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Trends in Body Mass Index among Ohio's Third-Grade Children: 2004–2005 to 2009–2010

Reena Oza-Frank, PhD, RD,

Principal investigator, Research Institute, Nationwide Children's Hospital, Columbus, OH, and research assistant professor, Department of Pediatrics, Ohio State University, Columbus; at the time of the study, she was a CDC/CSTE Applied Epidemiology Fellow, State Epidemiology Office, Ohio Department of Health, Columbus

Erinn M. Hade, PhD,

Biostatistician, Center for Biostatistics, The Ohio State University, Columbus

Angela Norton, MA,

Program chief, School and Adolescent Health Section, Bureau of Community Health Services, Ohio Department of Health, Columbus

Heidi Scarpitti, MS, RD, and

Public health nutritionist, School and Adolescent Health Section, Bureau of Community Health Services, Ohio Department of Health, Columbus

Elizabeth J. Conrey, PhD, RD

State maternal and child health epidemiologist, State Epidemiology Office, Ohio Department of Health, Columbus, as well as with the Division of Reproductive Health, Centers for Disease Control and Prevention, Atlanta, GA

Abstract

Substantial variation across states in the prevalence and trends in childhood overweight and obesity indicate a need for state-specific surveillance to make state comparisons to national estimates and identify high-risk populations. The purpose of this study was to examine body mass index (BMI) trends among third-grade children in Ohio between the 2004–2005 and 2009–2010 school years and examine changes in prevalence of obesity by specific demographic subgroups. Third-grade children (n = 33,672) were directly weighed and measured throughout the school years by trained health care professionals. Trends in overweight/obesity (≥85th percentile of BMI by age/sex), obesity (≥95th percentile), and obesity level 2 (≥97th percentile) over five time periods (2004–2005, 2006–2007, 2007–2008, 2008–2009, 2009–2010) were modeled using logistic regression, accounting for the survey design and adjusting for sex, race/ethnicity, National School Lunch Program (NSLP) participation, and age. Differences in these BMI categories were also examined by these subgroups. BMI estimates did not demonstrate a statistically significant trend over the five time periods for overweight/obesity (34% to 36%), obesity (18% to 20%), or

Address correspondence to: Reena Oza-Frank, PhD, RD, Research Institute at Nationwide Children's Hospital, 700 Children's Dr, Research Building 3, Columbus, OH 43205. reena.oza-frank@nationwidechildrens.org.

STATEMENT OF POTENTIAL CONFLICT OF INTEREST

No potential conflict of interest was reported by the authors.

obesity level 2 (12% to 14%). However, increases in overweight/obesity prevalence were found in Hispanic children (37.8% vs 53.1%; $P<0.01$). Decreases in obesity (16.6% vs 14.1%; $P=0.02$) and obesity level 2 (11.3% vs 9.3%; $P=0.02$) were found among children not participating in NSLP and residing in suburban counties (obesity [17.3% vs 14.7%; $P=0.03$] and obesity level 2 [11.8% vs 9.8%; $P=0.05$]). Finally, decreases in overweight/obesity and obesity level 2 among boys were observed (15% vs 12.9%; $P=0.02$). Despite no significant overall trends in overweight/obesity, obesity, or obesity level 2 between 2004 and 2010, prevalence changed among specific subgroups. Obesity prevention efforts should be widespread and include special emphasis on groups experiencing increases or no change in prevalence.

Keywords

Body mass index; Children's health; Obesity; Overweight; Ohio

Childhood obesity remains a substantial national public health issue, with 36% of children aged 6 to 11 years classified as overweight or obese based on recent data from the 1999–2010 National Health and Nutrition Examination Survey (NHANES).[1] Such national data is based on surveillance of the measurement of body mass index (BMI). Public health surveillance is the continuous, systematic collection, analysis, and interpretation of health-related data needed for the planning, implementation, and evaluation of public health practice.[2] BMI surveillance has been identified as a highly useful tool to collect data on a large number of people at relatively low cost.[3] Applications of BMI surveillance to planning, implementation, and evaluation include monitoring and clarification of the epidemiology of obesity to allow priorities to be set and to inform public health policy and strategies, such as identifying groups at highest risk; documenting the impact of an intervention; or tracking progress toward specified goals.

Although national data on childhood obesity is helpful in setting national priorities, comparable geographic and regional analyses from national surveys like NHANES are limited due to small sample sizes,[4] making state-level priorities difficult to set based on these rough estimates. The National Survey for Children's Health (NSCH) includes a large enough sample size for state-specific estimates and has shown substantial variation across states in the prevalence and disparities in overweight and obesity among 10- to 17-year-old children.[5] NSCH, however, is based on parent-reported data, as opposed to measured data as can be found in NHANES. Parent-reported data are not recommended for estimating overweight prevalence in elementary school–aged children[6] because parents tend to overestimate height and underestimate weight.[7] Accordingly, state health agencies have become increasingly interested in BMI surveillance of childhood obesity[8] to make state comparisons to national estimates, identify high-risk populations, and possibly most importantly, track population changes based on state-based policies and programs. States have also recognized that measuring BMI is a necessity to make comparisons to national, measured estimates of BMI like those in NHANES.

Height and weight measurements were collected among school-aged children in the 2004–2005 school year for the first time, as part of the Ohio Department of Health's (ODH) Oral

Health Survey.[9,10] This is an ongoing, state-based public health surveillance system in place since 1989. The Oral Health Program at ODH targeted third-graders because this age is a specific target age for national dental health surveillance.[11] Although ODH was already collecting measured obesity data on children from birth through age 4 (through CDC's Pediatric Nutrition Surveillance System[12]) and self-reported obesity data on adolescents in grades 9 to 12 (through CDC's Youth Risk Behavior Surveillance System[13]), the school-aged population was missing. Because obesity is responsible for at least 10% of medical costs in Ohio,[14] ODH decided to target funds for BMI surveillance of third-graders to capture the school-aged population in an effort to use the data to inform current programming efforts already established in various state-funded programs. The purpose of this study was to examine trends in the prevalence of measured high BMI among third-grade children in Ohio over five time periods (2004–2005, 2006–2007, 2007–2008, 2008–2009, and 2009–2010 school years) and to examine changes in prevalence of high BMI at two timepoints (2004–2005 and 2009–2010) by specific demographic subgroups.

METHODS

A stratified, cluster-sample survey design was used and designed to provide yearly representative, state-level data (2004–2005, 2006–2007, 2007–2008, 2008–2009, and 2009–2010) and every 5 years representative, state- and county-level data (2004–2005 and 2009–2010). To obtain reliable estimates at the county-level in 2004–2005 and 2009–2010, the number of schools sampled in these years was much larger. The sampling frame included all public schools in the state of Ohio that were not community schools (community schools are independently operated, publicly funded, tuition-free public schools that are created on the basis of a contract or "charter"). To obtain a representative sample of students in Ohio, the percentage of students participating in the National School Lunch Program (NSLP)[15] and the percentage of African-American students at each Ohio elementary school was obtained from the Ohio Department of Education and these data were used to stratify eligible schools. Schools were sampled without replacement to the sampling frame within each stratum by probability proportional to size sampling. In the event that schools were not able or declined to be involved in the survey, replacement schools were chosen. All third-graders at the selected schools were eligible to participate if parents gave permission.

Volunteer health care professionals were trained using a protocol for weighing and measuring children based on guidelines developed by the Ohio Department of Health (ODH).[16] Details on training the volunteers have been previously published.[9] Briefly, the registered dietitian from ODH's School and Adolescent Health Section staff conducted in-person regional trainings for more than 300 volunteers prior to the first BMI surveillance year (2004–2005). A training video was also developed for the subsequent survey years and sent as a web link to previously trained volunteers who used it as a refresher course. Students were weighed twice to the nearest 0.2 pound using Tanita electronic scales, model BWB-800 (Tanita Corporation of America, Inc). Standing heights were measured to the nearest 0.25 inch using SECA portable stadiometers, model 214 (Hamburg, Germany). All sets of equipment were newly purchased and tested by ODH staff before the first survey in 2004–2005, with calibration of the stadiometers annually and a re-certification of scales prior to the 2009–2010 survey. Measures were taken at schools throughout Ohio during each

school year (August to June), depending on school schedules and preferences as well as availability of the volunteer health care professional. Quality control measures were used to ensure that accurate height and weight measurements were taken; inter-rater reliability of Ohio's BMI surveillance data has previously been published.[17]

Statistical Methods

Children's height and weight were used to calculate percentiles for BMI-for-age and -sex according to the 2000 Centers for Disease Control and Prevention (CDC) growth charts, and using the standard formula included in the CDC-provided program.[18] Children's age in months was calculated from the date of measurement and the reported date of birth. Overweight/obesity was defined as BMI–for-age ≥85th percentile of the 2000 sex-specific CDC growth charts; obesity was defined as ≥95th percentile; obesity level 2 was defined as ≥97th percentile.[19,20] BMI definitions were chosen to be comparable to national estimates.[1] Outliers of the BMI-for-age percentile were flagged by the CDC–provided program. These flagged heights and weights corresponding to the outliers were verified using the original data forms. If the values in the dataset were the same as on the data form, then the data were considered valid; otherwise, the value was corrected based on documentation on the original data form.

Both unadjusted and adjusted prevalence were estimated accounting for the sample survey design by incorporating sample statistical weights, stratification, and clustering of students within schools. Statistical weights were calculated to account for differential nonresponse, to adjust for sampling by strata, and to be representative of the Ohio third-grade population. Trends in high BMI-for-age over five time periods (2004–2005, 2006–2007, 2007–2008, 2008–2009, and 2009–2010) were modeled using logistic regression, accounting for the survey design and including survey year as an ordinal variable in the models for each outcome. As previously mentioned, the survey was designed to generate state-level data in 2004–2005, 2006–2007, 2007–2008, 2008–2009, and 2009–2010, and state- and county-level data in 2004–2005 and 2009–2010. Among the survey years used for state-level estimation only, the survey design did not include provision of stratum-specific estimates. Therefore, differences by sex, race/ethnic groups, NSLP participation, and county type could be assessed only between survey years 2004–2005 and 2009–2010. Detailed data on Hispanic subgroups (ie, Mexican American, Puerto Rican, etc) were not collected in this survey because Hispanics comprise only approximately 3% of the total Ohio population.[21] In addition, comparisons were made by one of four county types Ohio uses to classify the population based on geography and population composition. These include: Appalachian: 32 of Ohio's 88 counties are considered to be Appalachian as designated by the Appalachian Regional Commission[22]; metropolitan: a non-Appalachian county that contains at least one city with 50,000 or more inhabitants; suburban: a non-metropolitan, non-Appalachian county that meets the US Census definition of an urbanized area); and rural/non-Appalachia: all other counties not classified as Appalachian, metropolitan, or suburban.

Adjusted prevalence estimates were calculated via the method of predictive margins.[23] Estimates were adjusted for age, sex, race/ethnicity, and NSLP participation because BMI estimates in children have been shown to vary by these characteristics.[1,24] These estimates

allow for comparisons of subgroups of children as if they had the same attributes on average except for the characteristic that is being compared. All reported *P* values are two-sided and *P* values ≤0.05 were considered statistically significant. Statistical analyses were done using STATA version 11.0 (StataCorp, 2009). This study was considered to be public health practice by the ODH Human Subjects Review Committee and deemed exempt from Institutional Review Board approval.

RESULTS

The number of participating schools and students can be found in Table 1. Student response rates ranged from 50% to 61% over the five time periods. Demographic characteristics were consistent across survey years: approximately half of students were girls, 74% were non-Hispanic white, and 53% resided in metropolitan counties. NSLP participation varied from 41% in 2004–2005 to 47% in 2009–2010.

Unadjusted and adjusted BMI estimates were similar. Adjusted BMI estimates did not demonstrate a statistically significant trend over the five time periods for overweight/obesity, obesity, or obesity level 2 (overweight/obesity *P*-for-trend = 0.5; obesity *P*-for-trend = 0.7; obesity level 2 *P*-for-trend = 0.6) (Table 2). Overall prevalence of overweight/obesity remained 34% to 36%; obesity, 18% to 20%; and obesity level 2, 12% to 14% (Table 2). However, between 2004–2005 and 2006–2007 there was a 2.4% (95% CI: −4.5% to −0.3%) decrease in the prevalence of obesity level 2. This decrease was mirrored in the trends for overweight/obesity and obesity prevalence, but was not as strong (Table 2). Further, a slight decrease was observed in obesity level 2 prevalence between 2004–2005 and 2009–2010 (2004–2005: 13.9% vs 2009–2010: 12.4%; *P*=0.07) (Table 3).

Among some demographic subgroups, statistically significant changes in each BMI outcome were observed between years. Between 2004–2005 and 2009–2010, decreases in obesity level 2 among boys were observed (15% vs 12.9%, respectively; *P*=0.02) (Table 3). Increases in overweight/obesity prevalence were found in Hispanic children (37.8% vs 53.1%; *P*=0.01) (Table 3). For the same two time periods, decreases in obesity (16.6% vs 14.1%; *P*=0.02) and obesity level 2 (11.3% vs 9.3%; *P*=0.02) were found among children not participating in NSLP. Similar decreases in obesity (17.3% vs 14.7%; *P*=0.03) and obesity level 2 (11.8% vs 9.8%; *P*=0.05) were observed for the same time periods among children residing in suburban counties. No statistically significant changes in any BMI outcome were observed among any other demographic groups between these two time periods.

DISCUSSION

These Ohio data mirror national trends in the lack of significant changes in high BMI among children in the past decade. Specifically, national data from NHANES indicate a stabilization of the prevalence of high BMI among children between 1999–2000 and 2007–2008.[1]

A contributing factor to the overall stabilization in BMI trends may be attributable to increased awareness at the local level. These results were widely distributed and requested

by many of Ohio's local health departments and school districts. County-level BMI data provided in 2004–2005 and 2009–2010 may have reinforced the need for local intervention efforts, both in the schools and local health agencies. In addition, effective June 2010, a bill was passed[25] to require changes to food and beverages provided in Ohio's schools, implementation of physical activity pilot programs, and BMI screenings with provision of resources for parents. Ohio has grant funds (outside of the Affordable Care Act) targeted to improve student health and wellness. For example, Ohio has a CDC Coordinated School Health Grant that has dedicated funding to 13 Ohio School Districts (a pilot program) to assist schools in implementing improvements related to physical activity, school nutrition, and school wellness policies. In addition, there are other grants to assist schools in implementing nutrition education curriculums in Ohio's schools. These new activities may aid in decreasing high BMI among children over the next few years.

Observed increases in overweight prevalence among Hispanic children in Ohio may be because these children are not exposed to local and/or statewide programs. The need to target Hispanic children for obesity prevention is not unique to Ohio. BMI surveillance of children in kindergarten through eighth grade in New York City indicated decreases in obesity prevalence from 2006–2007 and 2010–2011; however, obesity prevalence remained higher among Hispanic and black children and those living in poor neighborhoods.[26] National data indicate that compared with other subgroups, Hispanic boys and girls experienced higher increases in BMI between kindergarten and eighth grade.[27]

This study is subject to some limitations. The use of BMI may not represent adiposity; however, it is not clear whether adiposity is a stronger predictor of obesity-related health outcomes compared with BMI,[28] and current BMI cutoffs in children can identify a high prevalence of high adiposity in children with high BMI-for-age.[29] Another limitation is that for a population-based sample, a participation rate of 60% or more is considered acceptable,[13] and the low participation rates ranging from 50% to 61% in this survey may have biased estimates. However, these participation rates are similar to other states collecting BMI data through Oral Health Surveys and utilizing active consent,[30] and the low participation rate in this study is largely due to low form return rather than to nonconsent.[31] This study is limited in its generalizability to children other than third-graders; however, children in third grade have been shown to be representative of elementary school–aged children in terms of estimating school-level prevalence of childhood obesity.[32] Finally, because not all children eligible for NSLP participate in the program,[33] all children who might be considered low-income based on NSLP participation may not have been included in this category because of the limitation of parent-reported information on participating, not eligibility. Therefore, the number of children in Ohio that would qualify for this low-income program may be underestimated in this study.

CONCLUSIONS

The results of this study indicate differences in overweight/obesity across subpopulations and highlight the need for future state funding for obesity prevention in Ohio targeted to Hispanic youth, youth who participate in NSLP, and youth who do not live in suburban areas. Such state data provides insights about why previously observed national trends in

BMI-for-age among children and adolescents may be stabilizing. Dietetics practitioners working in clinical and community or public health nutrition practice areas can play important roles in these efforts by providing accurate BMI measurements of school-aged children as well as providing expertise to the planning, implementation, and evaluation of policy, systems, and environmental changes and nutrition and physical activity programs targeted to children identified as high risk.

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Table 1

Demographic characteristics among third-graders in Ohio: 2004–2010[a]

	2004–2005	2006–2007	2007–2008	2008–2009	2009–2010
Number of participating schools	387	30	30	30	377
Number of participating students	14,501	1,201	1,251	1,357	15,698
Student response rate (%)	56	56	58	61	50
Age (y) (mean standard error)	9.1±0.02	9.1±0.03	9.2±0.07	9.2±0.04	9.1±0.02
Girls (%)	51.5	53.2	51.9	49.1	50.6
Race/ethnicity (%)					
Non-Hispanic white	74.5	73.9	73.6	73.3	73.9
Non-Hispanic black	13.9	17.4	17.1	15.7	15.3
Non-Hispanic other	7.5	7.6	8.3	9.7	8.3
Hispanic	4.1	1.1	1.0	1.3	2.5
NSLP[b] participation (%)	40.5	43.3	44.0	40.9	46.8
County type, (%)[cd]					
Metropolitan	53.0	—	—	—	53.4
Suburban	18.7	—	—	—	18.7
Rural, Appalachian	15.3	—	—	—	15.3
Rural, non-Appalachian	13.0	—	—	—	12.7

[a] All estimates represent weighted, unadjusted data.

[b] NSLP = National School Lunch Program.

[c] Among the survey years used for state-level estimation only (2006–2007, 2007–2008, 2008–2009), the survey design did not include provision of stratum-specific estimates; therefore, county type data was not estimated for these years.

[d] Terms used to classify each Ohio county into one of four categories: Appalachian: designated by the Appalachian Regional Commission; metropolitan: a non-Appalachian county that contains at least one city with 50,000 or more inhabitants; suburban: a non-metropolitan, non-Appalachian county that meets the US Census definition of an urbanized area); and rural/non-Appalachia: all other counties not classified as Appalachian, metropolitan, or suburban.

Table 2

Trends in overweight and obesity among Ohio third-graders by school year, 2004–2010[a]

Year	Overweight/Obese (≥85th percentile)[b]	Obese (≥95th percentile)[b]	Obese Level 2 (≥97th percentile)[b]
	prevalence (%) (95% CI)		
2004–2005	35.6 (33.9–37.3) (n = 5,120)	18.9 (17.4–20.3) (n = 2,754)	13.4 (12.3–14.6) (n = 1,899)
2006–2007	34.3 (31.3–37.3) (n = 399)	16.6 (14.2–19.4) (n = 202)	11.5 (9.5–13.7) (n = 138)
2007–2008	34.6 (30.3–38.9) (n = 444)	19.7 (16.7–22.7) (n = 248)	13.4 (10.7–16.7) (n = 169)
2008–2009	35.9 (32.5–39.5) (n = 475)	18.5 (15.5–21.5) (n = 246)	13.6 (11.3–16.2) (n = 184)
2009–2010	34.7 (32.9–36.5) (n = 5,466)	18.3 (16.7–20.2) (n = 2,898)	12.5 (11.2–13.8) (n = 1,987)

[a] Total n by year was: 2004–2005, n = 14,501; 2006–2007, n = 1,201; 2007–2008, n = 1,251; 2008–2009, n = 1,357; 2009–2010, n = 15,698.

[b] According the Centers for Disease Control and Prevention body mass index–for-sex and -age calculation.

Table 3

Adjusted prevalence[a] (predictive margins) of overweight and obesity among Ohio third-graders by sex, race/ethnicity, National School Lunch Program participation, and county type, 2004–2005 and 2009–2010

Population subgroup	Overweight/Obese (> 85th percentile)[b]		Obese (>95th percentile)[b]		Obese Level 2 (>97th percentile)[b]	
Survey year	**2004–2005**	**2009–2010**	**2004–2005**	**2009–2010**	**2004–2005**	**2009–2010**
			prevalence (%)(95% CI)			
Total	36.0 (34.4–37.7) (n = 5,120)	34.7 (33.0–36.4) (n = 5,466)	19.3 (17.8–20.8) (n = 2,754)	18.3 (16.6–20.0) (n = 2,898)	13.9 (12.7–15.0) (n = 1,899)	12.4 (11.1–13.6) (n = 1,987)
Sex						
Boys	37.5 (35.8–39.3) (n = 2,622)	35.1 (33.0–37.3) (n = 2,750)	20.2 (18.7–21.7) (n = 1,456)	19.1 (17.4–20.7) (n = 1,503)	15.0 (13.6–16.5) (n = 1,024)	12.9 (11.8–13.9)* (n = 1,043)
Girls	34.5 (32.0–37.0) (n = 2,498)	34.2 (32.0–36.5) (n = 2,716)	18.2 (16.1–20.3) (n = 1,298)	17.5 (15.2–19.7) (n = 1,395)	12.8 (11.0–14.5) (n = 875)	11.9 (10.0–13.7) (n = 944)
Race and ethnicity						
Non-Hispanic white	34.4 (32.9–36.0) (n = 4451)	32.6 (31.3–34.0) (n = 4530)	18.7 (17.4–20.0) (n = 2,369)	17.4 (16.1–18.7) (n = 2,422)	12.9 (11.8–14.0) (n = 1,628)	11.9 (11.0–12.8) (n = 1,661)
Non-Hispanic black	42.6 (36.0–49.2) (n = 252)	40.0 (32.9–47.0) (n = 301)	21.8 (15.8–27.7) (n = 145)	19.5 (10.8–28.3) (n = 152)	17.3 (13.1–21.4) (n = 108)	13.0 (6.3–19.7) (n = 103)
Hispanic	37.8 (30.0–45.7) (n = 160)	53.1 (45.3–60.8)** (n = 386)	21.1 (14.9–27.4) (n = 95)	30.0 (21.2–38.8) (n = 65)	16.8 (11.5–22.1) (n = 66)	19.2 (9.4–28.9) (n = 47)
Non-Hispanic other	37.4 (31.5–43.3) (n = 257)	36.9 (31.5–42.3) (n = 125)	20.1 (14.8–25.4) (n = 145)	19.3 (14.8–23.9) (n = 203)	15.6 (10.3–20.9) (n = 97)	12.7 (9.0–16.3) (n = 139)
NSLP[c] participation						
NSLP participation	40.7 (38.3–43.1) (n = 2,081)	40.7 (38.3–43.1) (n = 2,641)	22.8 (20.5–25.1) (n = 1,196)	23.7 (20.8–26.6) (n = 1,563)	17.2 (15.5–19.0) (n = 853)	16.3 (14.2–18.3) (n = 1,124)
No NSLP participation	32.4 (30.4–34.3) (n = 3,039)	30.0 (27.8–32.2) (n = 2,825)	16.6 (15.0–18.3) (n = 1.558)	14.1 (12.6–15.6)* (n = 1,335)	11.3 (10.0–12.6) (n = 1,046)	9.3 (8.3–10.4)* (n = 863)
County type						
Appalachian	40.0 (37.0–43.0) (n = 1,391)	39.2 (37.4–41.0) (n = 1,537)	22.9 (20.6–25.2) (n = 778)	22.1 (20.5–23.7) (n = 887)	16.6 (14.6–18.6) (n = 554)	15.5 (14.1–17.0) (n = 625)
Rural (non-Appalachian)	36.3 (34.2–38.3) (n = 1,424)	35.2 (33.2–37.1) (n = 1,668)	20.1 (18.5–21.6) (n = 755)	18.8 (17.3–20.3) (n = 890)	13.7 (12.5–14.8) (n = 517)	13.5 (12.1–14.9) (n = 620)
Suburban	32.9 (30.6–35.3) (n = 1,396)	31.0 (29.2–32.7) (n = 1,248)	17.3 (15.6–18.9) (n = 729)	14.7 (13.0–16.4)* (n = 586)	11.8 (10.4–13.1) (n = 487)	9.8 (8.4–11.2)* (n = 384)

Population subgroup	Overweight/Obese (> 85th percentile)[b]		Obese (>95th percentile)[b]		Obese Level 2 (>97th percentile)[b]	
Survey year	**2004–2005**	**2009–2010**	**2004–2005**	**2009–2010**	**2004–2005**	**2009–2010**
Metropolitan	36.0 (33.2–38.9) (n = 909)	34.8 (31.7–37.8) (n = 1,013)	19.0 (16.4–21.5) (n = 492)	18.4 (15.4–21.5) (n = 535)	14.0 (12.0–16.1) (n = 341)	12.2 (10.0–14.4) (n = 358)

[a] Adjusted for age, sex, race/ethnicity, NSLP participation.

[b] According the Centers for Disease Control and Prevention body mass index (BMI)–for-sex and -age calculations: overweight/obese, ≥85th BMI–for-age percentile; obese, ≥95th percentile; obese level 2, ≥97th percentile.

[c] NSLP National School Lunch Program.

[*] Within group 2004–2005 vs 2009–2010, $P<0.05$.

[**] Within group 2004–2005 vs 2009–2010, $P<0.01$.

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