

Associations among the food environment, diet quality and weight status in Cree children in Québec

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Abstract

Objective: To explore the relationship among children's diet quality, weight status and food environment in subarctic Canada.

Design: In the cross-sectional study, children's BMI was calculated, diet quality was assessed using three 24 h dietary recalls and children were asked about their home food environment and source of meals.

Setting: Two Aboriginal Cree communities in northern Québec.

Subjects: Two hundred and one children in grades 4–6.

Results: The majority (64.2%) of children were overweight (29.9%) or obese (34.3%). Weight status was not associated with reported restaurant meal frequency or the home food environment. The 18% of children who consumed three or more restaurant meals in the three days of recall consumed, on average, 2004 kJ (479 kcal) more energy daily than children consuming no restaurant meals and had higher intakes of fat, saturated fat, Ca and soda. Most foods contributing to energy and dietary fat were energy-dense market foods of low nutritional value such as sweetened beverages and snack foods. Only 68% of children reported often having fruits and vegetables in the home and 98.5% of children consumed less than 5 fruits and vegetables daily. Many children (42.8%) were at risk of Zn inadequacy. Only 19% of children consumed 2 or more servings of milk daily, and the mean intakes of Ca and vitamin D were below the recommended adequate intake. Traditional game meat was consumed infrequently, but contributed significantly to Fe and Zn intake.

Conclusions: Childhood obesity in subarctic communities prevailed in a food environment typified by high-energy-density commercial foods of low nutritional value.

Keywords

Nutrition environment
Diet quality
Aboriginal
Childhood obesity

Overweight and obesity is prevalent worldwide and increasing^(1,2), likely due to the dramatic changes in both lifestyle and environment. In recent decades there has been increased accessibility to restaurants and fast-food outlets and people are spending more of their disposable income on foods away from the home. Indeed, since the late 1970s, energy intake from restaurant meals/fast foods has increased by 91% to 208% for all age groups⁽³⁾; as many as 25% of Canadians and 30% of Americans eat fast-food restaurant meals on any given day^(3,4). Meals served at restaurants and fast-food establishments are generally energy-dense (i.e. high in fat and sugar) and the portions served typically exceed recommended portion sizes⁽⁵⁾.

As convenience becomes a priority in many households, home-cooked meals are being replaced with prepared or away-from-home foods (i.e. take-out foods, frozen entrees

and pre-cooked, pre-packaged foods)⁽⁶⁾. Although the availability of foods in the home, such as fruits and vegetables, has been correlated with actual intake^(7,8), when take-out foods make a substantial contribution to the home diet, the association between home food availability and foods consumed at home may become less pronounced.

In Canada, 'Aboriginal people' is a collective name for the indigenous peoples of North America and their descendants. First Nations, the largest Aboriginal group, are diverse geographically and in language and culture. First Nations and Native American Indian children have higher rates of overweight and obesity than do children from other ethnic groups^(1,9,10). Lower literacy levels, lower education levels and lower incomes are likely underlying causes of health disparities between Aboriginal and non-Aboriginal populations⁽¹¹⁾. The nutrition

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transition reflects the rapid change from the consumption of a cultural group's traditional foods to the adoption of a more 'Westernized diet'⁽¹²⁾. Aboriginal peoples undergoing the nutrition transition have an increasing proportion of their diet from store-bought foods and a decreasing proportion from traditional foods obtained from hunting, trapping, fishing and gathering^(13,14). Rates of obesity in First Nations children are thus likely the result of the loss of traditional lifestyle and the transition to market foods of low nutritional quality⁽¹⁴⁾. We completed a school-based study of First Nations children that examined the association of children's reported household food availability and restaurant/take-out meal frequency with dietary intake, risk of micronutrient inadequacy and weight status in two subarctic communities in Canada.

Experimental methods

Setting

The Active Kids Project was a cross-sectional study that examined weight status and lifestyle behaviours of students in grades 4–6 in two isolated Cree First Nation communities in the northern part of the Province of Québec; an isolated community being one having fewer than 10 000 people and being more than 80 km from an urban centre⁽¹⁵⁾. Each community had less than 3500 people and was 90 or 561 km from the closest town. Both communities had two grocery stores with prices that were high relative to urban areas⁽¹³⁾ and three locally run restaurants that served fast foods such as *poutine* (French fries, brown sauce, cheese curds), French fries, hamburgers, fried battered chicken and pizza. Fried chicken, including nuggets, and French fries were sold ready-to-serve in some grocery stores. The portion sizes were similar to urban fast-food restaurants.

One school from each community participated in the study, which took place in the autumn of 2004 in one community and the autumn of 2005 in the other. Children ate breakfast and lunch away from school. Prior to collecting data, students were given information sheets and parental consent forms, researchers met with school and Cree Health Board staff to discuss the study, and radio announcements were broadcast in English and Cree to inform community members about the study. Only those students with signed parental consent forms participated. English was often a second language. For this reason, information sheets and consent forms were at approximately a grade 5 reading level. To ensure cultural sensitivity, a Steering Committee of community members and Cree Health Board staff was formed that was available to explain the study to the community. The study was approved by the Human Ethics Research Board, Faculty of Agriculture, Forestry, and Home Economics, University of Alberta; The Cree Board of Health and Social Services of James Bay (Québec); and the school principals.

Weight status

Weight status was determined from measured heights and weights taken in light indoor clothing with shoes removed in a private area of the school. University research assistants were trained in the proper anthropometric measurement techniques by an exercise physiologist. BMI was calculated to the nearest 0.01 kg/m². International Obesity Taskforce age- and sex-specific cut-offs were used to categorize a child's BMI as normal, overweight or obese⁽¹⁶⁾.

Dietary intake

University researchers completed three 24 h dietary recalls with each child at the school on non-consecutive days, including one weekend day, using a multiple-pass interview method⁽¹⁷⁾. The recalls were conducted unannounced and researchers rotated among the participants. Probes, food models, pictures and packaging of locally sold products provided detailed information about the quantity and type of food and drinks consumed. While completing the dietary recalls each child was asked where they ate their meal and the source of their meal. This information was used to categorize restaurant/take-out food intake. Dietary information was entered into the Food Processor SQL for Windows package version 9.6.2 (Esha Research, Salem, OR, USA) and the Canadian Nutrient File (1997) was used to obtain the nutrient composition of Canadian foods and beverages. One researcher assigned the Food Processor codes for the dietary data entry, which was then checked three times to ensure accuracy of input.

Sweetened drinks (powdered fruit drinks, sports drinks and other drinks with added sugars, not including carbonated soda) were considered a single category, and a separate category was formed for sweetened carbonated soda. Fruits (excluding fruit juices) and vegetables (excluding French fries and fried potatoes) were reported as the average daily number of times a child reported eating these foods. The contribution that specific foods or food categories made to energy, energy from fat and micronutrients was calculated by summing the nutrient intakes from all three dietary recalls associated with each food or food category, then dividing by the total intake of energy, energy from fat or the specific micronutrient. When calculating the top foods contributing to energy, sweetened drinks and sweetened carbonated soda were considered together as sweetened beverages. The top five foods or food categories contributing to nutrients are reported.

Restaurant and take-out food

Children were asked if their meals were from a restaurant or take-out. The number of meals reported to be from restaurant or take-out in the three days of recall were categorized as none, 1 or 2, or 3 or more, and were called 'restaurant meals'.

The home food environment

The home food environment was assessed using a food availability questionnaire adapted from the food availability portion of the University of Minnesota Project EAT (Eating Among Teens) survey⁽⁷⁾. Its original use was to assess the availability of foods in the homes of adolescents, and it was intended for parents to complete⁽⁷⁾. In the Cree study, the interviewer asked children the questions at the time of the child's first 24 h recall. The questionnaire was pilot-tested to ensure that it was appropriate for use with children. The interviewers did not inquire about a specific time period or season. Children were asked questions regarding the home availability of fruits and vegetables, potato chips, milk, soda pop and real fruit juice, and if vegetables were served on children's plates at dinner. 'Vegetables on the plate at dinner' was considered a proxy measure of overall vegetable intake and meal quality. For each question, children were asked to respond whether the item was never, sometimes, usually or always available. Due to the small number of responses for some categories, the 'usual' and 'always' categories were combined (referred to as 'often'), as were the 'sometimes' and 'never' categories (referred to as 'seldom') for descriptive purposes and statistical analyses.

Statistical analysis

Continuous variables are reported as means and standard deviations. For variables that were not normally distributed, the median and interquartile ranges are also reported. The χ^2 statistic was used to test for group differences involving categorical data. Independent *t* tests and ANOVA were used to assess group differences for continuous variables. To test for group differences for continuous variables that were not normally distributed and that were not normalized with log transformations, the Mann-Whitney *U* test (two groups) or the Kruskal-Wallis test (three groups) were used. General linear model (GLM) analyses were conducted to identify the independent main effects of restaurant food intake frequency and gender on anthropometry, nutrient intake and amount of food consumed. There were no significant interaction terms between the main effects for any outcome variable, so boys and girls were analysed together. The Bonferroni *post hoc* test was used to determine differences among restaurant meal frequency groups if the overall *F* statistic was significant. Statistical analyses were performed using the SPSS for Windows statistical software package version 14.0 (SPSS Inc., Chicago, IL, USA). Statistical significance was considered at $P < 0.05$.

PC-SIDE software version 1.0 (Iowa State University, Ames, IA, USA) was used to adjust micronutrient intakes and report risk of nutrient inadequacy based on the Estimated Average Requirement (EAR) cut-point method⁽¹⁸⁾, to report the percentage of children with below adequate nutrient intakes, and to report adjusted means and standard deviations. As the Canadian Nutrient File was missing

data for folate and for vitamin A for some foods, these two nutrients were excluded from the analyses.

Results

Two hundred and twenty-five students were eligible to participate; 103 children were recruited from one community and ninety-eight children were recruited from the second community (89% participation rate). The associations among variables were comparable for each community; therefore data were combined to increase the statistical power of the sample.

Weight status

Children had high rates of overweight (29.9%) and obesity (34.3%).

Household characteristics

Children's average household size was 6.0 (SD 1.6) persons. Household size ranged from two persons to thirteen persons; 68.2% of households had six persons or more. The number of persons living in a household was not associated with weight status or dietary indicators (data not shown).

Dietary intake

Less than one-fifth (19.1%) of children consumed at least 2 servings of milk daily as recommended by Canada's Food Guide. Almost all children (98.5%) consumed fewer than 5 fruits and vegetables daily. Table 1 identifies the top five food sources of energy, energy from fat and selected micronutrients. Traditional game meat made important contributions to children's intake of Fe and Zn despite contributing to only 3% of total energy in the diet. Adjusted means and standard deviations, and risk of inadequacy for select nutrients, are reported in Table 2.

Restaurant/take-out food

The number of restaurant meals consumed over the three days of food recalls ranged from none to five: more than three-quarters (77.6%) of children consumed at least one restaurant meal and 18.4% of children consumed three or more restaurant meals. Children who ate three or more restaurant meals had higher daily intakes of energy, energy from fat and saturated fat, Ca and carbonated soda beverages and a lower percentage of energy from protein (Table 3).

The home food environment

The percentage of children often having the following foods in the home was 16% for potato chips, 29% for soda pop, 65% for real fruit juices, 68% for fruits and vegetables, 87% for milk and 40% for vegetables on the dinner plate. Whereas only 22.4% of children who seldom had potato chips at home often had soda pop at

Table 1 Top five dietary contributors to energy, energy from fat and select micronutrients among children from two Aboriginal Cree communities in northern Québec, Canada, 2004 and 2005

Nutrient	Food item	% of total intake
Energy	Sweetened beverages†	8.9
	Milk	7.1
	White bread	6.4
	Snack foods‡	6.3
	<i>Poutine</i> §	5.0
Energy from fat	Snack foods‡	11.7
	Milk	7.9
	<i>Poutine</i> §	7.5
	Chicken	6.7
	Pizza	5.9
Vitamin D (µg)	Milk	89.3
	Eggs	3.5
	Ice cream	2.2
	Butter	1.8
	Cereal	1.5
Vitamin C (mg)	Real fruit juice	32.9
	Fruit drinks	25.6
	Oranges	11.7
	Potato chips	6.9
	Spaghetti sauce with beef	2.4
Fe (mg)	Cereal	20.8
	Traditional food¶	16.7
	White bread	11.3
	Boxed macaroni and cheese††	3.6
	Beef	3.2
Zn (mg)	Traditional food¶	16.8
	Milk	15.8
	Beef	9.6
	Cereal	8.6
	Chicken	5.4
Ca (mg)	Milk	43.4
	Cheese	11.9
	Pizza	5.0
	Yoghurt	3.5
	Ice cream	2.7

†Sweetened beverages: punches, sweetened powdered beverages, sweetened carbonated sodas, sports drinks.

‡Snack foods: potato chips, corn chips, puffed corn snacks.

§*Poutine*: French fries, cheese curds and brown sauce.

||Fruit drinks: non-carbonated fruit punches and sweetened powdered fruit-flavoured beverages with vitamin C added.

¶Traditional foods: bear, moose, goose, moose stew, rabbit and beaver.

††This boxed prepared food is common in Canada.

home, 63.6% of children who often had potato chips at home often had soda pop at home ($P < 0.001$). Compared with children who seldom had fruits and vegetables at home, children who often had fruits and vegetables at home were more likely to often have vegetables on their plate at dinner (50% *v.* 31%, $P = 0.011$) and to often have milk in the home (91% *v.* 77%, $P = 0.004$). Children who reported often having soda, real fruit juice or milk in the home consumed significantly greater quantities of these beverages than children who reported seldom having these beverages in the home ($P = 0.049$, $P = 0.024$ and $P = 0.024$, respectively). The home food environment was associated with children's dietary intake of beverages (Table 4). There were no statistical differences in the home food environment between children who were of normal weight and overweight/obese children (data not shown). Frequency of consumption of restaurant foods was comparable between all household food availability categories.

Discussion

The majority of Cree schoolchildren in the subarctic region of Québec were overweight or obese, which corroborates research that First Nations and American Indian children in Canada and the USA have excess weight^(9,10,19). Cree children had diets that were energy-dense and low in foods of high nutrient density such as fruits and vegetables. Similar observations have been made for children from other First Nations and American Indian communities^(20,21) and might be due, in part, to the high cost of nutrient-dense foods⁽¹³⁾. Cree children were at risk for Zn inadequacy and had intakes of vitamin D and Ca below the adequate intake, which confirms findings of low intakes of several micronutrients in Aboriginal communities in Canada^(22,23). Milk was an important source of Ca and vitamin D for Cree children and an increase in diet quality would be anticipated if milk consumption was increased. A positive finding of the study was the contribution of traditional game foods to both Fe and Zn intake. Studies in Aboriginal communities have indicated that when traditional foods are consumed, micronutrient nutrition is improved^(22–24). Traditional foods, if consumed more often, could improve children's nutrient profile.

Despite the remoteness of communities, 77% of the children consumed at least one restaurant or take-out meal during the three days of food recall, which is comparable to findings that 25% of Canadian children eat fast-food restaurant meals on any given day⁽⁴⁾. The foods served at fast-food establishments are generally energy-dense and contain high amounts of fat and sugar⁽⁵⁾. For this reason, when children eat restaurant meals they consume significant energy from fat and saturated fat⁽²⁵⁾, and often have low intakes of some micronutrients⁽²⁶⁾. Bowman *et al.*⁽³⁾ reported that children who ate meals from fast-food restaurants consumed 782 kJ (187 kcal) more energy per day than children who did not consume these meals. In comparison, Cree children who ate the highest number of restaurant meals consumed, on average, 2004 kJ (479 kcal) more energy per day than children who consumed no restaurant meals. If the excess energy associated with restaurant meal intake in Cree children is not counterbalanced with increased energy expenditure, the persistence of this behaviour might result in dramatic weight gain.

There was no association between weight status and restaurant meal intake or the home food environment, which is consistent with the literature for children^(6,27). Many pre-packaged foods that are assembled in the home may have comparable nutritional quality to restaurant foods. It is therefore possible that the absence of a relationship between weight status and restaurant meal frequency reflects the quality of the foods also being consumed at home.

Cree children who often had soda, real fruit juice and milk in the home consumed significantly higher quantities

Table 2 Estimated usual micronutrient intakes and the risk of inadequacy among children from two Aboriginal Cree communities in northern Québec, Canada, 2004 and 2005

Micronutrient	Boys	Girls	Sexes combined	Dietary reference intake
Fe (mg)				
Mean	15.0	11.3**	Not applicable	EAR, 9–13 years:
SD	4.5	2.5		♂ 5.9 mg/d
% below EAR	0.25	0.18		♀ 5.7 mg/d
Zn (mg)				
Mean	8.2	7.1	7.6	EAR, 9–13 years:
SD	2.6	1.6	2.1	7 mg/d
% below EAR	35.9	50.4	42.8	
Vitamin C (mg)				
Mean	125.5	96.8	109.7	EAR, 9–13 years:
SD	60.6	45.7	54.9	39 mg/d
% below EAR	2.6	7.2	4.9	
Ca (mg)				
Mean	970.6	817.4	884.4	AI, 9–13 years:
SD	389.0	257.4	316.4	1300 mg/d
Vitamin D (µg)				
Mean†	4.1	3.7	3.9	AI, 4–13 years:
SD†	3.0	2.4	2.7	5 µg/d

EAR, Estimated Average Requirement; AI, Adequate Intake; % below EAR, the adjusted percentage of children with average nutrient intakes below the EAR; ♀, the requirements for girls in the specified age group; ♂, the requirements for boys in the specified age group. Mean value was significantly different from that of boys: ** $P < 0.01$. † indicates an unadjusted mean and standard deviation.

Table 3 The association of frequency of restaurant meals in the three days of recall with dietary variables among children from two Aboriginal Cree communities in northern Québec, Canada, 2004 and 2005

Variable	0 meals		1 or 2 meals		3 or more		<i>P</i> value	Total	
Non-dietary data									
No. of children	45		119		37		n/a	201	
Obese (%)	40.0		32.8		32.4		0.504	34.3	
	Mean	SD	Mean	SD	Mean	SD		Mean	SD
Age (years)	10.9 ^a	0.9	10.7 ^a	1.0	10.3 ^b	0.9	0.033*	10.7	1.0
BMI (kg/m ²)	23.8	4.7	22.9	5.2	22.6	5.1	0.462	23.0	5.1
Energy, macronutrients and fibre									
Energy (kJ)	8824 ^a	2360	9234 ^a	2807	10 828 ^b	3314	0.01**	9435	2883
(kcal)	2109 ^a	564	2207 ^a	671	2588 ^b	792		2255	689
Energy from fat (kJ)	2582 ^a	983	2774 ^a	979	3448 ^b	1113	0.001***	2858	1042
(kcal)	617 ^a	235	663 ^a	234	824 ^b	266		683	249
% energy from fat	28.8 ^a	6.0	29.9 ^a	4.3	31.9 ^b	4.8	0.009**	30.0	4.9
Energy from saturated fat (kJ)	946 ^a	347	996 ^a	393	1226 ^b	372	0.005**	1026	1637
(kcal)	226 ^a	83	238 ^a	94	293 ^b	89		245.3	93.5
% energy from saturated fat	10.5	2.0	10.6	1.9	11.4	1.9	0.075	10.7	1.9
% energy from protein	15.2 ^a	3.4	14.1 ^a	3.0	13.6 ^b	2.7	0.023*	14.3	3.1
% energy from carbohydrate	57.0	7.3	57.4	5.5	56.0	5.8	0.639	57.0	6.0
Fibre (g)	13.1	4.6	13.2	5.3	14.6	5.9	0.439	13.4	5.3
Micronutrients									
Ca (mg)	844.8 ^a	366.1	828.9 ^a	388.0	1033.1 ^b	390.3	0.04*	870.0	389.5
Fe (mg)	14.6	4.9	13.4	5.1	15.1	6.8	0.361	14.0	5.4
Zn (mg)	8.9	3.4	7.6	3.3	8.2	3.4	0.074	8.0	3.4
Vitamin D (µg)	4.1	2.7	3.7	2.5	4.3	3.2	0.565	3.9	2.7
Vitamin C (mg)	110.9	84.1	107.5	77.0	96.5	63.0	0.534	106.2	8.0
Food and beverages consumed									
Milk (ml)	331	233	307	237	353	245	0.700	320	237
Sweetened drinks (ml)	269	278	398	352	349	250	0.043*	360	322
Median (IQR)	177 (55–457)		319 (135–553)		277 (177–457)			276 (118–492)	
Soda (ml)	146	177	209	234	334	234	0.000***	218	229
Median (IQR)	60 (0–249)		120 (0–285)		333 (134–501)			176 (0–334)	
Fruits (number)	0.9	0.9	0.8	1.0	0.7	0.9	0.634	0.8	0.9
Median (IQR)	0.7 (0.0–1.5)		0.3 (0.0–1.0)		0.3 (0.0–1.0)			0.3 (0.0–1.0)	
Vegetables (number)	0.8	0.7	0.7	0.7	0.6	0.9	0.253	0.7	0.8
Median (IQR)	0.7 (0.3–1.3)		0.7 (0.0–1.0)		0.3 (0.0–0.7)			0.7 (0–1.0)	

n/a, not applicable; IQR, interquartile range.

Central tendency is expressed as the mean and standard deviation; in addition, the median and IQR are included for variables that were not normally distributed and the Kruskal–Wallis test was used to compare groups in these cases because data were non-parametric.

Asterisks indicate significant group differences (* $P < 0.05$, ** $P < 0.01$, *** $P < 0.001$). For data that were normally distributed, different superscript letters indicate significant differences among groups.

Table 4 Child-reported household availability of food in relation to actual intake among children from two Aboriginal Cree communities in northern Québec, Canada, 2004 and 2005

Reported typical daily food and beverage intake	Child-reported household availability		P value
	Seldom	Often	
Fruit & vegetables			
No. of fruit & vegetables			
Mean	1.4	1.6	0.341
SD	1.1	1.3	
Median (IQR)	1.0 (0.7–1.9)	1.3 (0.7–2.3)	
Vegetables on plate at dinner			
No. of vegetables			
Mean	0.7	0.8	0.075
SD	0.7	0.8	
Median (IQR)	0.3 (0.0–1.0)	0.7 (0.3–1.2)	
Real fruit juice			
Real fruit juice (ml)			
Mean	200	262	0.024*
SD	203	214	
Median (IQR)	150 (0–327)	237 (83–384)	
Carbonated soda			
Carbonated soda (ml)			
Mean	190	285	0.049*
SD	194	288	
Median (IQR)	118 (0–296)	198 (60–434)	
Milk			
Milk (ml)			
Mean	225	335	0.024*
SD	152	245	

IQR, interquartile range.

For data that were not normally distributed, the median and IQR are reported in addition to the mean and standard deviation.

Asterisk indicates significant group differences (* $P < 0.05$).

of these beverages than children who seldom had these beverages in the home. The availability of fruits and vegetables has consistently been found to be a predictor of actual intake^(7,8,28); however, we found no significant differences between household fruit and vegetable availability and children's consumption. Unlike beverages which can be easily poured from a container, fruits and vegetables may not be consumed by children who do not have the skills or knowledge to prepare them. Children who often had fruits and vegetables in the home were more likely to have milk in the home and vegetables on their plate at dinner, whereas children who often had soda in the home were more likely to often have potato chips in the home. These results suggest a coupling of healthy or unhealthy eating behaviours in Cree families.

The average household size where Cree children lived was more than double the national Canadian average of 2.6 persons per household⁽²⁹⁾. Household crowding is a known determinant of poor health in Aboriginal communities⁽³⁰⁾. Household size can influence household food purchasing⁽³¹⁾, yet we found no association between household number and dietary variables. Approximately 20% of Cree mothers in northern Québec worry about having enough money to buy food for their children⁽³²⁾. Cree children, regardless of household size, may experience all or most aspects of food insecurity due to limited economic opportunities in the communities, the high cost of market food, and limited food choices⁽³²⁾. There is an inverse relationship

between the energy density of food and its cost⁽³³⁾. For this reason, diets comprised of energy-dense foods may be more affordable for families with food insecurity⁽³³⁾. Studies in the USA and Canada have found differences in the price and availability of foods in lower-income neighbourhoods and communities; healthier foods generally are more expensive and less readily available⁽³⁴⁾. Poverty limits access to healthful foods and increases exposure to unhealthy foods, and may be a direct cause of obesity in Cree children⁽³³⁾.

Limitations

The present study had a cross-sectional design that allowed us to report observations but not causal relationships. A longitudinal study would be required to appreciate the contribution of restaurant meals and the home food environment to obesity in Cree children. There is the risk of respondent bias when using self-reported measures of dietary intake and behaviours. A potential limitation of the study was that children were asked food availability questions that were intended to be administered to parents; however, our results suggest that children were accurately reporting their home food environment as intake of beverages was associated with home availability.

Conclusion

Interventions to improve healthy eating among Aboriginal children should target determinants of health.

Improved access and availability to traditional foods and market foods of high nutritional value will give Cree the opportunity to make healthy choices. The nutrition environment as a whole must be targeted to ensure the adoption of healthy eating⁽³⁵⁾. Food-based changes to improve micro-nutrient intakes, such as increased milk, fruit and vegetable, and traditional food promotion, are required.

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References

- Shields M (2005) Measured Obesity: Overweight Canadian children and adolescents. <http://www.statcan.ca/english/research/82-620-MIE/2005001/pdf/cobesity.pdf> (accessed January 2006).
- Wang Y & Lobstein T (2006) Worldwide trends in childhood overweight and obesity. *Int J Pediatr Obes* **1**, 11–25.
- Bowman SA, Gortmaker SL, Ebbeling CB, Pereira MA & Ludwig DS (2004) Effects of fast-food consumption on energy intake and diet quality among children in a national household survey. *Pediatrics* **113**, 112–118.
- Garriguet D (2006) Nutrition: Findings from the Canadian Community Health Survey, Overview of Canadians' Eating Habits. <http://www.statcan.ca/english/research/82-620-MIE/82-620-MIE2006002.pdf> (accessed November 2006).
- Prentice AM & Jebb SA (2003) Fast foods, energy density and obesity: a possible mechanistic link. *Obes Rev* **4**, 187–194.
- Anderson PM & Butcher KE (2006) Childhood obesity: trends and potential causes. *Future Child* **16**, 19–45.
- Hanson NI, Neumark-Sztainer D, Eisenberg ME, Story M & Wall M (2005) Associations between parental report of the home food environment and adolescent intakes of fruits, vegetables and dairy foods. *Public Health Nutr* **8**, 77–85.
- Davis M, Baranowski T, Resnicow K, Baranowski J, Doyle C, Smith M, Wang DT, Yaroch A & Hebert D (2000) Gimme 5 fruit and vegetables for fun and health: process evaluation. *Health Educ Behav* **27**, 167–176.
- Willows ND (2005) Overweight in Aboriginal children: prevalence, implications and solutions. *J Aboriginal Health* **2**, 76–85.
- Story M, Stevens J, Himes J, Stone E, Rock BH, Ethelbah B & Davis S (2003) Obesity in American-Indian children: prevalence, consequences, and prevention. *Prev Med* **37**, Suppl., S3–S12.
- Frohlich KL, Ross N & Richmond C (2006) Health disparities in Canada today: some evidence and a theoretical framework. *Health Policy* **79**, 132–143.
- Popkin BM & Gordon-Larsen P (2004) The nutrition transition: worldwide obesity dynamics and their determinants. *Int J Obes Relat Metab Disord* **28**, Suppl. 3, S2–S9.
- Willows ND (2005) Determinants of healthy eating in Aboriginal peoples in Canada: the current state of knowledge and research gaps. *Can J Public Health* **96**, Suppl. 3, S32–S41.
- Kuhnlein HV, Receveur O, Soueida R & Egeland GM (2004) Arctic indigenous peoples experience the nutrition transition with changing dietary patterns and obesity. *J Nutr* **134**, 1447–1453.
- Pong RW & Pitblado JR (2001) Don't take 'geography' for granted! Some methodological issues in measuring geographic distribution of physicians. *Can J Rural Med* **6**, 103–112.
- Cole TJ, Bellizzi MC, Flegal KM & Dietz WH (2000) Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ* **320**, 1240–1243.
- Gibson RS (2005) *Principles of Nutritional Assessment*, 2nd ed. New York: Oxford University Press.
- Institute of Medicine (2000) *Dietary Reference Intakes: Applications in Dietary Assessment*. Washington, DC: National Academy Press.
- First Nations Centre (2005) Children's survey: Preliminary findings of the First Nations Regional Longitudinal Health Survey (RHS) 2002–03. http://www.health-disciplines.ubc.ca/iah/acadre/site_files/resources/RHS_preliminary_adult_sept_9_04.pdf (accessed September 2006).
- Trifonopoulos M, Kuhnlein HV & Receveur O (1998) Analysis of 24-hour recalls of 164 fourth- to sixth-grade Mohawk children in Kahnawake. *J Am Diet Assoc* **98**, 814–816.
- Stroehla BC, Malcoe LH & Velie EM (2005) Dietary sources of nutrients among rural Native American and white children. *J Am Diet Assoc* **105**, 1908–1916.
- Berti PR, Hamilton SE, Receveur O & Kuhnlein HV (1999) Food use and nutrient adequacy in Baffin Inuit children and adolescents. *Can J Diet Pract Res* **60**, 63–70.
- Kuhnlein HV, Soueida R & Receveur O (1996) Dietary nutrient profiles of Canadian Baffin Island Inuit differ by food source, season, and age. *J Am Diet Assoc* **96**, 155–162.
- Kuhnlein HV & Receveur O (2007) Local cultural animal food contributes high levels of nutrients for Arctic Canadian Indigenous adults and children. *J Nutr* **137**, 1110–1114.
- Zoumas-Morse C, Rock CL, Sobo EJ & Neuhaus ML (2001) Children's patterns of macronutrient intake and associations with restaurant and home eating. *J Am Diet Assoc* **101**, 923–925.
- French SA, Story M, Neumark-Sztainer D, Fulkerson JA & Hannan P (2001) Fast food restaurant use among adolescents: associations with nutrient intake, food choices and

- behavioral and psychosocial variables. *Int J Obes Relat Metab Disord* **25**, 1823–1833.
27. Gable S & Lutz S (2000) Household, parent, and child contributions to childhood obesity. *Fam Relat* **49**, 293–300.
 28. Haire-Joshu D & Nanney MS (2002) Prevention of overweight and obesity in children: influences on the food environment. *Diabetes Educ* **28**, 415–423.
 29. Statistics Canada (2002) *Profile of Marital Status, Common-Law Status, Families, Dwellings and Households, for Canada, Provinces, Territories, Census Divisions and Census Subdivisions, 2001 Census. 95F0487XCB2001001*. Ottawa: Statistics Canada.
 30. Government of Canada (2004) Canada's performance, annual report to parliament. http://www.tbs-sct.gc.ca/report/govrev/04/dwnld/cp-rc_e.pdf (accessed January 2006).
 31. Ricciuto L, Tarasuk V & Yatchew A (2006) Socio-demographic influences on food purchasing among Canadian households. *Eur J Clin Nutr* **60**, 778–790.
 32. Willows ND, Iserhoff R, Napash L, Leclerc L & Verrall T (2005) Anxiety about food supply in Cree women with infants in Quebec. *Int J Circumpolar Health* **64**, 55–64.
 33. Drewnowski A & Specter SE (2004) Poverty and obesity: the role of energy density and energy costs. *Am J Clin Nutr* **79**, 6–16.
 34. Cummins S & Macintyre S (2006) Food environments and obesity – neighbourhood or nation? *Int J Epidemiol* **35**, 100–104.
 35. Glanz K, Sallis JF, Saelens BE & Frank LD (2005) Healthy nutrition environments: concepts and measures. *Am J Health Promot* **19**, 330–333.