Prevalence of Overweight among Baltimore City Schoolchildren and its Associations with Nutrition and Physical Activity

Megan L. Jehn,† Joel Gittelsohn,‡ Margarita S. Treuth,‡ and Benjamin Caballero‡*

Abstract

JEHN, MEGAN L., JOEL GITTELSOHN, MARGARITA S. TREUTH, AND BENJAMIN CABALLERO. Prevalence of overweight among Baltimore City schoolchildren and its associations with nutrition and physical activity. *Obesity.* 2006;14:989–993.

Objective: To determine the prevalence of overweight and at-risk-for-overweight in schoolchildren from Baltimore City.

Research Methods and Procedures: Ten schools within city limits were randomly selected from each tertile of income, using eligibility for free school lunch as a proxy. A total of 209 third grade students from eight public schools in Baltimore City were surveyed in May 2000. Anthropometric data including height, weight, subscapular and triceps skinfold thickness, and percentage body weight from bioelectrical impedance were collected. Nutrition-related knowledge, attitudes, and behaviors were assessed using a validated questionnaire. Physical activity was assessed by questionnaire.

Results: Based on International Obesity Taskforce reference values for BMI-for-age, 20.7% of girls and 17.2% of boys were overweight (BMI > 95th percentile) and 15.3% of girls and 14.1% of boys were at-risk-for-overweight (BMI between the 85th and 95th percentiles). The prevalence of overweight and at-risk-for-overweight did not vary by self-reported physical activity levels or by nutrition-related knowledge and behaviors.

Discussion: The high prevalence of overweight and at-risk-for-overweight in this sample of inner-city children from Baltimore City highlights a need for targeted preventive and treatment interventions.

Key words: overweight, children, urban, diet, physical activity

Introduction

The prevalence of overweight in United States children is reaching epidemic proportions. The most recent national estimates suggest that the prevalence of at-risk-for-overweight continues to remain alarmingly high, with no signs of decreasing (1). Currently, 31.0% of children 6 to 11 years of age are estimated to be at-risk-for-overweight or obesity, and 16.0% are estimated to be overweight (1). In addition to the psychological and economic implications of overweight, many studies have shown that overweight children have adverse cardiovascular risk profiles such as dyslipidemia, hypertension, and abnormal glucose tolerance (2). From a public health perspective, childhood obesity is also particularly concerning because it has been documented that obesity in childhood tracks into adulthood (2,3).

The current obesity epidemic may be even more pronounced in minority children and children with low socioeconomic status (4), possibly as a result of poor food choices and decreased opportunities for physical activity. However, there are few reports of the prevalence of overweight in inner-city children incorporating combined detailed measures of adiposity, nutrition, and physical activity.

The Nutrition and Physical Activity of Baltimore City School Children Study (NAPS)[1] was a cross-sectional survey of children in Baltimore City, MD. Data on anthropo-

Received for review May 9, 2005.
Accepted in final form March 28, 2006..
The costs of publication of this article were defrayed, in part, by the payment of page charges. This article must, therefore, be hereby marked "advertisement" in accordance with 18 U.S.C. Section 1734 solely to indicate this fact.
*Department of Epidemiology, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland; †Department of Health Management and Policy, Arizona State University, Tempe, Arizona; and ‡Center for Human Nutrition, Johns Hopkins Bloomberg School of Public Health, Baltimore, Maryland.
Address correspondence to Joel Gittelsohn, Room 2041A, Center for Human Nutrition, Department of International Health, 615 N. Wolfe Street, Baltimore, MD 21205.
E-mail: jgittels@jhsph.edu

[1] Nonstandard abbreviations: NAPS, Nutrition and Physical Activity of Baltimore City School Children Study.

metric measurements, body composition, physical activity, diet- and obesity-related knowledge, attitudes, and behaviors were collected. The main objective of the NAPS was to describe the distribution of anthropometric and body composition values and associated health behaviors in a sample of third grade inner-city children.

Research Methods and Procedures

Study Population

The NAPS was designed to sample third grade students across a range of socioeconomic areas in Baltimore City. Baltimore is a large metropolitan city (~650,000 individuals), largely African-American (64%), and has a relatively low socioeconomic status compared with other U.S. cities (22.9% of the population living below the poverty line) (5). For each elementary school in Baltimore City, a poverty index was created based on the proportion of children on free or reduced lunch programs at that school (range, 56.8% to 94.8%), and 10 schools were randomly selected within each tertile of the poverty index using a random number generator available in the Stata software package (StataCorp LP, College Station, TX). Each of these schools was contacted and invited to participate in the survey. All third grade students at each school with documented parental consent were eligible to participate in the survey.

Data Collection

Baseline data were collected from February to May 2000. Anthropometric measurements, including weight, height, mid upper arm circumference, and triceps and subscapular skinfold thickness, were collected by trained staff using a standardized protocol (6). All children were measured at school in light clothing with shoes and jewelry removed. All anthropometric measurements were measured in triplicate by the same observer, and the average was used for all analyses. Skinfolds were measured on the right side of the body using Lange skinfold calipers (Cambridge, MD) to the nearest 0.1 mm. Triceps were measured over the triceps muscle at the midpoint between the acromion and the olecranon process; subscapular thickness was measured ~20 mm below the tip of the scapula using standard protocols (6). Midarm circumference was measured to the nearest 0.5 mm at the midpoint of the upper arm with the arm hanging freely. The Shorr Board vertical stadiometer (Shorr Production, Olney, MD) was used to measure standing height to the nearest 0.1 cm. A TANITA scale (model TBF 300 GS) was used to record weight and to estimate percentage body fat using bioelectric impedance. The built-in software uses the measured impedance, the subject's sex, age and height, and the measured weight to calculate body composition estimates based on previously derived equations obtained from regression analyses with DXA as the reference method (Tanita Corp., Tokyo, Japan). All anthropometric measurements (height, triceps, and subscapular thickness) were highly reproducible, with interclass correlation coefficients >0.98.

To collect information regarding children's knowledge, attitudes, and behaviors related to diet and physical activity behaviors, a questionnaire (7) developed during the feasibility phase of the Pathways study (a randomized clinical trial designed to evaluate a comprehensive primary prevention program for childhood obesity) (8) was used.

Physical activity was assessed by a physical activity questionnaire. The questionnaire was designed to assess activity during the previous 24 hours and was divided into three time periods: before school, during school, and after school. Using a standardized checklist of potential activities, children were asked about the type of activities they participated in during each time period. Questionnaires were distributed to children in their classrooms. Trained staff read aloud each question and the corresponding answer choices. Children followed along and marked their answers on the questionnaire. An overall weighted activity score was derived by weighting the estimated energy cost by the duration. This study was approved by the Johns Hopkins Bloomberg School of Public Health Institutional Review Board.

The prevalence of overweight/at-risk-for-overweight was estimated for the overall sample and by sex subgroups using BMI-for-age reference values and triceps skinfolds. Overweight classifications based on BMI were made using The International Obesity Task Force criteria for children (9). At-risk-for-overweight was defined as ≥85th percentile and <95th percentile for BMI-for-age (10). Overweight was defined as ≥95th percentile for BMI-for-age. Reference values for triceps skinfolds, derived by Must et al., were used to classify children as normal, at-risk-for-overweight, or overweight (11). At-risk-for-overweight was defined as between the 85th and 95th percentiles, and overweight was defined as ≥95th percentile of race- and sex-specific reference values for triceps skinfolds.

Data Analysis

Comparisons in overweight prevalence by sex were performed using the χ^2 test. Comparisons of continuous variables between groups defined by sex and/or overweight category were made using Student's *t* test. For continuous variables with a normal distribution, means and standard deviations are presented. Data on "other and missing" ethnic groups are included in the overall prevalence estimates but not presented when comparing African-American and non-Hispanic white children. All analyses were performed using Stata statistical software version 8.0 (Stata).

Results

Of the 30 schools selected, 8 schools agreed to participate in the survey (response rate of 27%), with 2 to 3 schools from each tertile. Parental consent was obtained for 217 (102 boys and 115 girls) of 243 third grade students enrolled at the time of the study (89.3% response rate). Of the 217 students examined, we excluded 2 children who were <8 years of age and 6 students who had incomplete anthropometry data. The final analytic sample was 209 children (99 boys and 110 girls); 72% of the children were African-American, and the mean age of the students was 9.0 years (range, 8.4 to 10.8 years). Girls had significantly higher BMI (19.4 vs. 18.1 kg/m^2; $p < 0.05$), percent body fat (21.3% vs. 16.8%, $p < 0.05$), and triceps skinfold thickness values (15.3 vs. 10.6 mm; $p < 0.05$) than boys.

Overall, the prevalence of at-risk-for-overweight (BMI > 85th percentile and <95th percentile) was 14.8%, and the prevalence of overweight (BMI > 95th percentile) was 19.1%. Comparisons between African-American children and non-Hispanic white children suggested that the prevalence of overweight was higher among African-American children (18.5%) vs. non-Hispanic white children (15.2%), whereas the prevalence of at-risk-for-overweight was higher among non-Hispanic white children (18.2%) than African-American children (15.5%). However, because of the small number of non-Hispanic white children included in this study ($N = 34$), comparisons between racial/ethnic groups could not be estimated with a high degree of statistical reliability.

When sex-specific triceps skinfold thickness cut-off points were used to categorize obesity, the prevalence of at-risk-for-overweight was 16.6% and the prevalence of overweight was 11.8% (Table 1). More specifically, 12.8% of boys and 18% of girls were classified as overweight (triceps skinfold thicknesses > 95th percentile), and an additional 12.9% of boys and 11.8% of girls were classified as at-risk-for-overweight (triceps skinfold thicknesses between the 85th and 95th percentiles). Although triceps skinfold measurements were significantly higher than standard reference values for both boys and girls, the prevalence of overweight was most pronounced in girls. When comparing the prevalence of overweight and at-risk-for-overweight based on BMI with the prevalence based on triceps skinfolds, a greater number of boys and girls were classified as both overweight and at-risk-for-overweight when using BMI.

In Table 2, we present the prevalence of overweight for boys and girls by selected nutritional and physical activity behaviors including breakfast skipping, consumption of breakfast and lunch in school programs, health knowledge score, and physical activity assessed by self-report. We did not identify any significant correlates of overweight for either boys or girls in this sample.

Table 1. Prevalence of at-risk-for-overweight and overweight by sex in Baltimore City schoolchildren

	N	At-risk-for-overweight [% (standard error)]	Overweight [% (standard error)]
BMI*			
Both sexes	209	14.8 (2.2)	19.1 (2.3)
Boys	99	14.1 (2.1)	17.2 (4.1)
Girls	110	15.3 (3.5)	20.7 (2.6)
Triceps skinfolds†			
Both sexes	209	11.8 (2.9)	16.6 (2.1)
Boys	99	12.9 (4.6)	12.8 (3.3)
Girls	110	10.8 (3.5)	18.0 (1.9)

* BMI values were compared with age- and sex-specific International Obesity Taskforce cut-off points (9). At-risk-for-overweight was defined as BMI for age ≥85th percentile and <95th percentile, and overweight was defined as BMI for age ≥95th percentile.
† Triceps skinfold measurements were compared with reference values by Must et al. (11).

Discussion

Our findings indicate a high prevalence of overweight and at-risk-for-overweight in this population of inner-city Baltimore City schoolchildren. Overall, 33.9% of children in this sample were overweight or at-risk-for-overweight based on age-specific BMI reference values. Differences were noted in the prevalence of at-risk-for-overweight and overweight for boys and girls, with a higher prevalence of overweight in girls. Other indices of adiposity including triceps and subscapular skinfolds and percentage body fat from impedance provided similar results.

Defining overweight in children is difficult, and there is currently no expert consensus for quantifying measures of body fat to determine obesity. In many studies, BMI is the single measure used to estimate the prevalence of overweight in children. Although BMI-for-age is a simple measure, height and weight do not grow linearly throughout childhood, and a given BMI may predict a different body composition at different ages (12). However, a recent report suggested that BMI cut-offs based on both age and pubertal stage were not superior to BMI cut-offs based solely on age for correctly identifying high adiposity based on using DXA (13). An advantage of this study was the use of triceps skinfolds and percentage body fat, in addition to overweight, to estimate overweight prevalence. We found high correlations between BMI and triceps skinfolds ($r = 0.89$) and BMI and percentage body fat from bioelectrical impedance analysis ($r = 0.92$).

Our finding of higher rates of overweight for girls in Baltimore City schools compared with the national average

Table 2. Nutrition- and physical activity-related characteristics of boys and girls above vs. below the 85th percentile for BMI*

	Boys			Girls		
	BMI < 85th percentile ($N = 68$)	BMI ≥ 85th percentile ($N = 31$)	*p*†	BMI < 85th percentile ($N = 71$)	BMI ≥ 85th percentile ($N = 40$)	*p*†
Breakfast skipping (%)	7 (10.2)	2 (6.5)	0.69	10 (14.1)	7 (17.5)	0.63
Eat school breakfast (%)	50 (73.5)	19 (61.2)	0.52	53 (74.6)	36 (90.0)	0.17
Eat school lunch (%)	61 (89.7)	27 (87.1)	0.39	65 (91.5)	37 (92.5)	0.41
Health Knowledge Score (%)‡						
1 to 9	35 (36.7)	11 (38.7)	0.99	26 (36.6)	15 (37.5)	0.98
10 to 14	43 (63.2)	20 (64.3)	0.99	45 (63.3)	25 (62.5)	0.91
PAQ score, mean (standard deviation)§						
Before school	35.8 (21.2)	37.9 (23.6)	0.66	37.3 (21.2)	39.8 (23.7)	0.67
During school	37.9 (17.5)	38.8 (19.3)	0.82	40.8 (18.3)	42.6 (17.8)	0.63
After school	57.6 (22.1)	55.5 (19.9)	0.66	60.0 (22.3)	65.6 (18.4)	0.19

* Values are expressed as number (percentage) unless otherwise indicated.

† *p* Values reflect sex-specific comparisons for each variable for those above and below 85th percentile for BMI. *p* Values were calculated by two-sided χ^2 test for categorical variables and Student's *t* test for continuous variables.

‡ Health Knowledge Score ranges from 0 to 14. A higher score reflects better health-related knowledge.

§ Physical Activity Questionnaire provides a weighted activity score derived from the estimated energy cost of each reported activity (estimated energy cost) by the duration. The range of scores is 0 to 100, and a higher value reflects greater self-reported physical activity levels.

is consistent with other studies of urban populations. Recently, the results from a large cohort study reported that children with lower socioeconomic status showed the largest increases in BMI, standardized BMI, sum of skinfold thickness, waist circumference, and triceps skinfold thickness over an 8-year follow-up period (14). Similarly, a longitudinal study of urban children from Canada recently reported secular trends of increasing overweight in a multiethnic, low-income inner city population (15). Various studies have also reported a higher prevalence of obesity (16) and decreased levels of physical fitness (17) in urban children.

There has been very little research done in children, especially in minority children, in the area of nutrition-related risk factors for obesity. We examined the role of several potential nutrition-related risk factors, including consumption of breakfast and lunch in school programs, breakfast skipping, and children's nutrition-related knowledge, attitudes, and behaviors. Interestingly, none of these factors was significantly correlated with overweight.

There are some limitations to these data. This survey was cross-sectional in design and consequently cannot be used to make causal inferences. It is unclear whether the nutritional and/or physical activity patterns described are a cause or consequence of childhood overweight. The limitations of behavioral data collected by self-report are well known, for both children and adults. A strength of this study is that, in addition to self-reported health data, we also have multiple objective measures of adiposity and a measure of physical activity.

Childhood overweight is a serious problem, and addressing this problem will require comprehensive interventions aimed at improving healthful food choices and increasing physical activity levels. Given the small sample size and exploratory nature of our study, we were not able to identify any significant nutrition- or physical activity-related predictors of overweight in this sample. Larger studies may help elucidate the relative contributions of children's health behaviors and their effect on overweight, particularly in urban, inner-city populations. We had limited data on the home environment, an environment that may have a significant impact on the development of childhood overweight. In this sample, the majority of children consumed both breakfast and lunch at school, which may provide an important target for future nutritional interventions to improve healthy food choices in children. Our results highlight the severity of the obesity epidemic in urban inner-city children and suggest a need for appropriate preventive interventions that meet the unique needs of this population.

Acknowledgments

This study would not have been possible without cooperation from the students, parents, teachers, and administrators in the Baltimore City school district. This study was supported by a research award from the U.S. Department of Agriculture.

References

1. **Hedley AA, Ogden, CL, Johnson CL, Carroll MD, Curtin LR, Flegal KM.** Prevalence of overweight and obesity among US children, adolescents, and adults, 1999–2002. *JAMA.* 2004;291:2847–50.
2. **Dietz WH.** Health consequences of obesity in youth: childhood predictors of adult disease. *Pediatrics.* 1998;101:518–25.
3. **Steinberger J, Daniels SR.** Obesity, insulin resistance, diabetes, and cardiovascular risk in children: an American Heart Association scientific statement from the Atherosclerosis, Hypertension, and Obesity in the Young Committee (Council on Cardiovascular Disease in the Young) and the Diabetes Committee (Council on Nutrition, Physical Activity, and Metabolism). *Circulation.* 2003;107:1448–53.
4. **Strauss RS, Knight J.** Influence of the home environment on the development of obesity in children. *Pediatrics.* 1999;103:e85.
5. **U.S. Census Bureau.** *Baltimore City Fact Sheet.* http://factfinder.census.gov/home/saff/main.html (Accessed January 8, 2005).
6. **Lohman T, Roche A, Martorell R.** *Anthropometric Standardization Reference Manual.* Champaign, IL: Human Kinetics Publishers; 1988.
7. **Stevens J, Cornell CE, Story M, et al.** Development of a questionnaire to assess knowledge, attitudes, and behaviors in American Indian children. *Am J Clin Nutr.* 1999;69:773–81.
8. **Davis C, Hunsberger S, Murray D, et al.** Design and statistical analysis for the Pathways study. *Am J Clin Nutr.* 1999;69:760s–3s.
9. **Cole TJ, Bellizzi MC, Flegal KM, et al.** Establishing a standard definition for child overweight and obesity worldwide: international survey. *BMJ.* 2000;320:1240–3.
10. **Himes JH, Dietz WH.** Guidelines for overweight in adolescent preventive services: recommendations from an expert committee. The Expert Committee on Clinical Guidelines for Overweight in Adolescent Preventive Services. *Am J Clin Nutr.* 1994;59:307–16.
11. **Must A, Dallal GE, Dietz WH.** Reference data for obesity: 85th and 95th percentiles of body mass index (wt/ht2) and triceps skinfold thickness. *Am J Clin Nutr.* 1991;53:839–46.
12. **Daniels SR, Khoury PR, Morrison JA.** The utility of body mass index as a measure of body fatness in children and adolescents: differences by race and gender. *Pediatrics.* 1997;99:804–7.
13. **Taylor R, Falomi A, Jones I, Goulding A.** Identifying adolescents with high percentage body fat: a comparison of BMI cutoffs using age and stage of pubertal development compared with BMI cutoffs using age alone. *Eur J Clin Nutr.* 2003;57:764–9.
14. **Moore DB, Howell PB, Treiber FA.** Adiposity changes in youth with a family history of cardiovascular disease: impact of ethnicity, gender and socioeconomic status. *J Assoc Acad Minor Phys.* 2002;13:76–83.
15. **O'Loughlin J, Paradis G, Meshefedjian G, Gray-Donald K.** A five-year trend of increasing obesity among elementary schoolchildren in multiethnic, low-income, inner-city neighborhoods in Montreal, Canada. *Int J Obes Relat Metab Disord.* 2000;24:1176–82.
16. **Melnik TA, Rhoades SJ, Wales KR, Cowell C, Wolfe WS.** Overweight school children in New York City: prevalence estimates and characteristics. *Int J Obes Relat Metab Disord.* 1998;22:7–13.
17. **Chatrath R, Shenoy R, Serratto M, Thoele DG.** Physical fitness of urban American children. *Pediatr Cardiol.* 2002;23:608–12.