Diet, physical activity, and adiposity in children in poor and rich neighborhoods: a cross-sectional comparison

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ABSTRACT

Background: Obesity in Canadian children increased three-fold in twenty years. Children living in low-income neighborhoods exercise less and are more overweight than those living in more affluent after accounting for family socio-economic status. Strategies to prevent obesity in children have focused on personal characteristics, ignoring neighborhood characteristics. It is essential to evaluate diet and physical activity patterns in relation to socio-economic conditions to understand the determinants of obesity. The objective of this pilot study is to compare diet, physical activity, and the built environment in two Hamilton area elementary schools serving socio-economically different communities.

Methods: We conducted a cross-sectional study (November 2005-March 2006) in two public elementary schools in Hamilton, Ontario, School A and School B, located in low and high socioeconomic areas respectively. We assessed dietary intake, physical activity, dietary restraint, and anthropometric measures in consenting children in grades 1 and higher. From their parents we assessed the family characteristics and walkability of the built environment.

Results: 160 children participated in this study (n=48, School A and n=112, School B), and 156 parents (n=43, School A and n=113, School B). The parents at School A were less educated and had lower incomes than those at School B. The School A neighborhood was perceived to be less walkable than the School B neighborhood. Children at School A consumed more baked foods, chips, sodas, jello, and candies and less low fat dairy, and dark bread than those at School B. Children at School A watched more television and spent more time in front of the computer than children studying at

School B, but reported spending less time sitting on weekdays and weekends. There was no difference in the BMI z-scores of the children studying at the two schools (School A=0.65 versus School B=0.81, p-value=0.38).

Conclusions: The potential determinants of overweight within a city may be different depending on neighborhood characteristics. Customizing messages to meet community needs may make interventions to prevent weight gain more effective.

INTRODUCTION

Obesity in children is increasing rapidly but interventions to prevent it have met with limited success [1]. Since obesity does not result from any one single factor, researchers have tested combined interventions, with several messages, as well as single interventions with a single message. Out of six long-term studies with combined dietary education and physical activity interventions, five resulted in no difference in overweight status between groups and one resulted in improvements for girls receiving the intervention, but not in boys [1]. In contrast, interventions with a single message, such as reducing television watching [2] or soda consumption [3], or increasing physical activity [4], have demonstrated an impact. The main reasons for interventions failing to show results have been hypothesized to be first, the length of the interventions were not sufficient, second, there were changes in the children in the control group because they were being followed closely, and the underlying social and environmental determinants of obesogenic behavior were not addressed [1]. However, it is also possible that the messages are diluted when combined, and not all messages may be relevant in all conditions. Therefore, customizing the messages to better meet the needs of the community may increase the chances of success.

In preparation to conduct an intervention study to prevent obesity among elementary school children in the Hamilton area, we conducted a pilot study of lifestyle characteristics and perceptions in two schools in Hamilton located in socio-economically disparate neighborhoods. The objectives of this pilot study were to compare diet, physical activity, and the built environment in relation, and body weight in two Hamilton area elementary schools serving socio-economically different communities.

METHODS

Permission to conduct the study was obtained from the principals of two public elementary schools in Hamilton, Ontario, School A and School B, the Research Ethics Board of McMaster University, and Hamilton-Wentorth District School Board. All study personnel coming into contact with children received police clearance for a history of criminal charges following a record check.

Study population: School A is located in a neighborhood with low socio-economic status (postal code L8L 6T9), and School B is situated in a high socio-economic status neighborhood (postal code L8S 1K6). All children in grade one and above were approached, and those who provided written consent from their parents were included in the study. We asked the principals of both schools for permission to administer the children questionnaires and carry out the measurements at the respective schools. The principal of School A agreed but the principal of School B only permitted us to conduct the measurements at the school. We therefore sent both the child and parent forms home. In the instructions we requested the children complete the child questionnaires. Children in grades 3 and higher were able to do so without help. In School A we helped the younger children with the questions and at School B we requested the parents to do so.

Assessment: All children were asked to complete the child questionnaire and allow physical measurement of height, weight, waist and hip circumference. All parents were asked to complete a parent questionnaire.

Child questionnaire: In this questionnaire diet, dietary restraint and physical activity were measured. Before administration of the questionnaire it was pretested it among a group of Canadian children of similar ages and found the responses to have face validity.

Food intake was assed using items from the Youth and Adolescent Questionnaire (YAQ) to assess diet [5]. This instrument was developed in a multiethnic sample of US children. Pearson correlation coefficients for reproducibility for nutrients ranged from 0.26 for protein and iron to 0.58 for calcium, and for foods it ranged from 0.39 for meats to 0.57 for soda [5]. In a validation study the Pearson correlation coefficients ranged from 0.21 for sodium to 0.58 for folate, with an average correlation coefficient of 0.54 after correcting for within-person error [5]. Food intakes (continuous variable) were converted into servings per day by multiplying the average portion size by frequency of intake.

Dietary restraint was measured using the three factor eating questionnaire (TEEQ), which measures cognitive restraint, uncontrolled eating, and emotional eating, and has been used in similar studies [6,7] and reflects behavioral strategies to control dietary intake. It has been adapted and validated for use in the general population and among adolescents. High scores on the cognizant restraint scale are positively correlated with intake of healthy foods such as green vegetables, and negatively correlated with the intake of unhealthy foods such as French fries and sugar [6]. We coded the responses so that a low score indicated little dietary restraint and a high score showed a high degree of dietary restraint. Then we summed all the responses to this set of questions to obtain a dietary restraint score.

Physical activity was evaluated using questions on TV watching, using the computer, watching movies, participation in organized sport, and time spent in play, from a previously validated questionnaire [8]. To estimate the average time (min/day) spent on various activities we multiplied the reported amount of time (min/day) spent in that activity by the number of days per week it was performed; and then divided by 5 to estimate average time spent on a typical weekday, by 2 for a typical weekend, and by 7 for a typical day of the week.

Anthropometry: Children's height, weight, and waist and hip circumferences were measured using a standardized protocol used in the past [9]. Height was measured without shoes correct to the nearest 0.1 cm using a stadiometer, and weight in light clothes measured to the nearest 0.1 kg using a portable scale. Waist circumferences was measured to the nearest 0.1 cm using non-stretchable standard over the unclothed abdomen at the smallest diameter between the costal margin and the iliac crest (the hip) at the end of a normal expiration by using non-stretchable standard tape measure attached to a spring balance exerting a force of 750 g. Body mass index (BMI) was calculated by dividing the weight in kilograms by height in meters squared, and BMI z-scores (BMIZ) computed using the Centers for Disease Control Anthropometric computer program [10]. Children were classified as at or overweight or obese if they were at or above the 85^{th} percentile of BMI z-score.

Parent questionnaire: In this questionnaire we ascertained household income, ethnicity, marital status, and education level of parents. Parental perception on neighbourhood built environment and walkability was assessed using the Neighborhood Environment Walkability Survey (NEWS) questionnaire [11]. The domains were: population density, street connectivity, land use mix (e.g. presence of shops and services), pedestrian-supportive infrastructure/facilities (e.g. sidewalks and lighting), esthetics, and safety [11,12]. The questions on built environment were on an ordinal scale and re-coded so that a low score indicated not walkable and a high score walkable trait. The scores from each of the 4 domains of neighborhood walkability were summed up to obtain a total walkability score.

Statistical methods: To compare differences between schools we used the t-test for continuous variables and the Cochran-Mantel-Hanszel chi-square test for categorical variables. We used servings per day to compare food intake, and minutes per day for physical activity. We used SAS Version 9 (Charlotte, N.C.) in all the analyses.

RESULTS

160 children (48 children from School A and 112 from School B), and 156 parents (43 parents from School A and 113 from School B) participated in this study. The general characteristics of the study participants are shown in Table 1. Briefly, responses to questions confirmed that School A parents were more socially disadvantaged than School B parents. School A parents were less educated and had lower incomes than those at School B; they also had higher reported BMI (27.1 versus 23.3 kg/m^2, p-value<0.001).

About half the children were males at both schools; however, the children at School A were older than those at School B (8.1 versus 11.0 years respectively, p-value<0.001). Dietary analyses did not reveal differences in fruit, vegetable, and legume consumption among children at the two schools, although children at School A consumed more baked foods, chips, sodas, jello, and candies and less low fat dairy, and dark bread than children at School B. No significant difference in dietary restraint between children at the two schools was identified (dietary restraint score was 15 for School A versus 14 for School B).

Sedentary behavior analyses indicated that children at School A watched more television and spent more time in front of the computer than children at School B, but they reported spending less time sitting on weekdays and weekends. As School B had better standardized test results than School A, it could be speculated that the children at School B were spending more time studying even though they were watching less television, and hence being more sedentary, than those at School A. No differences in the BMI z-scores of the children studying at the two schools were detected (School A=0.65 versus School B=0.81, p-value=0.38). The prevalence of overweight or obese children in School A was 33.3% (16/48) versus 27.7% (31/112) in School B, p-value=0.47.

Overall, the neighborhood in which School A is located was perceived to be less walkable than the School B neighborhood. The School A neighborhood was perceived to be less safe, less esthetic, and have a lower population density than that surrounding School B. No differences in the perception of the presence of facilities, such as presence of streetlights, sidewalks, and parks, were detected in these two areas.

DISCUSSION

The BMI of the children at the two schools did not differ but School A parents were heavier than School B parents. The School A households had lower income and education levels than School B households. There were significant differences in the determinants of obesity. The School A neighborhood was perceived as being less walkable than the School B neighborhood. Children at School A ate more junk food but were more active than children at School B. The BMI z-scores in the children in the two schools were similar even though their socio-economic status was different and they ate different foods, and had different physical activity patterns. The factors contributing to body weight in these were likely different.

Our findings are consistent with prior studies that demonstrate the powerful influence of the environment on obesogenic lifestyles. Children living in neighborhoods with low mean income in Canada are more likely to be overweight or obese compared with neighborhoods with high mean income after accounting for family income and individual characteristics [13,14]. Janssen et al reported that Canadian adolescents living in low-income neighborhoods were more likely to be obese after accounting for family affluence, perceived family affluence, age, and sex in a large national sample [13].

These results imply that some characteristics of the neighborhood predispose children to obesity independent of demographic and socio-economic factors. The foods available in low-income neighborhoods are of lower quality [15], cost more, and have less variety, than foods available in more affluent neighborhoods, because larger suppliers tend to target higher income clients [16]. Moreover, healthy foods such as fruits and vegetables, poultry, fish and whole grain cost more compared with less healthy alternatives which may promote obesity such as refined grain, French fries, bakery products, and snacks containing high sugar, and fat [17]. Likewise, low-income neighborhoods have fewer facilities for recreational physical activity; the presence of facilities in neighborhoods is directly correlated with individual physical activity and BMI [18].

We did not evaluate the relation between diet, physical activity, and BMI in this study. The likelihood of a type 1 error was large because of multiple testing; likewise the sample size was too small to make that comparison increasing the possibility for a type-2 error (power=14%, with alpha level of 0.05). The mean BMI z-scores were not statistically different between the two schools, although the point estimate for School B was slightly higher than that for School A. In contrast, the prevalence of overweight or obese children was non-significantly higher in School A as compared with School B. This may be due to inadequate power or because the children in School A were older than those in School B. The comparison of risk factors between the schools, however, was possible because of the large differences in diet and physical activity. The determinants of BMI in these children need to be established in a larger, more definitive study. Another limitation was that these children were self-selected, and therefore probably more motivated and health conscious. This may explain why fruit and vegetable intake in the children at both schools was high. Information on diet and physical activity were obtained from self-report and could result in biased reporting. School B children may have reported more healthy behaviors because the questionnaires were filled at home and the parents could have influenced the responses. However, the children reported differences in the types of foods they ate; those at School A reported eating more cruciferous vegetables, while those at School B more green leafy vegetables. As green leafy vegetables are generally not perceived to be more "healthy" than other types of vegetables it seems that bias did not impact these responses substantially. Similarly, children at School A reported being more physically active than those at School B, and there were differences in the perception of the walkability the neighborhoods reported by the parents. Moreover, the same instruments were used to obtain information from all the children and their parents. Taken together, these facts suggest that bias was probably not a large factor in these results. However, in a larger study these limitations would need to be overcome by supplementary objective measures for physical activity such as pedometers, and biomarkers or alternative nutritional assessment for diet. The main implications of our study are that the factors causing obesity in communities may be quite different even though they are in the same city (within 10 km of each other). Customizing messages to meet community needs may make interventions to prevent weight gain more effective. For instance, at School A the main messages may be to reduce television time, soda, and baked food consumption, while at School B it could be for the children to be more active on weekdays and weekends.

Most intervention studies to date have first, targeted the individual (and generally ignored the environment), and second promoted a standard message at all the intervention sites. The first direction of futures studies may therefore be to evaluate structural changes that are anti-obesogenic by design. The second direction, which is consistent with our results, is to customize the message for community. These conclusions are consistent with the findings from a recent review of interventions to prevent overweight and obesity in children [19]. There is evidence that ethnicity and family characteristics and behaviors influence physical activity [20] and obesity [21] in Canadian children, but these have not been adequately evaluated in the current studies. Because of the heterogeneity of the population, parts of a single message may be redundant for many of the participants, and may be an unappreciated reason for the failure to observe demonstrated clear benefits in obesity prevention trials in children.

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Table 1, Characteristics of study population

	School A	School B	Both
	N=48	N=112	N=160
Child			
Age (mean, SD)	11.2, 2.0	8.2, 1.5	9.0, 2.1
Male (%, n)	47.9%, 23	48.2%, 54	48.1%, 77
Grade			
Grade 1	2.1%, 1	24.7%, 22	16.8%, 23
Grade 2	6.3%, 3	21.4%, 19	16.1%, 22
Grade 3	8.3%, 4	21.4%, 19	16.8%, 23
Grade 4	2.1%, 1	22.5%, 20	15.3%, 21
Grade 5	14.6%, 7	10.1%, 9	11.7%, 16
Grade 6	12.5%, 6	0.0, 0.0	4.4%, 6
Grade 7	29.2%, 14	0.0, 0.0	10.2%, 14
Grade 8	25%, 12	0.0, 0.0	8.8%, 12
BMI z-scores (mean, SD)	0.65 (1.14)	0.81 (0.71)	0.75 (0.88)
BMI≥85th percentile z-score (%, n)	33.3%, 16	27.7%, 31	29.4%, 47
Parents	N=43	N=113	N=156
Father's Education			
High school or less (%, n)	65%, 28	13.5% , 13	29.5%, 41
Trade school (%, n)	25.6%, 11	17.7%, 17	20.1%, 28

Bachelor's degree (%, n)	0, 0	22.9%, 22	15.8%, 22
Postgraduate (%, n)	4.7%, 2	44.8%, 43	32.7%, 45
Mother's Education			
High school or less (%, n)	63%, 29	11%, 11	27.4%, 40
Trade school (%, n)	26.1%, 12	21%, 21.0	22.6%, 33
Bachelor's degree (%, n)	8.7%, 4	42%, 42	31.5%, 46
Postgraduate (%, n)	2.2%, 1	26%, 26	18.5%, 27
Income			
<$20,000 (%, n)	13.3%, 6	9.2%, 9	10.5%, 15
$20-30,000 (%, n)	29%, 13	7.1%, 7	14%, 20
$30-45,000 (%, n)	20%, 9	7.1%, 7	11.2%, 16
$45-65,000 (%, n)	26.7%, 12	14.3%, 14	18.2%, 26
$65-90,000 (%, n)	11.1%, 5	28%, 27	22.4%, 32
>$90,000	0, 0	34.7%, 34	23.8%, 34
Marital status			
Never married (%, n)	8.3%, 4	2.9%, 3	4.6%, 7
Married (%, n)	64.6%, 31	83.5%, 86	77.5%, 117
Common law (%, n)	16.7%, 8	3.9%, 4	8%, 12
Widowed, Separated, or Divorced (%, n)	10.5%, 5	9.7%, 10	10.0%, 15
Ethnicity			

White (%, n)	73.0%, 33	77.5%, 79	76.2%, 112
Black (%, n)	8.9%, 4	1.0%, 1	3.4%, 5
Chinese (%, n)	0.0, 0	13.7%, 14	9.5%, 14
South Asian (%, n)	2.2%, 1	3.9%, 4	3.4%, 5
Other Asian (%, n)	6.7%, 3	2.0%, 2	3.4%, 5
Other (%, n)	8.9%, 4	2%, 2	4%, 6
BMI, kg/m^2 (mean, SD)	23.2, 4.0	27.3, 6.0	24.6, 5.1

Table 2, Comparison of child intake of selected foods (servings/d) by school

	School A	School B	Both
	N=46	N=112	N=158
	Mean (SD)	Mean (SD)	Mean (SD)
Green leafy vegetables *	0.25 (0.37)	0.39 (0.34)	0.35 (0.36)
Cruciferous vegetables *	0.39 (0.52)	0.23 (0.20)	0.28 (0.34)
All vegetables	2.09 (2.05)	1.90 (1.10)	1.96 (1.44)
Legume *	0.21 (0.47)	0.26 (0.33)	0.25 (0.37)
Fruit	4.78 (2.80)	4.77 (2.39)	4.78 (2.51)
Fruit and vegetables	6.71 (4.07)	6.70 (3.18)	6.71 (3.45)
Dairy *	2.02 (1.77)	2.80 (1.43)	2.60 (1.56)
Low fat dairy *	1.01 (1.05)	1.38 (0.80)	1.27 (0.89)
Juice	1.89 (1.50)	1.53 (1.04)	1.64 (1.20)
Soda *	0.74 (0.80)	0.12 (0.28)	0.30 (0.57)
Sugar drink *	2.34 (1.82)	1.59 (1.07)	1.81 (1.37)
Baked *	3.61 (3.07)	0.95 (0.77)	1.72 (2.13)
Chips *	0.64 (1.05)	0.20 (0.34)	0.32 (0.66)
Jello *	4.16 (2.11)	0.22 (0.25)	1.35 (2.12)
Candy *	8.85 (2.95)	0.38 (0.42)	2.90 (4.22)
Cracker *	0	0.30 (0.30)	0.30 (0.30)
Peanut *	0.15 (0.25)	0.06 (0.12)	0.09 (0.17)
Dark bread *	0.39 (0.81)	0.77 (0.94)	0.66 (0.92)

White bread *	1.01 (1.13)	0.58 (0.79)	0.71 (0.93)

* p-value<0.05 comparing the two schools using the t-test

Table 3, Comparisons of school by time children spent participating in physical activity

	School A	School B	Both
	N=46	N=111	N=153
	Mean, sd	Mean, sd	Mean, sd
Watching television min/d *	102 (115)	18 (56)	43 (87)
In front of computer min/d *	107 (175)	6 (45)	37 (113)
Sitting on weekdays min/d	135 (144)	268 (672)	181 (413)
Sitting on weekends min/d *	43 (51)	61 (31)	47 (47)

* p-value<0.05 comparing the two schools using the t-test

Table 4, Comparisons of school by parental assessment of characteristics built environment[†]

	School A	School B	Both
	N=48	N= 95	N=143
	Mean, sd	Mean, sd	Mean, sd
Safety *	21 (4)	23 (3)	23 (3)
Residential density *	14 (2)	16 (2)	15 (2)
Esthetics *	7 (2)	10 (2)	9 (2)
Presence of facilities	9 (2)	9 (2)	9 (2)

* p-value<0.05 comparing the two schools using the t-test

† A higher score represents a built environment favoring walking

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