4% experiencing "severe" food insecurity.[20] In comparison, 7.2% of non-Indigenous households were food insecure and 2.5% experienced severe food insecurity.[20] Much of this discrepancy can be explained by the higher prevalence of sociodemographic risk factors in Indigenous households (e.g. household crowding, lower household income),[19] many of which have also found to be related to obesity.[21]

Previous qualitative research with off-reserve Métis and First Nations parents found that food insecurity was perceived by community members to be an important cause of obesity in their communities.[22] In those interviews, food insecurity was thought to be not only a result of low income, but also the high price of fresh food in some locations and a lack of transportation. For some, the loss of traditional food and knowledge about its preparation was also important, leading to poorer diets.[22] However, the association between food insecurity and obesity in Indigenous children has not been quantitatively examined. Moreover, it is important to consider this relationship in the context of other potentially important effects, including household characteristics, school-level factors, geography and cultural factors. In this paper, we make use of the 2012 Aboriginal Peoples Survey (APS)[23] to examine the association between household food security status and obesity among off-reserve First Nations and Métis children and youth in Canada, independent of other household, school, geographic and cultural factors.

Methods

Data and participants

The 2012 APS was a postcensal, national survey of the population aged 6 years and older identified in the 2011 National Household Survey,[24] and living outside of First Nations reserve communities as well as select Indigenous communities in the North.[21,23]

This study focussed on First Nations and Métis children and youth aged 6 to 17 years. Inuit children and youth were excluded, as the geography-driven factors affecting their food security status, as well as their unique BMI profiles and body fat distribution, require independent investigation.[25,26] After excluding the Inuit population and adults aged 18 years and over, the final sample included 6900 individuals. Questions for children aged 6 to 14 years were answered by the "person most knowledgeable" (PMK) about the child, generally a parent or guardian. Youth aged 15 to 17 years were interviewed directly. Details about the sampling, data collection and weighting are available in the APS concepts and methods guide.[23]

Main variables

Obesity status

The dependent variable was weight-status based on BMI categorization using Cole's BMI cut-offs.[27] BMI was calculated using PMK-reported height and weight of children. The APS asked, "How tall is [your child] without shoes on?" and "How much does [your child] weigh?" in order to calculate BMI.[28] Weight status categories included normal, overweight and obese.

Food insecurity

The 2012 APS measured household food insecurity over the past 12 months using a series of six statements to which the PMK responded, "often true," "sometimes true" or "never true." The statements captured whether households were able to afford balanced meals, if meals had been downsized or skipped because there was not enough money for food, the frequency of these events, and how often household members experienced hunger. These responses were used by Statistics Canada to categorize households into four levels of food security: high, marginal, low and very low.[28] In the analyses, "highly secure" and "marginally secure" were combined into one category.

Covariates

In addition to household food insecurity, covariates included demographic, household, school, geographic and cultural variables previously identified as having potential relationships with food insecurity or obesity.

The demographic variables included were Indigenous identity group (First Nations or Métis), age (6 – 11 or 12 – 17 years) and gender (male, female). Household socioeconomic characteristics included annual household income and mother's educational attainment. Household income was divided by the number of household members to provide a "per capita" household measure, which was included as quartiles (less than $9510; $9510 – $16 680; $16 690 – $27 260; and $27 280 and above). Other household characteristics included family structure (two-parent, lone-parent or other), as well as household crowding, which was measured based on the number of people per room.

The APS included questions about the school environment. Respondents were asked to indicate their level of agreement using a four-point scale (strongly disagree, disagree, agree, strongly agree) with eight statements. Aspects of a positive school environment were captured by asking:

1) "Overall, respondent feels/felt safe at school"; 2) "Overall, respondent is/was happy at school"; 3) "Most children enjoy/enjoyed being at school"; and 4) "The school provides/provided many opportunities to be involved in school activities." Negative aspects of the school environment were captured by agreement with 1) "Racism is/was a problem at school"; 2) "Bullying is/was a problem at school"; 3) "The presence of alcohol is/was a problem at school"; 4) "The presence of drugs is/was a problem at school"; and 5) "Violence is/was a problem at school." For each child, responses to the positive and negative environment questions were averaged, so that higher scores indicate more positive or more negative environments.

Regional and urban/rural geography were also part of the analysis, as research strongly suggests the importance of broader environmental factors.

Lastly, the cultural variables, "exposure to Indigenous language" and "family members' attendance of residential schools," were also included to capture their potential influence on children's weight status. It has been suggested that cultural characteristics such as language retention are important for Indigenous peoples' health in general, and previous research using the 2006 APS has found that parental residential school attendance was predictive of obesity among Métis children.[9,22] Children who were reported to be exposed to an Aboriginal language at home or outside the home were coded as "exposed." The APS asked whether the child's PMK (usually a parent) or the PMK's mother or father (the child's grandparent) had attended Indian residential or industrial schools. Those who did not respond to these questions (17%) were retained as a separate category called "not stated."

Statistical analyses

We used Pearson chi-square tests to assess bivariate associations between the independent variables and obesity. Thereafter we used a binary multivariate logistic regression to test the likelihood of children and youth having BMI in the "normal" range, versus being "overweight" or "obese," conditional on the independent variables that we found to have significant bivariate associations with overweight and obesity. A total of five nested models were fitted, including different groups of predictor variables. We performed our statistical analysis using SAS software version 9.4.[29] We used bootstrap weights provided by Statistics Canada and balanced repeated re-estimation (BRR) to adjust variance estimates for the survey's complex sampling design.

Results

Table 1 provides demographic, socioeconomic and other characteristics of the sample. Approximately 22% of First Nations and Métis children and youth aged 6 to 17 years were overweight, and 14.9% were classified as obese. While 83.8% of the sample reported as food secure, 9.4%

TABLE 1
Sample characteristics by body mass index, First Nations and Métis youth aged 6 to 17 years, Canada, 2012

Variable	N	Normal weight (%)	Overweight[a] (%)	Obese[b] (%)	*p*-value
Household food security status					
Marginal or high food security	5780	63.6	22.1	14.3	< .001
Low food security	650	58.5	24.6	16.9	
Very low food security	470	53.1	27.7	19.2	
Regional geography					
Atlantic	460	63.0	19.6	17.4	< .001
Quebec	400	62.5	25.0	12.5	
Ontario	1730	61.3	23.7	15.0	
Prairies	2970	60.8	23.0	16.2	
British Columbia	1260	68.3	20.6	11.1	
Territories	70	71.4	14.3	14.3	
Urban/rural geography					
Rural	1590	65.6	18.8	15.6	< .001
Small population centre	1640	57.5	27.3	15.2	
Medium population centre	890	61.1	22.2	16.7	
Large population centre	2780	64.3	21.4	14.3	
Age group					
6–11 years	3110	52.7	24.1	23.2	< .001
12–17 years	3790	70.4	21.4	8.2	
Gender					
Male	3530	59.7	24.1	16.2	< .001
Female	3370	65.5	21.1	13.4	

Continued on the following page

TABLE 1 (continued)
Sample characteristics by body mass index, First Nations and Métis youth aged 6 to 17 years, Canada, 2012

Variable	N	Normal weight (%)	Overweight[a] (%)	Obese[b] (%)	*p*-value
Indigenous identity					
First Nations	3930	59.8	23.7	16.5	< .001
Métis	2970	65.9	21.6	12.5	
Mother's educational attainment					
Less than secondary school graduation	1130	59.3	23.9	16.8	.002
Secondary school diploma or equivalent	1300	59.9	23.9	16.2	
Some post-secondary education	720	61.1	22.2	16.7	
Post-secondary certificate, diploma or degree	3750	64.6	22.1	13.3	
Annual household income per capita					
1st quartile	1890	55.6	25.9	18.5	< .001
2nd quartile	1660	60.8	21.7	17.5	
3rd quartile	1690	65.7	22.5	11.8	
4th quartile	1660	68.1	21.1	10.8	
Family structure					
Two-parent family	4270	64.4	22.5	13.1	< .001
Lone-parent family	2350	58.7	23.0	18.3	
Other	280	64.3	25.0	10.7	
Household crowding					
One or fewer people per room	6330	62.8	22.8	14.4	.007
More than one person per room	570	59.6	21.1	19.3	
Positive school environment index					
1st quartile (1.00–2.75)	1370	65.0	21.9	13.1	< .001
2nd quartile (3.00–3.00)	1980	60.1	25.8	14.1	
3rd quartile (3.25–3.67)	1640	65.2	22.0	12.8	
4th quartile (3.75–4.00)	1900	60.5	21.1	18.4	
Negative school environment index					
1st quartile (1.00–1.60)	1850	54.8	21.1	24.1	.031
2nd quartile (1.75–2.00)	2080	61.7	22.5	15.8	
3rd quartile (2.20–2.25)	1040	59.6	24.0	16.4	
4th quartile (2.40–4.00)	1930	63.2	23.8	13.0	
Exposure to Indigenous language					
No	3420	65.7	22.0	12.3	< .001
Yes	3480	59.5	23.3	17.2	
Family member attended residential schools					
No	2930	63.8	22.2	14.0	< .001
Yes	2780	59.7	23.4	16.9	
Not stated	1180	66.1	22.0	11.9	

Source: Data from the 2012 Aboriginal Peoples Survey.

Notes: Sample numbers according to BMI: normal weight: n = 4310; overweight: n = 1560; obese: n = 1030. Frequency counts for all variables were rounded to the nearest 10.

[a] Having a BMI ≥ 25kg/m^2 but < 30kg/m^2

[b] Having a BMI ≥ 30kg/m^2

experienced low food security and 6.8% were severely food insecure.

There were significant differences in the percentage of children and youth classified as normal, overweight and obese for all of the covariates examined (Table 1). At the individual level, among those who experienced very low food security, 27.7% were overweight and 19.2% were obese. Age was a critical factor for weight status, as 47.3% of Aboriginal children between the ages of 6 and 11 years were either overweight or obese compared to 30% of youth aged 12 to 17 years. A larger proportion of males fell into the overweight or obese classification (40.3%) compared to females (34.5%). Indigenous identity also had a marginal impact on the likelihood of overweight or obese weight status, as 40% of First Nations children fell into these weight categories, compared with 34% of Métis children. Children and youth who were exposed to an Aboriginal language were more likely to be overweight or obese (40.5%) compared to those who had no exposure (34.5%).

The family-level variables also tell an interesting story. The proportion of overweight or obese children does not largely differ based on mother's educational attainment; 41% of children whose mothers had less than secondary school graduation were overweight or obese, and approximately 35% of children whose mothers obtained a post-secondary certificate, diploma or degree fell into these weight categories. Almost half (44%) of children from the lowest income quartile were overweight or obese. The proportion of children from two-parent families classified as overweight or obese (35.6%) was almost six percentage points less than children from lone-parent families (41.3%), but similar to the proportion of overweight and obesity among children who lived in "other" family structures (i.e. children or youth living alone, with a relative or non-relative) (35.7%). Of children and youth living in households where there was more than one person per room, 40.0% were classified as overweight or obese compared to 37.2% of children living in households with one or fewer people per room. While 17% of the sample did not respond to the question about a family member attending residential schools, children whose family members had attended residential schools had a higher proportion of overweight or obese status (40.3%) compared to those who did not (36.2%).

The regional and urban/rural geography variables showed that almost 40% of Aboriginal children and youth living in the Atlantic provinces, Quebec and Ontario were either overweight or obese. In small population centres, the proportion of children and youth who were overweight or obese was 42.5%, followed by medium population centres (38.9%), large population centres (35.7%) and rural areas (34.4%).

The bivariate relationships between the school environment variables and overweight were unclear. Children and youth in school environments that were rated the most positive were the most likely to be obese (18.4%), although those in the third quartile were the least likely to be obese (12.8%). Those rating their school environments the least negatively were the most likely to be obese (24.1%), while those with the most negative school environment rating were the least likely (13.0%).

We investigated the adjusted associations between these variables and children's weight status using sequential multivariate logistic regression (Table 2). In Model I, only food security and demographic variables were included, and those with very low food security had higher odds of being obese or overweight (OR = 1.54, 95% CI: 1.11–2.15). In Model II, other household variables were added, and the effect of food security fell below significance. Mother's educational attainment, family structure and crowding had no significant independent effects, but those in the third (OR = 0.76, 95% CI: 0.59–0.97) and fourth (OR = 0.72, 95% CI: 0.55–0.95) income quartiles were significantly less likely to be overweight or obese than those in the first (lowest) quartile.

School environment variables were added in Model III. A positive school environment rating was unrelated to overweight or obesity, while those in the second, third and fourth quartiles of "negative" school environment were more likely to be overweight or obese than those in the first quartile. Those whose school environments were rated the most negatively were the most likely to be overweight or obese, relative to those who rated their school environments the least negatively (OR = 1.43, 95% CI: 1.11–1.84).

Model IV added geographic variables. Rural or urban residence had no effect, independent of the other variables, but First Nations and Métis children in British Columbia (OR = 0.65, 95% CI: 0.50–0.86) and the three territories (OR = 0.68, 95% CI: 0.49-0.95) were less likely to be overweight or obese, controlling for the other variables in the model.

Lastly, Model V included the two cultural variables—exposure to an Indigenous language and family members having attended residential schools. Neither had a significant independent effect on obesity status.

Discussion

This study provides additional evidence that Indigenous children and youth are at higher risk of overweight and obesity than are other Canadian children. Among youth aged 12 to 17 years in our study sample, 30% were classified as either overweight or obese, compared with 20.7% of all Canadian youth in 2013.[30] First Nations and Métis girls were less likely to be overweight or obese than were boys, an observation that is consistent with previous literature on weight status and sex/gender.[16,31,32]

Given that Indigenous children and youth are at a higher risk of overweight and obesity and the potential for weight to impact health outcomes over the life course,[3-7] it is important to understand the distal and "upstream" determinants that drive their weight status. The data shown here support the importance and utility of a socio-ecological perspective for those ends.[8]

There has been little exploration of the relationship between food security and weight status among Indigenous children and youth, despite research suggesting its importance for the health of Aboriginal peoples more generally.[33] Research on the relationship between food insecurity and obesity or overweight among children and youth has thus far been inconclusive, as studies have found either a positive association between food insecurity and obesity[15,34-36] or insignificant results.[37-39] There are only a few Canadian studies examining the food insecurity–obesity relationship.[14,40,41]

Overall, this study found that food insecurity is indeed a risk factor for overweight or obesity among Indigenous children, with children in very food-insecure households having significantly higher odds of

TABLE 2
Logistic regression analysis estimating overweight and obesity among First Nations and Métis youth aged 6 to 17 years, Canada, 2012

Variable	Model I OR (95% CI)	Model II OR (95% CI)	Model III OR (95% CI)	Model IV OR (95% CI)	Model V OR (95% CI)
Household food security status					
Marginal or high food security (ref)	1.00	1.00	1.00	1.00	1.00
Low food security	1.15 (0.89–1.50)	1.01 (0.77–1.33)	0.99 (0.75–1.31)	1.00 (0.75–1.33)	0.99 (0.74–1.32)
Very low food security	1.54[a] (1.11–2.15)	1.31 (0.91–1.90)	1.29 (0.89–1.86)	1.34 (0.93–1.92)	1.32 (0.92–1.89)
Age group					
6–11 years (ref)	1.00	1.00	1.00	1.00	1.00
12–17 years	0.43[a] (0.37–0.50)	0.43[a] (0.37–0.51)	0.41[a] (0.34–0.49)	0.41[a] (0.34–0.49)	0.41[a] (0.34–0.49)
Gender					
Male (ref)	1.00	1.00	1.00	1.00	1.00
Female	0.76[a] (0.65–0.88)	0.75[a] (0.65–0.88)	0.76[a] (0.65–0.89)	0.76[a] (0.65–0.89)	0.75[a] (0.64–0.88)
Indigenous identity					
First Nations (ref)	1.00	1.00	1.00	1.00	1.00
Métis	0.81[a] (0.67–0.98)	0.85 (0.69–1.04)	0.85 (0.69–1.05)	0.83 (0.68–1.02)	0.86 (0.70–1.06)
Mother's educational attainment					
Less than secondary school (ref)	—	1.00	1.00	1.00	1.00
Secondary school or equivalent	—	1.15 (0.85–1.57)	1.18 (0.87–1.59)	1.16 (0.86–1.58)	1.18 (0.87–1.59)
Some post-secondary	—	1.08 (0.77–1.51)	1.11 (0.80–1.53)	1.11 (0.80–1.54)	1.11 (0.80–1.54)
Post-secondary certificate, diploma or degree	—	0.94 (0.73–1.21)	0.95 (0.74–1.22)	0.95 (0.74–1.21)	0.94 (0.74–1.21)
Annual household income per capita					
1st quartile (< $9510) (ref)	—	1.00	1.00	1.00	1.00
2nd quartile ($9510–$16 680)	—	0.90 (0.70–1.15)	0.91 (0.71–1.16)	0.92 (0.72–1.18)	0.93 (0.73–1.19)
3rd quartile ($16 690– $27 260)	—	0.76[a] (0.59–0.97)	0.76[a] (0.59–0.98)	0.76[a] (0.59–0.98)	0.77[a] (0.60–0.98)
4th quartile (> $27 280)	—	0.72[a] (0.55–0.95)	0.74[a] (0.57–0.97)	0.75[a] (0.57–0.98)	0.76[a] (0.58–1.00)
Family structure					
Two-parent family (ref)	—	1.00	1.00	1.00	1.00
Lone-parent family	—	1.13 (0.94–1.36)	1.12 (0.93–1.35)	1.13 (0.93–1.37)	1.11 (0.91–1.34)
Other	—	0.91 (0.59–1.40)	0.92 (0.60–1.40)	0.90 (0.59–1.37)	0.95 (0.62–1.45)
Household crowding					
One or fewer people per room (ref)	—	1.00	1.00	1.00	1.00
More than one person per room	—	1.02 (0.73–1.43)	1.01 (0.72–1.42)	1.02 (0.72–1.44)	0.99 (0.70–1.39)
Positive school environment index					
1st quartile (1.00–2.75) (ref)	—	—	1.00	1.00	1.00
2nd quartile (3.00–3.00)	—	—	1.08 (0.82–1.44)	1.09 (0.82–1.44)	1.09 (0.82–1.43)
3rd quartile (3.25–3.67)	—	—	0.95 (0.70–1.28)	0.94 (0.69–1.27)	0.93 (0.69–1.25)
4th quartile (3.75–4.00)	—	—	1.12 (0.82–1.55)	1.10 (0.80–1.50)	1.09 (0.80–1.48)

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TABLE 2 (continued)
Logistic regression analysis estimating overweight and obesity among First Nations and Métis youth aged 6 to 17 years, Canada, 2012

Variable	Model I OR (95% CI)	Model II OR (95% CI)	Model III OR (95% CI)	Model IV OR (95% CI)	Model V OR (95% CI)
Negative school environment index					
1st quartile (1.00–1.60) (ref)	—	—	1.00	1.00	1.00
2nd quartile (1.75–2.00)	—	—	1.29[a] (1.02–1.62)	1.29[a] (1.03–1.62)	1.28[a] (1.03–1.60)
3rd quartile (2.20–2.25)	—	—	1.44[a] (1.10–1.90)	1.41[a] (1.07–1.85)	1.39[a] (1.06–1.82)
4th quartile (2.40–4.00)	—	—	1.43[a] (1.11–1.84)	1.40[a] (1.08–1.81)	1.38[a] (1.07–1.78)
Regional geography					
Atlantic	—	—	—	0.94 (0.59–1.49)	0.94 (0.60–1.48)
Quebec	—	—	—	0.98 (0.72–1.34)	0.97 (0.72–1.32)
Ontario (ref)	—	—	—	1.00	1.00
Prairies	—	—	—	1.00 (0.75–1.31)	0.95 (0.73–1.24)
British Columbia	—	—	—	0.65[a] (0.50–0.86)	0.64[a] (0.49–0.83)
Territories	—	—	—	0.68[a] (0.49–0.95)	0.64[a] (0.45–0.89)
Urban/rural geography					
Rural (ref)	—	—	—	1.00	1.00
Small population centre	—	—	—	1.21 (0.93–1.58)	1.19 (0.91–1.56)
Medium population centre	—	—	—	1.15 (0.84–1.57)	1.13 (0.83–1.55)
Large population centre	—	—	—	0.96 (0.74–1.25)	0.97 (0.75–1.26)
Exposure to Indigenous language					
No (ref)	—	—	—	—	1.00
Yes	—	—	—	—	1.17 (0.99–1.40)
Family members attended residential schools					
No (ref)	—	—	—	—	1.00
Yes	—	—	—	—	1.02 (0.84–1.23)
Not stated	—	—	—	—	0.85 (0.65–1.10)
C-Statistic	0.62	0.63	0.63	0.64	0.64

Data source: 2012 Aboriginal Peoples Survey.

Abbreviations: CI, confidence interval; OR, odds ratio; ref, reference category.

Notes: Sample numbers according to BMI (normal weight: n = 4310; overweight: n = 1560; obese: n = 1030). Values shown in the table are bootstrapped estimates. Model I included household food security and demographic variables. Model II added socioeconomic status variables and family-level factors. Model III included school environment variables. Model IV added geographic variables. Model V incorporated all variables by adding cultural factors.

[a] Significantly different from reference category ($p < .05$).

overweight or obesity, controlling for demographic factors. However, food insecurity did not have a significant effect independent of other household-level socioeconomic variables. As expected, household income is a significant predictor of weight status among Aboriginal children. Household income is an important determinant of numerous health outcomes as it can represent access to resources and recreational and physical activity opportunities for families, and is also a key factor in food security. Neither mother's education nor residential schooling of a family member were significant once income was controlled.

The socioecological approach led us to consider characteristics of schools as predictors of overweight and obesity. Our study uncovered an unexpected factor, perception of school environment, as an important predictor of weight status for children and youth. Although positive perceptions had no relationship to weight status, negative perceptions of school environment (including exposure to racism, bullying, alcohol, drugs or violence) were associated with an increased likelihood of obesity or overweight, independent of

household socioeconomic and demographic characteristics. Understanding these results requires further investigation, but it has been suggested elsewhere that schools with negative climates may also be less likely to offer effective opportunities for physical activity.[42]

Regional geography appeared to have an impact on weight status, as children and youth living in British Columbia or the three territories were significantly less likely to be overweight or obese compared to children living in Ontario, controlling for household socioeconomic characteristics. Similar variation has been observed previously, and some research suggests that greater emphasis on outdoor physical activity and availability of facilities may be partially responsible for the observed difference in weight status across provinces.[43] In addition, socioeconomic status[44,45] as well as being born outside of Canada[44] has been inversely associated with a lower BMI among adults in several provinces, including British Columbia.

Somewhat surprisingly, however, there was no difference between Indigenous children and youth living in rural, small, medium or large cities in their odds of being overweight or obese, suggesting that the more important factors were operating at the household and school levels.

Given previous literature on the determinants of Indigenous peoples' health, we had expected to find that exposure to an Indigenous language, as a measure of cultural preservation, would be protective against being overweight or obese, and that having a family member who attended residential schools would be a risk factor. Although neither had an independent effect, it must be recognized that these measures included in the APS are only weak measures of cultural attachment or preservation. Further research is necessary to understand whether cultural factors might be related to overweight and obesity at the population level, and if so, in what way.

Strengths and limitations

No other studies to date have examined the relationship between food insecurity and obesity among Aboriginal children and youth at the population level. This study used a national survey with the largest available sample size of Indigenous children and youth.

A key limitation of this study, as well as many others investigating the food insecurity–obesity relationship, is that the design is cross-sectional and does not allow us to establish causation or explore how the relationship changes over time. Subjective BMI data were collected, as caregivers were asked to report their children's height and weight. This may have resulted in an underestimate of the prevalence of obesity, as research shows that parents tend to underestimate their children's weight and overestimate height, leading to a lower BMI than when objectively measured.[45,46] Covariates not measured in this study, such as physical activity and diet, could be responsible for confounding effects. Additionally, given that this is not a well-studied topic, we were not able to compare this association in Aboriginal children and youth with any similar associations in the general Canadian population.

It is also difficult to compare our results with other studies, because different measures are used to assess food insecurity. The United States uses the Agricultural Department Food Security Scale,[47] which is different from the measures used in the APS or the Canadian Community Health Survey, limiting comparisons. Moreover, while the literature discusses the importance of including culture and access to traditional foods for an Aboriginal definition of food security,[8,9] the APS food security questions do not include these dimensions.

Conclusion

We concluded that off-reserve Indigenous children and youth who are in households with very low food security are indeed at higher risk for overweight and obesity, but that this excess risk is not independent of household socioeconomic status; household income adjusted for household size are reliable predictors. This suggests that household socioeconomic status is a major contributor to the high risk of overweight and obesity among First Nations and Métis children and youth. We also found that being in a negative school environment is associated with obesity risk, independent of demographic, household and geographic factors.

Given the complexity of childhood obesity and overweight, the available data limited our ability to identify conclusively the factors that are most important, including the potential role of food insecurity. There is a lack of longitudinal data to help us understand the interplay of various factors over the life course in different populations. Among Indigenous peoples specifically, community-based participatory research and research using qualitative methods would strongly complement quantitative investigations. Previous research on interventions in Aboriginal communities demonstrates the strength of such an approach.[33,41,42]

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Conflicts of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

Authors' contributions

JB conceived the idea for the paper, conducted the literature review and preliminary data analysis, and wrote the first draft. MC assisted with the data analysis and manuscript draft, revised the paper and is principal investigator (PI) on the supporting grant. YG conducted the data analysis, and revised and commented on later drafts. PW supervised the data analysis and is co-PI on the supporting grant. All authors read and approved the final manuscript.

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