Overweight among children and adolescents in a Native Canadian community: prevalence and associated factors

Anthony JG Hanley, Stewart B Harris, Joel Gittelsohn, Thomas MS Wolever, Brit Saksvig, and Bernard Zinman

ABSTRACT

Background: The prevalence of pediatric obesity in North America is increasing. Native American children are at especially high risk.

Objectives: The objective was to evaluate the prevalence of pediatric overweight and associated behavioral factors in a Native Canadian community with high rates of adult obesity and type 2 diabetes mellitus.

Design: Height and weight were measured in 445 children and adolescents aged 2–19 y. Fitness level, television viewing, body image concepts, and dietary intake were assessed in 242 subjects aged 10–19 y. Overweight was defined as a body mass index ≥85th percentile value for age- and sex-specific reference data from the third National Health and Nutrition Examination Survey (NHANES III). Multiple logistic regression was used to examine factors associated with overweight, with adjustment for age and sex.

Results: The overall prevalence of overweight in subjects aged 2–19 y was significantly higher than NHANES III reference data [boys: 27.7% (95% CI: 21.8, 34.5); girls: 33.7% (95% CI: 27.9, 40.1)]. In the subset aged 10–19 y, ≥5 h television viewing/d was associated with a significantly higher risk of overweight than was ≤2 h/d [odds ratio (OR) = 2.52; 95% CI: 1.06, 5.98]. Subjects in the third and fourth quartiles of fitness had a substantially lower risk of overweight than did those in the first quartile [third quartile compared with first quartile: OR = 0.24 (95% CI: 0.09, 0.66); fourth quartile compared with first quartile: OR = 0.13 (95% CI: 0.03, 0.48)]. Fiber consumption on the previous day was associated with a decreased risk of overweight (OR = 0.69; 95% CI: 0.47, 0.99 for each 0.77 g/MJ increase in fiber intake).


KEY WORDS Obesity, overweight, children, adolescence, Native Canadians, North America, diet, physical activity, epidemiology

INTRODUCTION

Pediatric obesity is a public health problem of increasing importance in the developed world and in populations undergoing cultural transition (1). Data from 5 nationally representative US health surveys covering the period starting 1963–1965 and ending 1988–1991 indicated that the prevalence of overweight increased during this period for all age and sex groups (2). The greatest changes occurred in the period starting 1976–1980 and ending 1988–1991; the prevalence of overweight in children and adolescents was > 20% at the end of this period [based on cutoffs from the National Health and Nutrition Examination Surveys (NHANES)] (2). High rates of pediatric obesity were reported in studies of several racial groups, including European, African American, Puerto Rican, Mexican, and Native Hawaiian subjects (1, 3). Native American children and adolescents are at particularly high risk of obesity (4–9); there is a notably elevated prevalence of obesity in tribes in the southwestern United States (6). In Canada, excessive pediatric obesity was reported in the eastern James Bay Cree of Quebec (10) and in the Mohawk community of Kahnawake (11). However, relatively little information is available on the anthropometric measurements of First Nation children and adolescents in other parts of Canada.

The cause of pediatric obesity has not been elucidated completely, although it is suspected that a complex interaction of genetic, environmental, and behavioral factors is responsible (1). Although the notion that obesity is caused by excess energy intake is not generally supported in the scientific literature (1, 12–16), recent research suggests that aspects of diet composition, including high fat and low carbohydrate intakes, may play a role in overweight (17–20). Findings on the role of energy expenditure are also inconclusive, although low physical activity rates were associated with obesity (21) and television viewing...
was shown to be a significant risk factor for pediatric obesity, both cross-sectionally and prospectively (22–24).

Overweight during adolescence predicts adult obesity (25, 26), which is associated in turn with several chronic diseases, including type 2 diabetes mellitus (27), coronary heart disease (28), and hypertension (29). Pediatric obesity has more immediate consequences, such as slipped capital femoral epiphysis, sleep apnea, pseudotumor cerebri, polycystic ovarian disease, and hypertension (1). Several studies showed an increased prevalence and incidence of type 2 diabetes in obese white, African American, and Native American children (30–32). Thus, understanding the prevalence and etiology of pediatric obesity has substantial public health implications for children and adults.

Native Canadians have very high rates of obesity and related metabolic disorders, including type 2 diabetes (33, 34). Evidence is accumulating on the increasing burden of type 2 diabetes among children and adolescents in this population (31, 32). Little information is available, however, on the prevalence and determinants of pediatric obesity in Native Canadian children and adolescents. We previously documented associations between obesity and type 2 diabetes, dyslipidemia, and hypertension among adults in an isolated Oji-Cree community in northern Ontario (35, 36). In the present study, we examined the prevalence of childhood obesity and associated behavioral factors, including television viewing, fitness level, body image concepts, and dietary intake in children and adolescents in this community.

SUBJECTS AND METHODS

Subjects

Sandy Lake First Nation is located ∼2000 km northwest of Toronto in the boreal forest region of central Canada. Approximately 1600 people live in this isolated community, which is accessible only by air for most of the year. Before their settlement on reserves in the early part of the 20th century, the inhabitants of this area lived in small, nomadic groups and subsisted through hunting and gathering typical of subarctic populations. Their lives were physically active and their diet was high in protein from wild meat and fish with seasonal supplementation with berries and roots. The lifestyle of the people of this region has changed dramatically over the past several decades, with a marked decrease in physical activity and an alteration in diet to one characterized by excessive consumption of saturated fat and processed foods (37). This population is consequently undergoing an epidemiologic transition (38) with a marked increase in morbidity related to chronic diseases such as obesity and type 2 diabetes (33–35, 39).

The method of the Sandy Lake Health and Diabetes Project was described in detail previously (35, 40, 41). From July 1993 to December 1995, 1016 (73%) of 1401 eligible residents of Sandy Lake volunteered to participate in a cross-sectional survey to determine the prevalence of type 2 diabetes and its associated risk factors. The analyses of the prevalence of overweight in this article are based on the subsample of 445 children and adolescents who were aged 2–19 y at the time of the survey and for whom complete height and weight data were available. Analyses of the factors associated with overweight were based on the subsample of 242 subjects who were aged 10–19 y at the time of the survey; the sample sizes for measurement of some variables were slightly different because of incomplete data. Signed, informed consent was obtained from all participants or their parents or guardians and the study was approved by the Sandy Lake First Nation Band Council and the University of Toronto Ethics Review Committee.

Assessment of anthropometry and fitness level

For anthropometric measurements, the subjects wore no shoes and wore either undergarments with a hospital gown or light athletic clothing. Each measurement was performed twice and the average measurement was used in the analysis. Height was measured to the nearest 0.1 cm with a wall-mounted stadiometer. Body weight was measured to the nearest 0.1 kg with a hospital balance-beam scale. Body mass index (BMI; in kg/m²) was also calculated.

Maximal oxygen uptake (VO₂max), a standard measure of fitness, was estimated by using a validated submaximal step test developed by Siconolfi et al (42). Participants stepped on a 25.4-cm exercise stepper for 3 min/stage to a maximum of 3 stages. Heart rate was measured with a finger-clip pulse monitor during the last 30 s of each phase. Exclusion criteria included a medical history of cardiovascular, respiratory, or severe musculoskeletal disease and an unwillingness to perform the test (n = 20). In the analysis, VO₂max was adjusted for lean body mass (estimated from bioelectrical impedance analysis; Tanita Corporation, Tokyo) (35).

Questionnaires to assess diet, television viewing, and body image

Information on dietary intake, body image concepts, and television viewing was collected by using standardized, interviewer-administered questionnaires (40). A food-frequency questionnaire assessed the frequency of consumption, over the previous 3 mo, of 34 commonly eaten foods (both store-bought and traditional). Additional questions inquired about added sugar, salt, and fat and about preparation techniques. Factor analysis was used to create 7 scales of underlying food consumption based on the original 34 items; these scales were described in detail elsewhere (43). A 24-h recall was administered, during which subjects were asked to report all foods consumed during the previous day; volumes and portion sizes were estimated with measuring cups and spoons and with 2- and 3-dimensional food models. The coding and preliminary analyses of these data were reported elsewhere (44). Energy intake was reported in kJ; fat, protein, and carbohydrate intakes were expressed as a percentage of energy; and fiber intake was expressed as g/MJ. From a series of 9 somatotype drawings, participants were asked to identify their own body build, the body build they would like to achieve in the future, and the most healthy somatotype for both men and women (45). Television viewing was assessed by self-reported usual hours of viewing (including video games and movies)/d (40).

Definition of overweight

Overweight was defined as a BMI ≥85th percentile value for age- and sex-specific reference data from NHANES III (46); a similar categorization (using NHANES II data) was used in previous studies (6–9, 11). The use of BMI to help define childhood and adolescent obesity was recommended by the Institute of Medicine Committee to Develop Criteria for Evaluating the Outcomes of Approaches to Prevent and Treat Obesity, The National Institutes of Health Consensus Conference on Obesity, and the Committee on Clinical Guidelines for Overweight in Adolescent Preventive Services (1, 47).
TABLE 1
Characteristics of subjects aged 2–19 y in the Sandy Lake Health and Diabetes Project

<table>
<thead>
<tr>
<th>Variable</th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Entire study population (n = 202 boys, 243 girls)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (y)</td>
<td>9.63 ± 5.55</td>
<td>11.04 ± 5.27</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>19.88 ± 4.39</td>
<td>21.75 ± 5.89</td>
</tr>
<tr>
<td>Subjects aged 10–19 y (n = 94 boys, 148 girls)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age (y)</td>
<td>14.90 ± 3.06</td>
<td>14.69 ± 2.85</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>22.11 ± 4.75</td>
<td>24.24 ± 6.01</td>
</tr>
<tr>
<td>Television viewing (h/d)</td>
<td>3.15 ± 1.86</td>
<td>3.28 ± 1.76</td>
</tr>
<tr>
<td>VO₂max (L·min⁻¹·kg lean body mass⁻¹)</td>
<td>0.07 ± 0.01</td>
<td>0.06 ± 0.01</td>
</tr>
<tr>
<td>Body image</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Healthy male</td>
<td>4.39 ± 1.16</td>
<td>4.02 ± 0.99</td>
</tr>
<tr>
<td>Healthy female</td>
<td>3.85 ± 0.83</td>
<td>3.80 ± 0.93</td>
</tr>
<tr>
<td>Total energy intake (kJ)‡</td>
<td>9160 ± 5060</td>
<td>9050 ± 4800</td>
</tr>
<tr>
<td>Protein intake (%‡)</td>
<td>15.02 ± 7.04</td>
<td>13.86 ± 5.61</td>
</tr>
<tr>
<td>Fat intake (%‡)</td>
<td>35.29 ± 10.68</td>
<td>36.77 ± 10.38</td>
</tr>
<tr>
<td>Carbohydrate intake (%‡)</td>
<td>48.41 ± 14.57</td>
<td>47.84 ± 11.52</td>
</tr>
<tr>
<td>Starch intake (%‡)</td>
<td>22.02 ± 9.84</td>
<td>24.28 ± 9.34</td>
</tr>
<tr>
<td>Simple sugar intake (%‡)</td>
<td>26.36 ± 14.82</td>
<td>23.48 ± 11.28</td>
</tr>
<tr>
<td>Fiber intake (g/MJ)</td>
<td>1.09 ± 0.83</td>
<td>1.33 ± 0.67</td>
</tr>
<tr>
<td>Vegetable scale</td>
<td>2.71 ± 0.99</td>
<td>2.87 ± 1.19</td>
</tr>
<tr>
<td>Junk food scale</td>
<td>4.47 ± 1.16</td>
<td>4.78 ± 1.21</td>
</tr>
<tr>
<td>Wild food scale</td>
<td>2.85 ± 1.14</td>
<td>2.79 ± 1.03</td>
</tr>
<tr>
<td>Breakfast food scale</td>
<td>4.77 ± 1.22</td>
<td>4.99 ± 1.43</td>
</tr>
<tr>
<td>Lunch food scale</td>
<td>2.37 ± 0.74</td>
<td>2.95 ± 1.06</td>
</tr>
<tr>
<td>Tea food scale</td>
<td>5.12 ± 1.36</td>
<td>5.06 ± 1.39</td>
</tr>
<tr>
<td>Bread food scale</td>
<td>5.03 ± 1.13</td>
<td>5.19 ± 1.08</td>
</tr>
</tbody>
</table>

1‡ ± SD.
2‡ From 24-h recall.
3‡ Mean factor analysis scores derived from food-frequency questionnaires (see Methods).

Statistical analyses

All statistical analyses were conducted by using SAS in the VMS environment (48). CIs for estimates of the prevalence of overweight (defined by using the NHANES III data) among Sandy Lake children and adolescents were calculated by using the quadratic method (49). Differences in the set of age-specific median BMIs for each sex between the Sandy Lake and NHANES III populations were analyzed by using the Wilcoxon matched-pairs signed-rank test. As described by Ryan and et al (50), this nonparametric procedure ranks the differences between the age- and sex-matched medians and tests the overall significance of the sum of these differences.

Associations between continuously distributed variables were assessed by using Spearman correlational analysis. Multiple logistic regression was used to examine factors associated with overweight in the study population, including television viewing, fitness level, body image concepts, and dietary intake. The outcome variable for these analyses was overweight as defined by using NHANES III reference data. Television viewing was analyzed as a 3-level categorical variable [low (0–2 h/d), moderate (3–4 h/d), or high (≥5 h/d)]; fitness level and dietary intake were analyzed by using the food-frequency questionnaire scales as quartiles; body image was analyzed per unit change in desirable body shape; and dietary intake was analyzed by using 24-h recall as a 1 SD change in intake based on the distribution in nonobese subjects. Age and sex were treated as potential confounding variables. Odds ratios (ORs) were estimated from logistic regression models by exponentiating the β coefficient. Initial models indicated that there were no significant interactions between sex and the exposure variables of interest. The sexes were thus combined for the logistic regression analyses to increase the statistical power for detecting associations.

RESULTS

Characteristics of the Sandy Lake pediatric population are presented in Table 1; median BMI by age and sex is shown in Table 2. Adiposity was generally similar between boys and girls until the age of 13 y, after which time girls tended to have a higher BMI than did boys. BMI increased with age; there were notable increases after the early adolescent years. There was an overall positive and significant association between age and BMI in the total sample (r = 0.26, P < 0.0001).

The percentages of subjects with values ≥85th percentiles for the NHANES III reference population, by age group and sex, are shown in Table 3. Data were grouped into 8 age and sex categories to mitigate statistical instability due to small cell sizes. The overall prevalence of overweight in subjects aged 2–19 y was 27.7% in boys and 33.7% in girls. The percentage of overweight was higher than the NHANES III reference data in all age and sex categories and ranged from 18.6% in boys aged 15–19 y to 45.2% in girls aged 2–5 y. The prevalence of overweight was higher in the younger age categories than in the older ones for both boys and girls; this trend in the prevalence of overweight across age categories was significant for both sexes. There was no significant difference in the prevalence of overweight between boys and girls. 95% CIs for all categories, except boys aged 10–14 y and 15–19 y, indicated significantly higher prevalences of overweight (P < 0.05) relative to the reference population.

Median BMIs by age for the Sandy Lake and NHANES III pediatric populations are shown in Figures 1 and 2. The median BMI was higher in the Sandy Lake population than in the NHANES III reference population; this was the case for most age and sex categories in boys and for all age and sex categories in girls except those aged 15 y. Small cell sizes resulted in variability in the curve. There were significant differences in the set of median BMIs for each sex between the Sandy Lake and NHANES III populations. Logistic regression analysis was used to investigate lifestyle factors that were associated with overweight in the study population. All models were adjusted for age and sex and results are presented in Table 4.

Fitness level and television viewing

There was a stepwise increase in the risk of overweight from the lowest through the highest category of usual daily television viewing. The risk of overweight was slightly and nonsignificantly higher in subjects who watched moderate amounts of television (3–4 h/d) than in subjects who reported watching 0–2 h/d. However, there was a 2.5-fold risk of overweight in subjects who watched ≥5 h/d (OR = 2.52; 95% CI: 1.06, 5.98). The risk of overweight decreased substantially as fitness increased. Subjects in the third and fourth quartiles of VO₂max had a significantly lower risk than did those in the lowest quar-
although this association was not significant (OR = 0.52; 95% CI: 0.23, 1.21). Intakes of other foods did not appear to be related to overweight, although there was some suggestion of a higher risk of overweight in subjects with a higher consumption of tea foods (tea and coffee, evaporated milk, and margarine).

**DISCUSSION**

We documented a high prevalence of overweight in children and adolescents aged 2–19 y in a remote First Nation community in Canada. We also showed that potentially modifiable factors were associated with overweight in subjects aged 10–19 y in this community.

**Prevalence of overweight**

Excessive overweight, defined on the basis of the 85th percentile of NHANES II, was described previously in reservation and nonreservation Native American schoolchildren and adolescents (6–9). Although these estimates are not directly comparable because of different time periods, methods of data collection, and reference values (we used more recent NHANES III cutoffs), it appears that the prevalence of pediatric overweight in the Sandy Lake study population (27.7% in boys and 33.7% in girls; Table 3) is generally similar to or higher than estimates that have been reported for Native American children and adolescents in the United States. The notable exception is the sample of subjects aged 14–17 y from southwest Arizona, in whom the prevalence of overweight was >70% for both boys and girls (6).

Relatively limited information is available on the magnitude of pediatric obesity in Native Canadian children and adolescents. The prevalence of overweight (relative to NHANES II data) in Mohawk children aged 5–12 y in Kahnawake, Quebec, was 29.5% and 32.8% for boys and girls, respectively (11). Findings from a survey in 2 eastern James Bay Cree communities indicated that 38% of children in grades 4, 5, 8, and 9 were overweight (10). Although these results are based on a slightly different definition of overweight (≥90th percentile of BMI for NHANES II), they indicate that the burden of overweight is generally similar to that in the Sandy Lake population.

This pattern of pediatric overweight is consistent with the increasing burden of diabetes and related metabolic disorders in children (30–32) and adults (33–35, 37–38) in these Native Canadian communities and suggests that the pathogenic process

<p>| TABLE 3 |
| Percentages and 95% CIs of subjects aged 2–19 y with BMI ≥85th percentile of third National Health and Nutrition Examination Survey (NHANES III) reference data, Sandy Lake Health and Diabetes Project. |</p>
<table>
<thead>
<tr>
<th>Age group (y)</th>
<th>Boys</th>
<th>Girls</th>
</tr>
</thead>
<tbody>
<tr>
<td>2–5 (n = 78 boys, 62 girls)</td>
<td>34.6 (24.4, 46.3)</td>
<td>45.2 (32.7, 58.2)</td>
</tr>
<tr>
<td>6–9 (n = 30 boys, 33 girls)</td>
<td>30.0 (15.4, 49.6)</td>
<td>35.3 (12.6, 48.9)</td>
</tr>
<tr>
<td>10–14 (n = 51 boys, 84 girls)</td>
<td>23.5 (13.2, 37.8)</td>
<td>32.1 (22.6, 43.3)</td>
</tr>
<tr>
<td>15–19 (n = 43 boys, 64 girls)</td>
<td>18.6 (8.9, 33.9)</td>
<td>26.6 (16.7, 39.4)</td>
</tr>
<tr>
<td>2–19 (n = 202 boys, 243 girls)</td>
<td>27.7 (21.8, 34.5)</td>
<td>33.7 (27.9, 40.1)</td>
</tr>
</tbody>
</table>

1 Percent; 95% CI in parentheses.
2 Significant trend across age groups (chi-square): $\chi^2 = 4.15$, $P = 0.042$; $\chi^2 = 4.49$, $P = 0.03$.
3 Significantly different from corresponding age and sex category of NHANES III population, $P < 0.05$. |
is initiated early in life in certain persons. Our finding of a very high prevalence of overweight in the youngest age groups (2–5 and 6–9 y) is particularly striking. It is possible that this finding represents a cohort effect that will lead to an even higher prevalence of obesity in the future. Rolland-Cachera et al (51) defined the “adiposity rebound” as the second period of rapid growth of body fat in childhood, occurring on average at ≈6 y. In a cohort of French children, these authors showed that an earlier age of adiposity rebound (<5.5 y) was followed by significantly greater adiposity in adolescence. Longitudinal data will be required to determine whether this pattern is also characteristic of children in the Sandy Lake population.

**Associated factors**

There was a significant inverse association between overweight and television viewing, fitness level, fiber intake in the previous 24 h, and moderate consumption of junk food in the previous 3 mo in Sandy Lake children and adolescents aged 10–19 y. Several factors contribute to physical fitness level, including the regularity and intensity of physical activity, and this mechanism may explain the association we found between fitness level and obesity. Three studies showed that activity level in children was associated with lower rates of obesity. Obarzanec et al (19) reported that physical activity was inversely related to BMI and percentage body fat in a large sample of 9- and 10-y-old African American girls. Wolf et al (52) documented a significant negative relation between BMI (adjusted for age) and activity level in girls aged 5–12 y, and Bernard et al (10) found that overweight Cree schoolchildren and adolescents participated in significantly less physical activity than did their normal-weight peers. Higher amounts of physical activity have the potential to protect against obesity through the maintenance of energy balance and thus the prevention of accumulation of excess adipose tissue (1).

We found that subjects who usually watched ≥5 h television/d (including videos and video games) had 2.5 times the risk of overweight as those who watched ≤2 h. Although the OR for intermediate amounts of television viewing was also higher than that for low amounts of viewing, the estimate was not significantly different from unity. This is consistent with the findings of previous studies, in which television viewing was associated with childhood obesity in cross-sectional (10, 19, 22, 23) and prospective (24) studies. Although not directly comparable, risk estimates are slightly lower than those reported by Gortmaker et al (24): 4–5 and ≥5 h/d were associated with obesity (adjusted ORs = 3.0 and 5.3, respectively) compared with the referent category (0–2 h/d). The risk associated with this behavior may operate through several mechanisms, including a reduction of time spent in higher-intensity activities, a lowering of the metabolic rate, and more frequent snacking (19, 53).

Our finding of an inverse association between overweight and fiber intake is consistent with the findings of Gazzaniga and Burns (20), who documented a significant negative relation between carbohydrate intake and percentage body fat in children aged 9–11 y. We also found a nonsignificant inverse association with vegetable intake. Of particular interest in the context of the present study are the results of Bernard et al (10), who reported that significantly fewer servings of fruit and vegetables were consumed by overweight schoolchildren and adolescents in 2 James Bay Cree communities than by their normal-weight counterparts. The biology, environment, language, and historical subsistence pattern of the James Bay Cree are similar to those of the members of Sandy Lake First Nation. We reported previously that consumption of fiber and vegetables had a significant protective association with diabetes in adults in this population (43, 54). The relation to obesity is biologically plausible in that increased consumption of vegetables and other high-fiber foods may be associated with lower intakes of dietary fat. Four studies showed that fat intake was significantly associated with obesity in prepubertal children (17–20). Although we did not find such an association, this may be due in part to the use of a single 24-h recall to document fat intake, which may not capture usual patterns of fat consumption (55). The significant inverse association
TABLE 4
Logistic regression analysis of lifestyle factors associated with obesity in 242 subjects aged 10–19 y in the Sandy Lake Health and Diabetes Project

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>Odds ratio (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical activity</strong></td>
<td></td>
</tr>
<tr>
<td>Television viewing (h/d)</td>
<td></td>
</tr>
<tr>
<td>3–4</td>
<td>1.39 (0.63, 2.08)</td>
</tr>
<tr>
<td>≥5</td>
<td>2.52 (1.06, 5.98)</td>
</tr>
<tr>
<td>VO₂ (L·min⁻¹·kg lean body mass⁻¹)</td>
<td></td>
</tr>
<tr>
<td>Second quartile</td>
<td>0.52 (0.23, 1.16)</td>
</tr>
<tr>
<td>Third quartile</td>
<td>0.24 (0.09, 0.66)</td>
</tr>
<tr>
<td>Fourth quartile</td>
<td>0.13 (0.03, 0.48)</td>
</tr>
<tr>
<td><strong>Body image concepts</strong></td>
<td></td>
</tr>
<tr>
<td>Healthy man (1 level difference)</td>
<td>0.91 (0.69, 1.20)</td>
</tr>
<tr>
<td>Healthy woman (1 level difference)</td>
<td>0.75 (0.53, 1.05)</td>
</tr>
<tr>
<td><strong>24-h diet recall</strong></td>
<td></td>
</tr>
<tr>
<td>Total energy (4770 kJ difference)</td>
<td>1.02 (0.76, 1.36)</td>
</tr>
<tr>
<td>Protein (6.2% difference)</td>
<td>1.10 (0.82, 1.48)</td>
</tr>
<tr>
<td>Fat (10.4% difference)</td>
<td>0.88 (0.65, 1.18)</td>
</tr>
<tr>
<td>Carbohydrate (12.7% difference)</td>
<td>1.07 (0.79, 1.45)</td>
</tr>
<tr>
<td>Starch (9.7% difference)</td>
<td>0.83 (0.61, 1.12)</td>
</tr>
<tr>
<td>Simple sugar (13.1% difference)</td>
<td>1.24 (0.91, 1.67)</td>
</tr>
<tr>
<td>Fiber (0.77 g/MJ difference)</td>
<td>0.69 (0.47, 0.99)</td>
</tr>
<tr>
<td><strong>Food-frequency questionnaire scales</strong></td>
<td></td>
</tr>
<tr>
<td>Vegetables</td>
<td></td>
</tr>
<tr>
<td>Second quartile</td>
<td>0.69 (0.31, 1.53)</td>
</tr>
<tr>
<td>Third quartile</td>
<td>0.77 (0.35, 1.70)</td>
</tr>
<tr>
<td>Fourth quartile</td>
<td>0.52 (0.23, 1.21)</td>
</tr>
<tr>
<td>Junk foods</td>
<td></td>
</tr>
<tr>
<td>Second quartile</td>
<td>0.27 (0.11, 0.69)</td>
</tr>
<tr>
<td>Third quartile</td>
<td>0.84 (0.39, 1.83)</td>
</tr>
<tr>
<td>Fourth quartile</td>
<td>0.63 (0.28, 1.41)</td>
</tr>
<tr>
<td>Wild foods</td>
<td></td>
</tr>
<tr>
<td>Second quartile</td>
<td>1.17 (0.51, 2.66)</td>
</tr>
<tr>
<td>Third quartile</td>
<td>1.23 (0.54, 2.90)</td>
</tr>
<tr>
<td>Fourth quartile</td>
<td>0.99 (0.42, 2.38)</td>
</tr>
<tr>
<td>Breakfast foods</td>
<td></td>
</tr>
<tr>
<td>Second quartile</td>
<td>0.78 (0.34, 1.81)</td>
</tr>
<tr>
<td>Third quartile</td>
<td>1.01 (0.44, 2.29)</td>
</tr>
<tr>
<td>Fourth quartile</td>
<td>1.22 (0.55, 2.70)</td>
</tr>
<tr>
<td>Lunch foods</td>
<td></td>
</tr>
<tr>
<td>Second quartile</td>
<td>1.27 (0.54, 2.97)</td>
</tr>
<tr>
<td>Third quartile</td>
<td>0.92 (0.41, 2.08)</td>
</tr>
<tr>
<td>Fourth quartile</td>
<td>1.56 (0.71, 3.42)</td>
</tr>
<tr>
<td>Tea foods</td>
<td></td>
</tr>
<tr>
<td>Second quartile</td>
<td>1.94 (0.85, 4.54)</td>
</tr>
<tr>
<td>Third quartile</td>
<td>2.22 (0.89, 5.56)</td>
</tr>
<tr>
<td>Fourth quartile</td>
<td>1.63 (0.68, 3.89)</td>
</tr>
<tr>
<td>Bread foods</td>
<td></td>
</tr>
<tr>
<td>Second quartile</td>
<td>0.96 (0.42, 2.19)</td>
</tr>
<tr>
<td>Third quartile</td>
<td>0.52 (0.22, 1.21)</td>
</tr>
<tr>
<td>Fourth quartile</td>
<td>1.16 (0.52, 2.59)</td>
</tr>
</tbody>
</table>

Footnotes:
1 Sample sizes varied slightly because of occasional missing values.
3 Odds ratios indicate risk relative to lowest category (0–2 h/d) of television viewing.
4 Odds ratios indicate risk relative to lowest quartile.
5 P = 0.0364.
6 Odds ratios indicate risk relative to lowest quartile.
7 P = 0.0058.
8 P = 0.0024.
9 Odds ratios indicate risk associated with a one-unit change.
10 Odds ratios associated with a 1 SD change in intake among nonobese subjects.

with junk food is difficult to explain, although several of the foods in the scale we used (eg, potato chips) have a relatively high fiber content. In some households, junk food may replace regular meals. In adults in the Sandy Lake population, a high frequency of junk food consumption is associated with a 2-fold increase in the risk of diabetes (43).

**Limitations**

There were several possible limitations to this study. It was suggested previously that BMI may not be suitable for assessing obesity in young children (1). We elected to use BMI because it allowed comparison of the prevalence of overweight with that from a standard population over a wide age range. BMI in subjects aged 10–19 y was strongly correlated with percentage body fat determined from bioelectrical impedance analysis and waist circumference (data not shown), suggesting that it is an adequate surrogate of adiposity in this age group. The findings of the analysis of factors associated with overweight should be interpreted with caution given the cross-sectional nature of the associations. This is particularly true for fitness level, because overweight persons may face physical or psychological barriers to participation in vigorous physical activity. Perception of healthy body shape is also likely to have been influenced by current body shape and by the use of adult images in the somatotype drawings. To the best of our knowledge, 2 of the instruments used in this study (food-frequency questionnaire and submaximal step test) were not validated in children. Finally, all of our data on factors associated with obesity were based on a subsample of children aged 10–19 y. It is clear that obesity begins in the Sandy Lake population at a much earlier age. Investigation of dietary and physical activity risk factors is needed for young children in this population.

In conclusion, we documented a high prevalence of overweight in subjects aged 2–19 y in a remote First Nation community in Canada. We also showed that potentially modifiable factors, including fitness level, body image concepts, and fiber intake, were associated with overweight in subjects aged 10–19 y. These findings have important public health implications given the associations we found between obesity and acute and chronic diseases. We are currently working with the members of Sandy Lake First Nation to implement a community-based obesity and diabetes intervention strategy (56), which includes a healthy diet and exercise curriculum for schoolchildren in grades 3, 4, and 5.

We acknowledge the following groups and individuals whose cooperation was essential in the design and implementation of this project: the chief, council, and community members of Sandy Lake First Nation; the Sandy Lake community surveyors (Louisa Kakegamic, Tina Noon, Madeleine Kakegamic, and Elda Anishinabie); the Sandy Lake nurses; the staff of the University of Toronto Sioux Lookout Programme; the Department of Clinical Epidemiology of the Samuel Lunenfeld Research Institute; Alexander Logan; and Annette Barnie. We also thank Joe Gao and Shelley Bull for advice on the statistical analysis.

**REFERENCES**


