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ORIGINAL RESEARCH

Childhood obesity: A comparison of health habits of middle-school students from two communities

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Objective: To assess whether children's diet and physical activity patterns differ between neighboring communities with differing resources.

Study design and setting: We compared the health behaviors of middle-school students in two Michigan communities; Ann Arbor and Ypsilanti; median household income of US$46,299 and 28,610, respectively. Self-reported diet and physical activity habits were collected.

Participants: A total of 733 middle-school students from two neighboring communities (five Ann Arbor and two Ypsilanti middle schools) participated in the study.

Measures: Data on age, gender, and racial/ethnic factors were collected as part of the baseline assessment. Students were also measured for height and weight. Body mass index was calculated. Information on diet and physical activity in addition to amounts and types of sedentary activities was assessed via questionnaires.

Results: More Ypsilanti schoolchildren were obese compared to the Ann Arbor schoolchildren (22.2% vs 12.6%; $P = 0.01$). The Ypsilanti schoolchildren reported higher consumption of fried meats (7.5% vs 3.2%; $P = 0.02$), French fries or chips (14.3% vs 7.9%; $P = 0.02$), punch or sports drinks (24.1% vs 12.2%; $P = 0.001$) and soda (18% vs 7.9%; $P < 0.001$) compared to the Ann Arbor children. School-based activities including physical education classes (58.6% vs 89.7%; $P < 0.001$) and sports teams (34.6% vs 62.8%; $P < 0.001$) differed for Ypsilanti schoolchildren vs Ann Arbor children. Sedentary behaviors were higher in the Ypsilanti children.

Conclusions: Differences in diet and physical activity habits among children from two neighboring communities with varying resources suggests a need for school-based interventions to promote healthy behaviors among middle-school students.

Keywords: childhood obesity, diet, physical activity, community health

Introduction

An estimated nine million children in the United States aged 6 to 19 years meet the criteria for being obese, defined as a body mass index (BMI) in the 95th percentile or greater for age and gender in the United States.[1–3] Overweight adolescents have a 70% likelihood of remaining overweight or being obese as adults,[4] which places them at increased risk for diabetes and cardiovascular disease. Prevention of obesity in children is largely dependant on healthy lifestyle behaviors including regular physical activity, decreased sedentary behaviors, and a healthy diet, low in saturated fats and sugars. Evidence suggests that environmental factors play a significant role in lifestyle behaviors.[5,6] Supermarkets with good selections of fruits and vegetables are more prevalent in higher income neighborhoods. Healthy foods cost more than calorie-dense foods high in saturated fats and sugars.[7] A similar pattern is observed for lower income neighborhoods having less access to safe venues for recreation or

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fewer programs related to physical activity.[6] In turn, lower levels of physical activity have been linked to increases in sedentary behavior such as television viewing,[8] which is associated with increased caloric intake and obesity among children.[9,10]

In southeastern Michigan, two neighboring communities have been using a school-based program, Project Healthy Schools (PHS) which focuses on a health education intervention to reduce or prevent childhood obesity.[11] Ann Arbor, with a median household income of US$46,299, has approximately 31 grocery stores and 156 city parks, while Ypsilanti, with a median household income of US$28,610, has approximately four grocery stores and 11 city parks. An estimated 61% of Ypsilanti schoolchildren qualify for free school lunches compared to 17% of Ann Arbor schoolchildren. As part of PHS, extensive baseline data on diet and physical activity were collected from participating middle-school students. Using these data, we compared dietary and physical activity habits from middle-school students residing in two neighboring communities. We hypothesized that a community with fewer resources would be associated with higher rates of obesity, lower quality diet, and more sedentary behaviors compared to a community with more resources.

Methods

The PHS program was designed to assess and improve cardiovascular risk factors, nutritional, and physical activity habits of middle-school students through educational and environmental changes at the middle-school. Five primary goals of the program include increasing intake of fruits and vegetables, reducing intake of beverages high in sugar, reducing intake of fast foods and fatty foods, a goal for physical activity (ie, exercise) of 150 minutes or more per week, and reducing the amount of time spent watching television and playing computer (or video) games. Educational modules were developed for use primarily during the students' homeroom periods. Modules were taught by either the students' homeroom teachers or the PHS staff. PHS also worked with school staff to effect environmental changes with a goal to improving school lunch programs for increased selections of vegetables, salads, and fruits. Healthy snack items were introduced and substitutions of fried snacks were made with healthier versions. Sugar-containing soft drinks were replaced with bottled water and other nonsoft drink selections. Baseline data collection including diet and physical activity assessments were performed prior to the start of the educational modules, which corresponded to the fall term for the middle-school students. Full details of PHS and its benefit on cardiovascular risk factors have been published elsewhere.[11]

Study population

Students enrolled in sixth grade (10–12 years old) within seven middle-schools (five from Ann Arbor and two from Ypsilanti) were eligible to participate in the PHS program. Parents of each student were sent letters explaining the program along with a consent form to sign. All sixth graders received the educational curriculum of the PHS program, however only data from students whose parents provided consent were used for this analysis. The study was approved by the University of Michigan Institutional Review Board.

Data collection

Data on age, gender, and racial/ethnic factors were collected as part of the baseline assessment. Students were also measured for height and weight. BMI was then calculated. Information on diet and physical activity in addition to amounts and types of sedentary activities was assessed via questionnaires. Students completed an abbreviated School Physical Activity and Nutrition (SPAN) survey.[12] This survey was developed and validated in similar school-based student populations. Questions relating to diet included number of servings of meats and fried meats, servings of vegetables (excluding French fries) and fruits (excluding juice), etc. Separate questions on fried potatoes such as French fries and chips were included in the survey. Information on consumption of fluids/liquids was reported via separate questions for sugar-containing soft drinks, diet soft drinks, juices, other fruit or sport drinks and milk (number of servings and type of milk such as low fat or skim). Frequency of servings consumed in the prior 24 hours was assessed via a Likert scale from none, one time, two times, to three or more times. Selections for type of milk included regular (whole), low fat (2%, 1.5% or 1%), skim (including nonfat or 0.5%), a combination of all types, other (rice or soy) and 'I don't drink milk.' Questions related to physical activity and sedentary behaviors included the number of days in the prior week the student had performed vigorous physical activity for at least 20 minutes with a separate question for vigorous activity of 30 minutes or greater. Additional questions were included to collect information on the number of physical education classes attended in the prior week, participation in school-based team sports, and sports or other physical activities outside the school. Sedentary behaviors were addressed with questions on the number of hours spent watching television per day,

number of hours spent on the computer (outside of school) per day, and the number of hours spent playing videogames per day. For each of these questions the frequency ranged from no time spent, less than one hour, one hour, two, three, four, five, and six hours.

Study site coordinators, were trained and were provided a manual of operations and standardized data forms to ensure a high degree of accuracy in data collection. Data not within the set limit ranges, inconsistencies, and/or unrecorded fields were flagged and were clarified and corrected where possible. Approximately 10% of forms were randomly selected for verification with double entry of the data. In consistencies which could not be resolved were excluded from the analysis.

Statistical analysis

The Statistical Package for the Social Sciences (version 15.0; SPSS Inc., Chicago, IL) was used for statistical analysis. All data were entered into a Microsoft Access database (Microsoft Corporation, Redmond, WA) at the Michigan Cardiovascular Research and Reporting Program. Univariate analyses using the questionnaire data included chi-squared tests for comparisons between discreet variables and *t*-tests for continuous variables. For all analysis, a P value < 0.05 was considered significant.

Results

A total of 733 boys and girls were included in this analysis, of which 598 were from the Ann Arbor public school system and 135 were from the Ypsilanti public school system (Table 1). Approximately half of the students surveyed were boys; 48.5% (n = 290) in Ann Arbor and 51.1% (n = 69) in Ypsilanti. The mean age between the two cohorts was similar as well (11.6 years ± 0.4 years for Ann Arbor vs 11.5 ± 1.4 years for Ypsilanti; $P = 0.13$). The racial/ethnic comparison of the two groups differed, with Ann Arbor having higher percentages of Caucasians (58.8% vs 34.8%) and Asians (15.1% vs 0.7%); whereas Ypsilanti had higher percentages of African Americans (44.4% vs 13.7%). Similar rates of Hispanic schoolchildren were observed in the two groups. The percentage of schoolchildren receiving free lunch was higher in Ypsilanti schoolchildren compared to African Americans (60.7% vs 16.9%; $P = 0.01$).

Although no difference in height was observed between the two groups, middle-school students in Ypsilanti were heavier. Mean height was 150.2 ± 7.7 cm and mean weight was 45.4 ± 12.1 kg for the Ann Arbor cohort and 150.6 ± 12.9 cm and 49.1 ± 13.8 kg, respectively for the Ypsilanti cohort. Thus, the mean BMI was significantly greater in the Ypsilanti schoolchildren (21.2 ± 4.8 kg/m^2 vs 19.9 ± 4.1 kg/m^2; $P = 0.001$) compared to the Ann Arbor schoolchildren. The percentage of schoolchildren who were obese was higher in the Ypsilanti cohort compared to the Ann Arbor cohort (22.2% vs 12.6%; $P = 0.01$), while the percentage of schoolchildren who were overweight was similar in the two communities.

Table 1 Baseline characteristics by community

Demographic characteristics (%)	Ann Arbor, MI N = 598 N (%)	Ypsilanti, MI N = 135 N (%)	*P* value
Male (%)	290 (48.5)	69 (51.1)	0.62
Age, year (SD)	11.55 ± 0.4	11.45 ± 1.4	0.13
Race/Ethnicity (%)			<0.001
Caucasian	347 (58.8)	47 (34.8)	
African American	81 (13.7)	60 (44.4)	
Hispanic	26 (4.4)	6 (4.4)	
Asian	89 (15.1)	1 (0.7)	
Height, cm (SD)	150.2 ± 7.7	150.6 ± 12.9	0.61
Weight, kg (SD)	45.4 ± 12.1	49.2 ± 13.8	0.001
BMI, kg/m^2	19.9 ± 4.1	21.2 ± 4.8	0.001
Overweight* (%)	114 (19.4)	26 (19.3)	0.56
Obese** (%)	74 (12.6)	30 (22.2)	0.01

Notes: *Overweight defined as at or beyond the 85th percentile of weight for age and gender; **Obese defined as at or beyond the 95th percentile of weight for age and gender.
Abbreviations: BMI, body mass index; MI, Michigan; SD, standard deviation.

Differences in self-reported dietary characteristics associated with childhood obesity were observed between the two communities (Table 2). Although similar rates of meat consumption were reported, schoolchildren in Ypsilanti were more likely to report consuming two or more servings of fried meats including chicken, steak, pork or fish (7.5% for Ypsilanti vs 3.2% for Ann Arbor; $P = 0.02$). Consumption of French fries or chips was also higher among the Ypsilanti schoolchildren compared to the Ann Arbor schoolchildren (14.3% vs 7.9%; $P = 0.02$). Ypsilanti schoolchildren were less likely to report consuming two or more servings of vegetables (excluding fries or chips) compared to Ann Arbor schoolchildren (33.8% vs 47.9%; $P = 0.003$). A similar trend in consumption of fruits (excluding juice) was observed (35.3% for Ypsilanti vs 43.8% for Ann Arbor; $P = 0.08$). In terms of beverages, milk consumption appeared higher in the Ann Arbor cohort. Ann Arbor schoolchildren reported two or more servings of milk (any type) compared to Ypsilanti schoolchildren (66.7% vs 45.9%; $P < 0.001$). However 80% of Ypsilanti schoolchildren reported consuming low fat or skim milk compared to 65% of Ann Arbor schoolchildren. Ypsilanti schoolchildren were more likely to report consuming two or more servings of punch, Kool-Aid or sports

Table 2 Self-reported dietary behaviors by community

Dietary characteristic (%)	Ann Arbor, MI N (%)	Ypsilanti, MI N (%)	*P* value
Two or more servings in prior 24 hours			
Hamburger meat, hot dogs, sausage, steak, bacon, or ribs	61 (10.9)	19 (14.3)	0.27
Fried meats (chicken, steak, pork, or fish)	18 (3.2)	10 (7.5)	0.02
Milk: any type (chocolate, regular, skim, etc)	372 (66.7)	62 (45.9)	<0.001
French fries or chips	44 (7.9)	19 (14.3)	0.02
Vegetables (excluding fries or chips)	268 (47.9)	45 (33.8)	0.003
Fruits (excluding juice)	243 (43.8)	47 (35.3)	0.08
Fruit Juice	157 (28.1)	37 (27.8)	0.94
Punch, Kool-Aid, Sport drinks	68 (12.2)	32 (24.1)	0.001
One or more servings in prior 24 hours			
Regular Soda or Soft Drinks	44 (7.9)	24 (18.0)	<0.001
Low fat or skim milk	364 (65.4)	100 (80.6)	<0.001
Consume school lunches: almost always or always	198 (35.5)	9 (6.8)	<0.001

drinks compared to the Ann Arbor schoolchildren (24.1% vs 12.2%; $P = 0.001$). Consumption of fruit juice was similar between the two groups. Consumption of regular soda or soft drinks was higher among Ypsilanti schoolchildren compared to Ann Arbor schoolchildren (18.0% vs 7.9%; $P < 0.001$).

Self-reported physical and sedentary activities also differed between the two communities. When asked about the amount of exercise per day over the past week, Ann Arbor and Ypsilanti schoolchildren reported similar amounts of exercise. However, the participation in physical education classes and team sports differed. The percent of schoolchildren who reported 20 minutes or more of exercise for five or more days in the past week was 53.3% for the Ann Arbor group and 48.1% for the Ypsilanti group ($P = 0.17$). A similar pattern was observed when schoolchildren were asked about exercise duration of 30 minutes or more for five or more days in the past week (36.4% for Ann Arbor and 34.6% for Ypsilanti; $P = 0.18$). In terms of school-based physical activities, the Ypsilanti schoolchildren appeared to have less opportunity for physical activity. Ann Arbor schoolchildren were more likely to report participation in one or more physical education classes compared to the Ypsilanti schoolchildren (89.7% vs 58.6%; $P < 0.001$). Ann Arbor schoolchildren were also more likely to participate in a school-based team sports compared to Ypsilanti schoolchildren (62.8% vs 34.6%; $P < 0.001$). In contrast, participation in team sports outside of school were similar between the two groups (65.2% vs 58.6%; $P = 0.16$). For activities other than sports, more Ann Arbor schoolchildren reported organized physical activities or lessons including martial arts, dance, or gymnastics than did the Ypsilanti schoolchildren (48.1% vs 33.8%; $P < 0.001$).

In general, Ypsilanti schoolchildren were more likely to report sedentary behaviors. The percentage of Ypsilanti schoolchildren reporting two or more hours of television watching in the prior 24 hours was 72.9% compared to 41.7% for Ann Arbor schoolchildren ($P < 0.001$). A similar trend was observed for computer time and videogame playing with almost double the number of Ypsilanti schoolchildren spending two or more of the past 24 hours on a computer compared to the Ann Arbor schoolchildren (40.6% vs 22.0%; $P < 0.001$) and more than double the number of Ypsilanti schoolchildren reported playing videogames two or more hours in the past 24 hours compared to the Ann Arbor schoolchildren (39.1% vs 15.0%; $P < 0.001$).

Discussion

In this study comparing two neighboring communities, we observed that middle-school students were more likely to be overweight or obese if residing in a community with fewer resources. A survey of lifestyle factors including questions on diet, physical activity, and sedentary behaviors demonstrated that children in a community with fewer resources were more likely to consume fried meats, French fries, or chips, and were less likely to consume vegetables and milk. Differences in physical activity and sedentary behaviors were also observed between the two groups.

Dietary factors

For families with limited means, energy-dense foods provide a low-cost option compared to the higher cost of healthy foods.[7] Several studies have demonstrated a positive association with socioeconomic factors and energy-dense foods,[6,13] including among children and adolescents in the US.[14] Energy-dense foods which are high in fats or sugars have been associated with obesity and cardiovascular risk factors.[15] Such foods may reduce satiety although they result in increased caloric intake.[16,17] Our data suggests Ypsilanti schoolchildren consume more energy-dense foods compared to the Ann Arbor children. Beyond cost, access to healthy foods may be limited in resource poor communities which tend to have fewer food markets and more fast food restaurants. In the two communities examined in this study, Ypsilanti currently has four grocery stores while Ann Arbor has 31.

Table 3 Self-reported physical activity or sedentary activities by community

Activity characteristics (%)	Ann Arbor, MI N (%)	Ypsilanti, MI N (%)	*P* value
In the past seven days			
Exercise time ≥20 min/day for ≥5 days	292 (53.3)	64 (48.1)	0.17
Exercise time ≥30 min/day for ≥5 days	200 (36.4)	46 (34.6)	0.18
Number of PE Classes (one or more per week)	499 (89.7)	78 (58.6)	<0.001
School sport teams (one or more teams)	346 (62.8)	46 (34.6)	<0.001
Organized sports teams (outside of school, one or more teams)	362 (65.2)	78 (58.6)	0.16
Organized physical activities other than sport teams*	279 (42.1%)	45 (33.8%)	<0.002
In the past 24 hours			
TV watching (two or more hours)	230 (41.7)	97 (72.9)	<0.001
Computer time (two or more hours	122 (22.0)	54 (40.6)	<0.001
Playing videogames (two or more hours)	83 (15.0)	52 (39.1)	<0.001

Notes: *Organized physical activities or lessons such as martial arts, dance, gymnastics, or tennis.
Abbreviations: MI, Michigan; PE, physical education.

Consumption of soft drinks and other sugar containing drinks such as sports drinks was greater in the Ypsilanti schoolchildren compared to the Ann Arbor schoolchildren. This is particularly concerning given the link between sugar-containing drinks and obesity.[18,19] In a study of 548 children (mean age 12 years), sugar-sweetened drink consumption was independently associated with both BMI and frequency of obesity after adjusting for other dietary and lifestyle factors.[19]

Physical activity factors

Regular physical activity is associated with prevention of obesity in children and adolescents and is inversely correlated with total body fat and BMI.[15,20] Current recommendations from the American Academy of Pediatrics suggest children and adolescents be physically active for at least 60 minutes each day.[21] However, declines in physical activity have been observed over the past several decades among children in the United States.[4] An estimated 62% of children aged between nine and 13 years do not participate in organized physical activity outside of school hours,[22] and inactivity is associated with lower economic status.[21] We observed that children in Ypsilanti reported less physical education classes, school-based sports, and nonsport team activities compared to the Ann Arbor children, while nonschool based participation in sports were similar between the two communities. School-based programs such as PHS may increase physical activity. In a systematic review of school-based interventions to increase physical activity, of the 14 interventions reviewed, most observed improvements in physical activity and a reduction in obesity among students in some interventions.[23,24] Understanding the differences in participation rates including possible gender differences, types of sports offered, and costs may inform on ways to increase participation in these sports teams as well as improve school-based physical activities.

Sedentary behaviors

Compared to Ann Arbor middle-school students, more Ypsilanti middle-school students reported watching television two or more hours per day. A similar pattern was observed for computer time and videogames, with over twice the number of Ypsilanti schoolchildren reporting having played two or more hours of videogames in the prior 24 hours compared to the Ann Arbor middle-school students. Prior studies have demonstrated an association between sedentary behaviors and reductions in physical activity.[1,8,25] In one study of 87 boys and girls (mean age 11.5 years), television viewing was associated with lower levels of physical activity.[8] This study observed an association between socioeconomic status and television watching for longer than two hours per day.

Other studies have observed a link between television watching and increased caloric intake or childhood obesity.[9,10] In one study, each hourly increase in television time was associated with a 167 kcal per day increase intake among children (average age 11.7 years).[10] Increased consumption of foods commonly seen in advertisements was positively related to television viewing time. An estimated 60% of commercials for children's programming are for food products.[26] Current recommendations from the American Academy of Pediatrics recommend limiting television and other media, such as videogames or computer time, to less than two hours per day.[27] However the average viewing time for American children is approximately three hours for television alone, and an average of 6.5 hours if all media (television, computers, and videogames) are combined.[27]

Study limitations

PHS is a community school-based educational intervention implemented in middle-schools from two communities. Real-life studies such as the one presented in this paper offer the

advantage that they provide data on a heterogeneous population that includes groups who are often under-represented in randomized trials. Nevertheless, as a nonrandomized observational study, these data are subject to inherent limitations and potential biases. Limitations of self-reported information on dietary and physical and sedentary behaviors are subject to measurement error and recall biases including seasonal biases in data collection which may of influences responses related to diet and/or physical activity. In addition, because participation was not 100%, there exists the possibility of selection bias; however, within each community, approximately 50% of all eligible 12-year-old children involved in the PHS program consented to participate. Thus, these results provide a foundation for collection of long-term follow-up data and development for intervention mechanisms that suit the unique needs of every community.

Conclusion

Environmental factors, particularly school-related factors, play a significant role in diet and physical activity habits of middle-school students. Efforts to improve diet and physical activity through school programs such as PHS are likely to result in significant improvements in children's knowledge for a healthy lifestyle. A prior PHS study involving Ann Arbor schoolchildren demonstrated improvements in blood pressure and cholesterol.[11]

School-related sports activities and other activities such as community farming, cooking skills, and dietary information is likely to impact on children and their families to improve overall health. Given the number of children who are overweight and the relationship of childhood overweight to adult obesity, it stands to reason that one central way to prevent obesity-related diseases, such as diabetes and cardiovascular disease, is to promote and facilitate healthy lifestyles among our schoolchildren through school-based programs such as the PHS.

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