

ORIGINAL ARTICLE

Rural Canadian adolescents are more likely to be obese compared with urban adolescents

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Abstract

Objective. Few studies have examined variations in overweight and obesity by geographic location in youth. The purpose of this study was to investigate the association between urban/rural geographic status and being overweight or obese among Canadian adolescents. **Methods.** The study involved an analysis of a representative sample of 4 851 Canadian adolescents in grades 6 to 10 from the 2001–02 *Health Behaviour in School-aged Children Survey*. Self-reports of participants' demographics, physical activity, screen time, diet, and body mass index (BMI) were assessed. Adiposity status was determined using the international BMI thresholds for children and youth. Urban/rural status was coded on a five-point scale based on the geographic location of the participants' schools. Logistic regression with generalized estimating equations to adjust for clustering was used to examine the association between urban/rural status and overweight/obesity. **Results.** The population was 53.3% female with a mean age of 13.9 years (standard deviation, SD = 1.5). Approximately 22.2% were living in rural areas while 14.4% were living in large metropolitan (metro) areas. After adjusting for age, sex, socioeconomic status, and Region of Canada, there was a trend for increasing overweight ($p = 0.001$) and obesity ($p = 0.03$) among adolescents as the level of "rurality" increased (relative odds for most urban to most rural regions for overweight or obese: 1.00, 0.98, 1.18, 1.57, 1.36; obesity: 1.00, 1.06, 1.39, 1.58, 1.56). **Conclusion.** This study provides new information about patterns of overweight/obesity among Canadian adolescents by urban-rural geographic status. These findings suggest that obesity prevention interventions should be particularly aggressive in rural areas.

Key words: Canada, adolescents, obesity, overweight, physical activity, rural

Introduction

Over the last two decades, there has been a dramatic rise in the prevalence of overweight and obesity among Canadian children and youth (1). In a recent cross-national comparison, Canada was ranked fifth out of 34 industrialized countries with respect to the prevalence of overweight and obesity in school-aged youth (2). Obesity in childhood is a risk factor for obesity (3,4) and cardiovascular disease (5,6) in the adult years.

In Canada, few studies have examined the patterns of overweight and obesity among adolescents

by geographic location. Two of these studies reported that rural youth were more overweight and obese than urban youth (7,8), while a third study reported no such differences (9). Given these conflicting findings and a recent US study finding rural residency as a risk factor for overweight and obesity (10), additional research is warranted to clarify the potential role of geographic location on overweight and obesity in Canadian youth.

A major limitation of past studies that have examined geographic residency in relation to overweight and obesity, both in Canada and elsewhere,

has been the crude, operational definitions of rural and urban. Previous definitions of geographic residency have been limited to population size (7,9,10) which fails to consider the potential relevance of the proximity of geographic residency in relation to urban settlements. An alternative method for measuring geographic status is a fixed coding system called the *modified Beale urban-rural code* (11). Unlike other coding systems that rely entirely on population size and density, the modified Beale urban-rural classification system contains both hierarchical (size) and settlement context components (12). Beale codes have been successfully applied to the study of a range of health indicators including injury (12,13), cancer (14) and physical activity (15).

An additional limitation of past research has been the lack of consideration of the possible mechanisms (e.g., physical activity, nutrition, and screen time) explaining the relationship between urban/rural status and obesity (7,9,10). Of the few studies describing urban/rural status and overweight/obesity, many isolate one or two potential mechanisms if any, and rarely examine multiple mechanisms in concert (7,9,10).

The primary purpose of this study was therefore to examine the association between adiposity status and geographic location using the Beale coding system among a representative sample of Canadian adolescents. A secondary purpose was to examine the potential role of physical inactivity, diet, and screen time in relation to urban/rural status and obesity.

Methods

Study population and procedures

This study involved analysis of the Canadian component of the 2001–02 Health Behaviour in School-Aged Children (HBSC) survey (16). HBSC is a repeated cross-sectional survey sponsored by the World Health Organization. It is designed to provide information about the health and health behaviours of youth from 34 nations. In Canada, participants were selected to be representative of students in grades 6 to 10 (ages 11–15). The methodology and procedures used to obtain the sample are outlined elsewhere (16). A total of 7 235 youth from 170 schools participated. The analysis for this study was limited to 4 851 (67%) participants from 169 schools with complete information on the variables of interest including demographics, urban/rural status, physical activity, television and computer use (screen time), diet, and body mass index (BMI). Using Beale codes (11), participants were grouped into five geographic categories based upon degree of

rurality of their school, as explained below. Ethics approval was obtained from the Queen's University General Research Ethics Board, and subject consent was obtained at the school board, parent, and student levels.

Overweight and obesity classification

BMI (in kg/m²) was calculated using each participant's self-reported height and weight. The international age- and gender-specific child BMI cut-points endorsed by the International Obesity Task Force were used to define participants as normal weight, overweight or obese (17). These cut-points were derived from a large international sample using a growth curve modeling regression techniques wherein the BMI growth curves passed through the health-related adult cut-points at 18 years of age (17). Youth with BMI values that corresponded to an adult BMI ≥ 25 were classified as overweight, and all others were considered normal weight. Among overweight participants, those with BMI values that corresponded to an adult BMI ≥ 30 were classified as obese.

Geographic location (urban/rural status)

A modified version of the Beale urban-rural coding system (11) was used to group youth into one of five categories based upon the school postal code (akin to the US zip code). The Beale urban-rural coding system was originally developed by the United States (US) Department of Agriculture (11) and has since been adapted to be compatible to Canadian Census Divisions (11,18). The system for Canada uses six categories (11) that were collapsed into five in order to have sufficient cell sizes to generate stable estimates (12). The five categories included: 1) *Large metropolitan regions* (large metro) are "a central and most populous Census Division of a Census Metropolitan Area with a population greater than one million or remaining Census Divisions within or partially within a Census Metropolitan Area with a population greater than one million"; 2) *Medium metropolitan regions* (medium metro) are "Census Divisions containing, within, or partially within a Census Metropolitan Area with a population between 250 000 and 999 999"; (3) *Small metropolitan regions* (small metro) are "Census Divisions containing, within or partially within a Census Metropolitan Area/Census Agglomeration with a population between 50 000 and 249 000"; (4) *Nonmetro-adjacent regions* are "Census Divisions that share a boundary with a Census Metropolitan Area/Census Agglomeration that has a population greater than 50 000"; (5) *Nonmetro-nonadjacent*

(rural) regions are “Census Divisions that do not share a boundary with a Census Metropolitan Area/ Census Agglomeration that has a population greater than 50 000.”

Health behaviours

Physical inactivity. Participants were provided a definition and common examples of moderate-to-vigorous intensity physical activities (e.g., running, brisk walking, biking) then asked two questions: 1) “Over the past 7 days, on how many days were you physically active for a total of at least 60 minutes per day?”; and 2) “Over a typical or usual week, on how many days are you physically active for a total of at least 60 minutes per day?” (19). Response options ranged from 0 to 7 days. Physical activity participation was calculated based upon an average number of physically active days from the past week and from a typical week (19). The average number of physically active days have been found to be reliable for classifying participants as meeting or not meeting physical activity guidelines of 60 minutes of physical activity on ≥ 5 days per week (20). Based on these guidelines, participants were categorized as physically inactive if they were active for < 5 days per week.

Unhealthy diet. Participants were asked how many times a week they usually ate or drank the following items: sweets (candy or chocolate), soft drinks (that contain sugar), cake or pastries, potato chips, and french fries. Response options included “never”, “less than once a week”, “once a week”, “2–4 days a week”, “5–6 days a week”, “once a day”, and “more than once a day”. Using principle component analysis, the frequency of the five items were used to create a composite score as per existing precedents, and participants in the top quartile were classified as unhealthy eaters (21).

Screen time. The following items assessed a participant’s screen time on weekdays and weekends separately: 1) “About how many hours a day do you usually watch television (including videos) in your free time?”; and 2) “About how many hours a day do you usually use a computer (for playing games, emailing, chatting or surfing the internet) in your free time?” The possible responses ranged from “none at all” to “about 7 or more hours a day”. An average of the four items was calculated, weighted to the number of days the question represented (i.e., 5 days for weekdays and 2 days for weekends), to create a screen time composite score. Participants in the top quartile were classified as high screen time.

Socioeconomic status

An individual measure of socioeconomic status (SES), the family affluence scale, was available. Categories of family affluence (low, medium, or high) were developed using existing protocols on the basis of four measures of material family wealth as reported by the students: 1) car ownership; 2) bedroom sharing; 3) holiday travel; and 4) computer ownership (16).

Region of Canada

A child’s geographic region within Canada (from west to east) has been associated with an increased prevalence of being overweight (22). To account for this variation, a participant’s residence within Canada was categorized into four geographic regions: 1) Western Canada (British Columbia, Alberta); 2) Prairies (Saskatchewan, Manitoba); 3) Central Canada (Ontario, Quebec); and 4) the Maritimes (Prince Edward Island, New Brunswick, Nova Scotia, Newfoundland and Labrador).

Analysis

Statistical analyses were conducted using STATA/SE 9.0 for Windows (Stata Corp., College Station, TX) and SAS version 8.2 (SAS Institute Inc., Cary, NC). Descriptive analyses were completed using frequencies and proportions. Prevalence rates of overweight and obesity were calculated.

Multiple logistic regression was used to examine the association between geographic location and each outcome variable (overweight and obesity) after adjusting for age, sex, SES, and geographic region in Canada. Ethnic background was originally considered as a potential covariate. However, ethnic background was excluded from the model after associations between ethnic background and overweight and obesity were found to be not statistically significant, nor to influence the association between geographic location and overweight and obesity. To account for clustering by schools and school classes, generalized estimation equations (GEE) were used. Interactions between geographic location and the other variables included in the model were tested. Strengths of the association were estimated by the odds ratio (OR) and 95% confidence interval (CI). In addition to this, the trend of the associations across categories of geographic location was tested by repeating the analysis after including the variable indicating geographic location as a continuous variable.

Results

Sample

A total of 4 851 adolescents (mean age of 13.9 years; standard deviation, SD = 1.5 years) were included in the analysis. Compared with the excluded participants, participants who were included were more likely to report high SES although the differences in proportion were small (51.0 vs. 48.2%; $p < 0.001$). Participants included in the analysis were also more likely to be in the older age group (29.3% vs. 14.5%; $p < 0.001$).

Overall, 53.3% of participants were female and most (51.0%) were from high SES homes. By geographic location, 14.4% were from large metro; 22.2% were from medium metro; 24.6% were from small metro; 16.7% were from nonmetro-adjacent and 22.2% were from rural areas.

Prevalence of weight classification and health behaviours by geographic location

Eighteen percent of the study population was overweight and 4.8% were obese (Table I). Higher prevalences of both overweight and obesity were observed in more rural areas ($\chi^2 = 33.7$, 4 df, $p < 0.001$ and $\chi^2 = 11.5$, 4 df, $p = 0.02$). When health behaviours were compared across the geographic location categories (Table I), there were no apparent differences for physical activity ($\chi^2 = 7.2$, 4 df, $p = 0.12$); however, in the more rural areas there were lower prevalences of youth in the high screen time category ($\chi^2 = 15.4$, 4 df, $p = 0.004$) and higher prevalences in the unhealthy diet category ($\chi^2 = 8.7$, 4 df, $p = 0.07$).

Multivariate associations between geographic location and weight classification

There was a statistically significant association between geographic location and adiposity status (Table II). After adjusting for age, sex, socioeco-

nomics status and region of Canada, increases in overweight and obesity were observed in association with increased rurality (relative odds from most urban to most rural regions for overweight: 1.00, 0.98, 1.18, 1.57, 1.36, $p = 0.001$; obesity: 1.00, 1.06, 1.39, 1.58, 1.56, $p = 0.03$). Participants residing in nonmetro-adjacent and rural areas were more likely to be overweight compared with participants residing in large metro areas. Similarly, those living in rural areas were more likely to be obese compared with those living in large metro areas. Adjustment for physical activity, diet, and screen time had a minimal impact on the relationship between urban/rural status and overweight/obesity (Table II, Model 1 versus Model 2).

Multivariate associations between geographic location and health behaviours

There were no strong or statistically significant associations observed between physical activity or unhealthy diet with geographic location after adjustment for age, sex and SES (Table III). Participants living in small metro, nonmetro-adjacent, and rural areas were 31% less likely to report high screen time than were participants living in large metro areas (Table III).

Discussion

The primary purpose of this study was to examine the association between geographic status and being overweight or obese among Canadian adolescents using a rural/urban index that considered both hierarchical (size) and settlement context components. The principle finding was that Canadian adolescents residing in rural areas were more likely to be overweight and obese in comparison with urban adolescents. The pattern of weight classification remained after controlling for age, sex, SES, region of Canada, physical inactivity, diet, and screen time.

Table I. Prevalence of weight classification and health behaviour outcomes by location of residence.

	Large metro N = 698 %	Medium metro N = 1079 %	Small metro N = 1191 %	Nonmetro-adjacent N = 808 %	Rural N = 1075 %	Total N = 4851 %	P-value
Weight classification							
Overweight	15.2	14.5	18.0	22.3	22.0	18.4	$P < 0.001$
Obesity	3.6	3.4	5.0	5.6	6.0	4.8	$P = 0.02$
Health behaviours							
Physical inactivity	20.9	20.3	19.1	16.7	21.2	19.7	$P = 0.12$
High screen time	31.5	26.7	24.0	24.8	24.9	26.0	$P = 0.005$
Unhealthy diet	24.1	25.4	23.3	28.3	27.1	25.5	$P = 0.07$

Table II. (Multivariate) associations between location of residence and overweight and obesity (n = 4 851).

Location of residence	N (%)	Model 1 OR (95% CI)	Model 2 OR (95% CI)
Overweight			
Large metro	106 (15.2)	1.00	1.00
Medium metro	156 (14.5)	0.98 (0.72, 1.33)	1.01 (0.74-1.37)
Small metro	214 (18.0)	1.18 (0.89, 1.57)	1.22 (0.92-1.63)
Nonmetro-adjacent	180 (22.3)	1.57 (1.14, 2.17)*	1.68 (1.22-2.31)*
Rural	237 (22.0)	1.36 (0.99, 1.87) [†]	1.42 (1.04-1.95)*
Obesity			
Large metro	25 (3.6)	1.00	1.00
Medium metro	37 (3.4)	1.06 (0.63, 1.80)	1.10 (0.66-1.86)
Small metro	59 (5.0)	1.39 (0.84, 2.31)	1.47 (0.88-2.45)
Nonmetro-adjacent	45 (5.6)	1.58 (0.92, 2.71) [†]	1.74 (1.01-3.01)*
Rural	65 (6.0)	1.56 (0.95, 2.57) [†]	1.65 (1.00-2.73)*

OR = odds ratio, CI = confidence interval.

Model 1: Adjusted for age, sex, socioeconomic status, and region of Canada.

Model 2: Adjusted for age, sex, socioeconomic status, region of Canada, physical activity, diet, and screen time.

*p < 0.05.

[†]p < 0.10.

Our findings are consistent with earlier research in Canada (7,8) and the US (10), although these previous studies only considered population density when developing a measurement of urban-rural residency. This is the first known study to use a geographic coding system that considers both the population density and context of a participant's residence. Thus, our findings build upon previous research and highlight the necessity of obesity prevention research and intervention strategies to target rural adolescents.

Intuitively, the higher prevalence of overweight and obesity in rural youth should be explained by differences in the behavioural factors that influence energy expenditure. Surprisingly, in this study urban-rural differences in the three obesogenic behaviours examined (physical inactivity, screen time, diet) did not account for the association between geographic location and overweight or obesity. While we cannot explain this finding, it is noteworthy that

Lutfiyya and colleagues (2007) were also unable to identify behavioural or socioeconomic risk factors that fully accounted for differences in overweight status in urban and rural American children (10). Clearly, further examination of populations of rural youth and the rural setting are required to determine the cause of the urban/rural gradient in youth obesity. Future studies may want to consider using a prospective design that focuses on measuring the rural environment (e.g., physical activity opportunities, condition of recreation facilities, accessibility of nutritious foods), rural youth's perceptions of social-cultural norms and issues (e.g., familial norms, peer norms, body image, fitness), and understanding how the changes in many rural communities (e.g., farming is less labour intensive, population decline, school and hospital closures) has affected the health and body weight of rural youth. This may provide insight into potential barriers (e.g., lack of opportunities, transportation)

Table III. Multivariate associations between location of residence and health behaviour outcomes (n = 4 851).

Location of residence	Physical inactivity		High screen time		Unhealthy diet	
	N (%)	OR (95% CI)	N (%)	OR (95% CI)	N (%)	OR (95% CI)
Large metro	146 (20.9)	1.00	220 (31.5)	1.00	168 (24.1)	1.00
Medium metro	219 (20.3)	0.99 (0.74, 1.32)	288 (26.7)	0.80 (0.61, 1.04) [†]	274 (25.4)	1.13 (0.88, 1.46)
Small metro	228 (19.1)	0.92 (0.69, 1.22)	286 (24.0)	0.66 (0.50, 0.88)*	277 (23.3)	0.91 (0.71, 1.17)
Nonmetro-adjacent	135 (16.7)	0.78 (0.57, 1.05)	200 (24.8)	0.70 (0.51, 0.95)*	229 (28.3)	1.29 (1.00, 1.66)*
Rural	228 (21.2)	1.03 (0.73, 1.45)	268 (24.9)	0.62 (0.46, 0.84)*	291 (27.1)	1.05 (0.80, 1.39)

OR = odds ratio, CI = confidence interval.

All odds ratios were adjusted for age, sex, socioeconomic status, and region of Canada.

*p < 0.05.

[†]p < 0.10.

and enablers of a lifestyle that promotes a healthy weight.

Several limitations of the present study warrant recognition. The first limitation pertains to the use of self-reported measures in the assessment of height and weight for the BMI classification. Several studies have proposed that a bias of underreporting of self-reported body weight may contribute to an underestimation of the prevalence of overweight and obesity among adolescents (23,24). Although, previous research in a large representative sample of American adolescents has reported a 94% correct classification of obesity based on self-reported height and weight (25).

A second limitation relates to the use of self-report for the health behaviour measures. While self-reported physical activity (19) and diet (26) measures correlate with objective measures, questions have been raised about the accuracy of self-reported physical activity (27) and the unhealthy eating index used in our study only reflected a portion of the participants' total diet. The use of more comprehensive and objective measures of physical activity (e.g., accelerometers) and diet (e.g., comprehensive food diaries) may contribute to our understanding of the disparity in weight classification by geographic location.

Third, the use of the postal codes of the schools to classify geographic residence of the students attending those schools may have contributed to the misclassification of participants. Future research may consider the use of the participant's residual postal code to enhance the accuracy of each participant's geographic residence. Fourth, this was a cross-sectional analysis. Longitudinal measures may provide further insight into the causal mechanisms of the examined relationships. Finally, seasonal variation was not controlled for in the survey. Adolescent health behaviours, such as physical activity, have been found to vary depending on the season (28), and these seasonal variations may differ in urban and rural settings.

Strengths of this study included the use of the standardized Beale Coding system for the classification of geographic location. The Beale Coding system considered the context of geographic residency as well as population density. A second strength was the consideration of possible pathways to explain the effect of rural/urban status on obesity. Another strength involved the implementation of a standardized assessment protocol, which in the past has been found to enhance the response rates and accuracy of the self-reported data (29).

The results of this study have important implications for public health efforts directed towards preventing and treating obesity in youth. Because

rural youth are a high risk population, greater attention should be given to modifying obesogenic behaviours in rural youth than in their urban counterparts. Furthermore, because the rural environment itself may not be conducive to healthy eating, physical activity and maintaining a healthy body weight, greater efforts on modifying rural environments may be warranted. Future research should be directed toward more rigorous (quantitative and qualitative) studies to better understand obesity and its determinants within rural settings. By identifying these determinants, we can develop culturally appropriate obesity prevention and intervention strategies that target rural populations.

In summary, this study provides new information about patterns of overweight/obesity among Canadian adolescents by urban-rural geographic status. The strong geographic gradients observed suggest that rural youth can be targeted via preventive interventions. Because this study is the first to examine obesity using a geographic coding system that considers both population density and context, replication of these findings is warranted.

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