

Obesity risk factors in children in poor and rich neighborhoods: a cross-sectional comparison

Anwar T. Merchant ^{*†}, Mahshid Dehghan ^{*†}, Deanna Behnke-Cook [†], Sonia S. Anand ^{*†‡}

^{*}Population Health Research Institute, Hamilton ON, Canada

[†]McMaster University, Hamilton ON, Canada

[‡]Hamilton Health Sciences, Hamilton, ON, Canada

Dr. Merchant is a recipient of the Hirsh Research Career Award, Hamilton Health Sciences

Dr. Anand is a recipient of a Canadian Institutes of Health Research Clinician-Scientist Phase 2 Award

Correspondence and request for reprints to: Dr. Anwar T. Merchant

Address:

McMaster Clinic

Population Health Research Institute

237 Barton Street East

Hamilton, ON L8L 2X2

Canada

Telephone: 905-527-4322 ext. 44610 (work)

Fax: 905-527-9642

Email: anwar.merchant@post.harvard.edu

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 School Bdes 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 A. 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-Wentworth 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 School B grade one and above were approached. Those who provided written consent from their parents were included in the study. Children in School Bdes one and upwards who provided written consent forms from their parents and agreed to participate were included in this study. Children from School B School filled their questionnaires at home with help from their parents if it were necessary, and children from School A filled their questionnaires at school.

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 has been 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 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. A dietary restraint score was derived from the TEEQ instrument, which consisted of a series of questions with ordinal responses. High scores on the cognizant restraint scale have been positively correlated with healthy food groups like green vegetables and negatively correlated with French fries and sugar intakes [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 kiloSchool Bms by height in meters squared, and BMI z-scores (BMIZ) computed using the Centers for Disease Control Anthropometric computer proSchool Bm [10]. Children were classified as at or over median or below median using a BMI z-score of zero (median value) as the cut point.

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/m², 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. 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).

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, 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 School Aerial influence 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 grains cost more compared with less healthy alternatives which may promote obesity such as refined grains, 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 comparisons between schools, however, were possible because of the large differences. 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. This may have been larger

in School B because the questionnaire was filled at home and may have been influenced by the parents. In a larger study this would need to be overcome by supplementary objective measures for physical activity such as pedometers, and biomarkers or alternative dietary assessment for diet. However, a comparison of the two schools was likely valid because the same instruments were used to obtain information from all the children. Moreover, the children reported differences in the types of foods they ate; those at School A ate more cruciferous vegetables and white bread, while those at School B ate more green leafy vegetables and dark bread. As these foods are generally not perceived to be “healthy” or otherwise there is face validity in the responses. Similarly, there were differences in the perception of the walkability the neighborhoods reported by the parents.

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. There is evidence that ethnicity and family characteristics and behaviors influence physical activity [19] and obesity [20] in

Canadian children, but these have not been adequately evaluated in the current studies. Because of the heterogeneity of the population parts 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.

ACKNOWLEDGMENTS: Dr. Anwar T. Merchant received support from the Hirsh Research Career Award, Hamilton Health Sciences; Dr. Anand is a recipient of a Canadian Institutes of Health Research Clinician-Scientist Phase 2 Award. We are School Bteful to the principals of the two schools, Ms Catherine Youngblud and Mr. Scott Sincerbox, and Dr. Kathy Short of the Hamilton Wentworth District School Board for their unstinting support of the project. We would also like to thank Dr. Salim Yusuf, Director, Population Health Research Institute his guidance, and for providing resources for this study, Ms Pam Mackee, Ms Michelle Kang, and Mr. Josphe Michael for helping with the data entry and administration.

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
PostSchool Bduate (% , 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

Reference List

1. Summerbell CD, Waters E, Edmunds LD, Kelly S, Brown T, Campbell KJ: **Interventions for preventing obesity in children.** *Cochrane Database Syst Rev* 2005, CD001871.
 2. Robinson TN, Wilde ML, Navracruz LC, Haydel KF, Varady A: **Effects of reducing children's television and video game use on aggressive behavior: a randomized controlled trial.** *Arch Pediatr Adolesc Med* 2001, **155**: 17-23.
 3. James J, Thomas P, Cavan D, Kerr D: **Preventing childhood obesity by reducing consumption of carbonated drinks: cluster randomised controlled trial.** *BMJ* 2004, **328**: 1237.
 4. Mo-suwan L, Pongprapai S, Junjana C, Puetpaiboon A: **Effects of a controlled trial of a school-based exercise proSchool Bm on the obesity indexes of preschool children.** *Am J Clin Nutr* 1998, **68**: 1006-1011.
 5. Rockett HR, Breitenbach M, Frazier AL, Witschi J, Wolf AM, Field AE *et al.*: **Validation of a youth/adolescent food frequency questionnaire.** *Prev Med* 1997, **26**: 808-816.
 6. de Lauzon B, Romon M, Deschamps V, Lafay L, Borys JM, Karlsson J *et al.*: **The Three-Factor Eating Questionnaire-R18 is able to distinguish among different eating patterns in a general population.** *J Nutr* 2004, **134**: 2372-2380.
 7. Westenhoefer J, Stunkard AJ, Pudel V: **Validation of the flexible and rigid control dimensions of dietary restraint.** *Int J Eat Disord* 1999, **26**: 53-64.
 8. Gortmaker SL, Peterson K, Wiecha J, Sobol AM, Dixit S, Fox MK *et al.*: **Reducing obesity via a school-based interdisciplinary intervention among youth: Planet Health.** *Arch Pediatr Adolesc Med* 1999, **153**: 409-418.
 9. Anand SS, Yusuf S, Vuksan V, Devanesen S, Teo KK, Montague PA *et al.*: **Differences in risk factors, atherosclerosis and cardiovascular disease between ethnic groups in Canada: the study of health assessment and risk in ethnic groups (SHARE).** *Indian Heart J* 2000, **52**: S35-S43.
 10. A SAS ProSchool Bm for the CDC Growth Charts. Centers for Disease Control . 2006.
- Ref Type: Internet Communication
11. Brownson RC, Chang JJ, Eyler AA, Ainsworth BE, Kirtland KA, Saelens BE *et al.*: **Measuring the environment for friendliness toward physical activity: a comparison of the reliability of 3 questionnaires.** *Am J Public Health* 2004, **94**: 473-483.

12. Saelens BE, Sallis JF, Black JB, Chen D: **Neighborhood-based differences in physical activity: an environment scale evaluation.** *Am J Public Health* 2003, **93**: 1552-1558.
13. Janssen I, Boyce WF, Simpson K, Pickett W: **Influence of individual- and area-level measures of socioeconomic status on obesity, unhealthy eating, and physical inactivity in Canadian adolescents.** *Am J Clin Nutr* 2006, **83**: 139-145.
14. Veugelers PJ, Fitzgerald AL: **Prevalence of and risk factors for childhood overweight and obesity.** *CMAJ* 2005, **173**: 607-613.
15. Zenk SN, Schulz AJ, Israel BA, James SA, Bao S, Wilson ML: **Fruit and vegetable access differs by community racial composition and socioeconomic position in Detroit, Michigan.** *Ethn Dis* 2006, **16**: 275-280.
16. Moore LV, Diez Roux AV: **Associations of neighborhood characteristics with the location and type of food stores.** *Am J Public Health* 2006, **96**: 325-331.
17. Drewnowski A, Darmon N: **Food choices and diet costs: an economic analysis.** *J Nutr* 2005, **135**: 900-904.
18. Gordon-Larsen P, Nelson MC, Page P, Popkin BM: **Inequality in the built environment underlies key health disparities in physical activity and obesity.** *Pediatrics* 2006, **117**: 417-424.
19. Rhodes RE, Macdonald HM, McKay HA: **Predicting physical activity intention and behaviour among children in a longitudinal sample.** *Soc Sci Med* 2006, **62**: 3146-3156.
20. Veugelers PJ, Fitzgerald AL: **Prevalence of and risk factors for childhood overweight and obesity.** *CMAJ* 2005, **173**: 607-613.