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Non-significant relationship between participation in school-provided meals and body mass index during the fourth-grade school year

Amy E. Paxton, MPH, RD, LD [Research Dietitian],
University of South Carolina Institute for Families in Society 1600 Hampton Street, Suite 507 Columbia, SC 29208

Suzanne Domel Baxter, PhD, RD, LD, FADA [Research Professor],
University of South Carolina Institute for Families in Society 1600 Hampton Street, Suite 507 Columbia, SC 29208 Phone: 803-777-1824 extension 12 sbaxter@mailbox.sc.edu

Joshua M. Tebbs, PhD [Associate Professor],
Department of Statistics University of South Carolina Columbia, SC 29208 Phone: 803-777-5163 tebbs@stat.sc.edu

Julie A. Royer, MSPH [Research Associate],
University of South Carolina Institute for Families in Society 1600 Hampton Street, Suite 507 Columbia, SC 29208 Phone: 803-777-1824 extension 23 ROYERJ@mailbox.sc.edu

Caroline H. Guinn, RD, LD [Research Dietitian],
University of South Carolina Institute for Families in Society 1600 Hampton Street, Suite 507 Columbia, SC 29208 Phone: 803-777-1824 extension 24 CGUINN@mailbox.sc.edu

Christina M. Devlin, RD, LD [Research Dietitian], and
University of South Carolina Institute for Families in Society 1600 Hampton Street, Suite 507 Columbia, SC 29208 Phone: 803-777-1824 extension 11 CDEVLIN@mailbox.sc.edu

Christopher J. Finney, MS [Research Associate]
University of South Carolina Institute for Families in Society 1600 Hampton Street, Suite 507 Columbia, SC 29208 Phone: 803-777-1824 extension 11 FINNEYC@mailbox.sc.edu

Abstract

Data from four cross-sectional studies involving fourth-grade children were analyzed to investigate the relationship between participation in school-provided meals and body mass index (BMI), and the effect observed energy intake has on that relationship. Participation and BMI data were available on 1,535 children (51% Black; 51% girls) for four school years (Fall 1999 to

Corresponding author: Amy Paxton Phone: 757-561-6511 PAXTONAE@mailbox.sc.edu.

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Spring 2003; one study per school year) at 13 schools total. Direct meal observations were available for a subset of 342 children (54% Black; 50% girls) for one to three breakfasts and one to three lunches per child for a total of 1,268 school meals (50% breakfast). Participation in breakfast, lunch, and combined (both meals on the same day) was determined from nametag records compiled for meal observations for each study. Weight and height were measured. A marginal regression model was fit with BMI as the dependent variable; independent variables were breakfast participation, lunch participation, combined participation, sex, age, race, and study. For the subset of children, observed energy intake at breakfast, lunch, and combined was included in additional analyses. Participation in breakfast, lunch, and combined was not significantly associated with BMI regardless of whether analyses included observed energy intake (*P* values > 0.181). The relationship between observed energy intake at breakfast and lunch, separately and combined, with BMI was positive (*P* values < 0.01). In conclusion, these results do not support a relationship between school-meal participation and BMI but do support a relationship between observed energy intake at school meals and BMI during fourth grade.

Keywords

Children; school; obesity; school meal programs; school-meal observations

INTRODUCTION

Although the incidence of obesity among youth in the United States has leveled in recent years, the prevalence remains high at nearly 17% (1). Given that American children spend about 32 hours each week at school (2) and regulations stipulate that a School Breakfast Program (SBP) meal and a National School Lunch Program (NSLP) meal provide one-fourth and one-third of the recommended dietary allowance for energy (3,4), respectively, children may consume a significant amount of their daily intake from school-provided meals. There is concern that participation in food assistance programs, such as the SBP and the NSLP, may be related to obesity (5-9).

To date, the two studies that have examined the relationship between school-meal participation and elementary school children's body mass index (BMI) have differed in the participation information sources, sample characteristics, and conclusions. Results from the Third School Nutrition Dietary Assessment Study (SNDA-III) showed that SBP participation was negatively associated with BMI, but only among White children (10). In that study, participation information was based on children's or parental reports, and the national sample of first- through twelfth-grade children consisted of various races (17% Black, 54% White, 22% Hispanic, 7% Other). In a second study, Baxter and colleagues (11) found no significant association between SBP and NSLP participation with BMI. Participation information in this study (11) was based on daily electronic administrative records, and the sample was predominantly minority (90% Black), including fourth-grade children from one district that had implemented offer-versus-serve foodservice, meaning that children could refuse one or more meal components (12).

Studies examining the relationship between school-meal participation and energy intake have also demonstrated mixed results. Results from SNDA-III showed a positive association between daily energy intake and NSLP participation (6). In contrast, Gleason and Suitor found significantly greater energy intake at lunch among NSLP participants when compared to nonparticipants (13). For both studies, participation information and energy intake were based on children's or parental reports.

To date, two studies have examined the relationship between children's BMI and energy intake at school-provided meals (11,14). Results from each study demonstrated a positive association, suggesting that children's energy intake at school-provided meals, rather than participation in school-provided meals, may be related to obesity. For both studies (11,14), energy intake was assessed from direct meal observations.

Although past studies have examined pairs of relationships — that is, the relationship between school-meal participation and BMI, between school-meal participation and energy intake, between BMI and energy intake at school-provided meals — only one study to date has examined all three simultaneously. That study (11) showed that SBP participation and NSLP participation were not significantly associated with children's BMI regardless of whether analyses included energy intake at school-provided meals. Energy intake was assessed from direct meal observations, and as mentioned previously, the sample was predominantly Black and from one district that had implemented offer-versus-serve foodservice (11).

When viewed collectively, the studies reviewed in the previous paragraphs reveal several gaps. Research is needed to investigate the relationship between school-meal participation and BMI, and the effect that energy intake at school-provided meals has on that relationship. This research is needed in additional samples of children and in districts that have not implemented offer-versus-serve foodservice, meaning that children receive all meal components. Research that utilizes objective measures of participation information and energy intake is especially needed, rather than relying on children's or parental reports.

The two objectives of this secondary-analysis project were to investigate (a) a possible relationship between school-meal participation and childhood obesity and (b) for a subset of children, the effect that observed energy intake at school-provided meals has on the relationship between school-meal participation and childhood obesity. This project used existing data from objective measures collected during four dietary-reporting validation studies with fourth-grade children.

METHODS

Sample

Approval was obtained from the institutional review boards for research involving humans at the Medical College of Georgia and the University of South Carolina. As information in Table 1 shows, data were collected in four cross-sectional studies during four consecutive school years with fourth-grade children from six to 11 elementary schools from one district in Augusta, Georgia. Written parental consent and child assent were obtained. Data collection methods for each study have been described in detail previously (15-18).

For each study, schools were selected from among 33 in the district to obtain a final sample of fourth-grade children with high participation in school meals and approximately equal numbers of children by race (Black, White) and sex. Because schools in the four studies had very few children of other races, analyses for this project excluded children of other races. For children who repeated fourth grade and were in more than one of the four studies, data from the “first” fourth-grade school year only were included. The district provided meals that complied with the SBP and NSLP standards (12) and had not implemented offer-versus-serve foodservice.

Participation in school-provided meals

School-meal participation was documented on nametag records compiled by research staff. During meal observations on randomly scheduled days during children's fourth-grade school

year, research staff marked nametag records to indicate which children participated in the SBP and the NSLP — that is, obtained breakfast and lunch provided by the school. On days when meal observations were conducted, all fourth-grade children in the classes observed and who agreed to be in the study wore nametags prepared by research staff; on those days, nametags were distributed immediately before, and collected immediately after, school meals. Children became accustomed to wearing nametags during reactivity meal observations conducted prior to data collection. Information in Table 1 shows, by study, the average number of days that nametag records were completed for breakfast, lunch, and both meals on the same day. Breakfast participation was defined as the ratio of the number of days on which a child participated in breakfast provided by the school to the number of days on which nametag records were completed for that class. Lunch participation was defined analogously. Combined participation was defined as the ratio of the number of days on which a child participated in both breakfast and lunch provided by the school to the number of days on which nametag records were completed for that class.

Weight/height measurements and age

Research dietitians measured children's weight and height at school on days when no meal observations were conducted. Standardized procedures were followed (19,20) to measure weight and height (without shoes) on digital scales (Precision Health Scale UC-300, A&D Engineering, Inc, Milpitas, CA) and portable stadiometers (Seca 214 Road Rod Portable Stadiometer, Seca Corporation, Hanover, MD) after lunch in March for the first three studies and after breakfast but before lunch in November for the fourth study. Inter-measurer reliability was assessed daily for pairs of research dietitians on a random sample of 10% of the children. For each study, intraclass correlation reliability was > 0.99 for weight and for height (21). Each child's age at the time of measurement was calculated by subtracting the date of birth (obtained from school records) from the date of measurement. After calculating BMI (kg/m^2), age/sex BMI charts from the Centers for Disease Control and Prevention (CDC) were used to determine each child's BMI percentile (22). The use of BMI is recommended to identify youth who are obese (23). For descriptive purposes, children were grouped according to BMI percentile category (23).

Observed energy intake at school meals

For a subset of 342 children, research dietitians completed direct meal observations for one to three breakfasts per child and one to three lunches per child, for a total of 1,268 school meals (50% breakfast). Research dietitians followed written protocols to observe one to three children simultaneously during regular meal periods with children seated according to their school's typical arrangement. Observations covered entire meal periods to account for food trading. Research dietitians used paper forms to record items and amounts eaten in servings of standardized school-meal portions. Interobserver reliability, which was assessed throughout data collection each week for three of the studies and bimonthly for one study, exceeded 89% (15-18).

Amounts observed eaten were recorded using qualitative labels and quantified in servings of standardized school-meal portions as none = 0.0, taste = 0.1, little bit = 0.25, half = 0.5, most = 0.75, all = 1.0 or as the actual number of servings if more than one serving was observed eaten. Information about energy (in kilocalories [kcal]) for standardized school-meal portions was obtained from the Nutrition Data System for Research database (Nutrition Coordinating Center, University of Minnesota, Minneapolis) or from the school district's nutrition program. Quantified observed servings were multiplied by per-serving energy values of standardized school-meal portions. For each observed meal for a child, the values for energy intake were summed across the items eaten. For combined breakfast and lunch per child, observed energy intakes for both meals on the same day were summed. For each

child with multiple days of observations, average observed energy intakes were calculated for each of breakfast, lunch, and combined.

Statistical Analyses

To investigate a possible relationship between school-meal participation and obesity, a marginal regression model was fit with BMI as the dependent variable; independent variables included breakfast participation, lunch participation, combined participation, sex, age (in months), race, and study (which was the same as school year). The sample included 1,535 children; although weight and height measurements were available for 1,542 children (21), complete nametag information was not available for seven of these children.

For a subset of children, to investigate the effect that observed energy intake at school-provided meals has on the relationship between school-meal participation and obesity, a marginal regression model was fit with BMI as the dependent variable; independent variables included breakfast participation, lunch participation, combined participation, average observed energy intake for breakfast (in units of 100 kcal), average observed energy intake for lunch (in units of 100 kcal), average observed energy intake for breakfast and lunch combined (in units of 100 kcal), sex, age (in months), race, and study. The subset sample included 342 children.

For each regression model, BMI was used as the dependent variable, instead of BMI percentile, because the underlying model assumptions were better satisfied when using BMI. Also, to account for the nested structure of children within school (because data for children within school are possibly correlated), generalized estimating equation methodology was used to fit marginal regressions, and a modified sandwich variance estimator, computed under an independent working correlation assumption, was used to obtain standard errors. Statistical analyses were performed using SAS/STAT ® software (Version 9.2, Copyright © 2002-2008, SAS Institute Inc., Cary, NC).

RESULTS AND DISCUSSION

Descriptives

For the 1,535 children, 51% were Black, 51% were girls, and the mean age was 10.23 ± 0.52 years. For the subset of 342 children, 54% were Black, 50% were girls, and the mean age was 10.23 ± 0.57 years. Information in Table 2 shows BMI percentile category for each study's total sample and subset of children for whom meal observations were conducted. The percentage of children in a BMI percentile category was similar for the four studies; specifically, across the four studies, 55% to 61% of the children were underweight or at a healthy weight, 15% to 18% were overweight, 17% to 21% were obese, and 4% to 9% were severely obese. Also, the percentage of children in a BMI percentile category for a study's total sample was similar to that for a study's subset. For example, for Study A's total sample of 329 children, 60% were underweight or at a healthy weight, 15% were overweight, 21% were obese, and 4% were severely obese; the respective percentages for Study A's subset of 98 children were 54%, 20%, 22%, and 3%.

Relationship between school-meal participation and BMI

None of the three participation indices (breakfast, lunch, combined) were significantly related to BMI (all three P values > 0.594). These results are similar to those from a previous study (11), which showed no significant association between school-meal participation and BMI, and also to those from SNDA-III (10), which showed a non-significant association between NSLP participation and BMI.

Race was significantly related to BMI ($P < 0.001$); on average, the BMI for Black children, after accounting for all other variables, was estimated to be 0.836 kg/m^2 greater when compared to White children. This finding for race is similar to previous studies and national trends (1,24,25). Age was positively related to BMI ($P < 0.001$), with average BMI increasing 0.076 kg/m^2 per one-month increase in age (holding all other variables constant). This finding for age is similar to previous studies and national trends (1,24). Sex was not significantly related to BMI in the presence of other independent variables ($P > 0.4282$). This finding for sex is similar to national trends (26). Finally, study was not significantly related to BMI in the presence of other independent variables ($P = 0.1760$); this non-significant result helps to resolve any concerns about including all four studies in this project.

When a Bonferroni-adjusted significance criterion of 0.00714 (0.05/7) was implemented for all seven independent variables, the race and age effects remained significant.

Effect of observed energy intake

Information in Table 3 provides a summary of the regression output. When the model included observed energy intake at breakfast, lunch, and both meals combined, none of the three participation indices were significantly related to BMI (all nine *P* values > 0.181). These results are similar to those from a previous study (11), which showed that SBP participation and NSLP participation were not significantly associated with children's BMI regardless of whether the analyses included observed energy intake at school meals.

Observed energy intake was positively related to BMI for breakfast, lunch, and combined meals (all three *P* values < 0.01). The average BMI increase was between 0.5-0.7 kg/m^2 for each 100-kcal increase observed eaten at school meals, after adjusting for the effects of the other independent variables. Although these findings are not unexpected, they are consistent with results from two studies (11,14) mentioned in the Introduction.

Race was significantly related to BMI (all three *P* values < 0.01). On average, the BMI for Black children, after accounting for all other variables, was estimated to be 1.56 to 1.62 kg/m^2 greater when compared to White children. Age was positively related to BMI (all three *P* values < 0.05). The BMI increase was 0.055 to 0.066 kg/m^2 per one-month increase in age (holding all other variables constant). Sex, in the presence of the other independent variables, was significantly related to BMI for breakfast and combined meals (two *P* values < 0.05); also, sex was marginally related to BMI for lunch ($P = 0.052$). The average BMI was greater for girls than for boys. Study was not significantly related to BMI in the presence of other independent variables (all three *P* values > 0.0885).

When a Bonferroni-adjusted significance criterion of 0.005 (0.05/10) was implemented for all ten independent variables, each of the effects of observed energy intake at lunch, observed energy intake at combined meals, race for breakfast, and race for combined meals remained significant. However, each of the effects of observed energy intake at breakfast, race for lunch, sex, and age were not significant.

Additional BMI-dependent variables

Other studies have used additional BMI-dependent variables such as BMI z score, BMI percentile category, and obesity status (10,27). The BMI z score indicates the number of standard deviations a child's BMI is from the mean BMI of the CDC reference population for that child's age and sex (10,27). The BMI percentile categories (23) are defined in Table 2. An obesity status variable (10) can be created by dichotomizing children as *not obese* (< 95th percentile) or *obese* (≥ 95th percentile). For this project, similar analyses were repeated

with each of BMI z score, BMI percentile category, and obesity status as the dependent variable. Each additional analysis led to the same conclusions as those reached when using BMI.

Limitations

First, the four studies that provided the data were not designed specifically to address the objectives of this project nor were they designed to determine whether eating school-provided meals *causes* children to have greater BMIs. Second, weight/height measurements were available for only one time point per child. Third, the sample included only fourth-grade children from one school district. Fourth, estimates of energy intake were based on standardized school-meal portions, which may be imprecise; however, the same process was used consistently for each observed school meal. Fifth, although physical activity and obesity may be related, physical activity data were not collected for the four studies. Sixth, although socioeconomic status (SES) and obesity may be related, SES information was not collected for the four studies. However, during each study's school year of data collection, a mean of 59% to 70% of the children across all grades at the schools were eligible to receive free or reduced-price school meals; thus, most children in the sample were likely from families of low to moderately-low SES. Finally, this project did not differentiate between free, reduced-price, and full-price school meals. Therefore, definitions for participation did not change as a result of meal price. This was appropriate because children's participation in school-provided meals, rather than meal price, was the independent variable (13,28).

CONCLUSIONS

Results from this project do not support a relationship between school-meal participation and BMI during children's fourth-grade school year. This finding contributes to the growing body of evidence showing a lack of association between participation in school meals and childhood obesity. Results also support a positive relationship between observed energy intake at school meals and BMI during children's fourth-grade school year. Further research is needed to help explain this relationship. For example, do children with greater BMIs eat more of the standardized school-meal portions? Do they consume flavored milk rather than plain milk? Do they receive kcals in food trades? School meals are an important source of nutrition for children and understanding the impact on childhood obesity is critical. Longitudinal evidence (e.g., from first grade through fifth grade) is also needed to further explore the relationship among school-meal participation, energy intake at school meals, and BMI.

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Table 1

Information about four cross-sectional studies with fourth-grade children in Augusta, GA from which data were analyzed to investigate a relationship between school-meal participation and body mass index and, for a subset of children, the effect that observed energy intake at school-provided meals has on that relationship.

Study	School year	Number of schools	School codes[a]	Number of children in study	Number of children in subset observed eating school-provided meals	Average number of days that nametag records[b] were completed for breakfast (range)	Average number of days that nametag records[b] were completed for lunch (range)	Average number of days that nametag records[b] were completed for breakfast and lunch on the same day (range)
A	1999-2000	6	a,b,c,d,e,f	329	98	35 (26-51)	10 (1-17)	9 (1-16)
B	2000-2001	11	a,b,c,d,e,g,h,i,j,k,l	570	121	26 (7-36)	6 (1-11)	5 (0-10)
C	2001-2002	10	a,b,c,d,e,g,h,i,j,k	362	67	16 (12-18)	4 (2-8)	2 (0-7)
D	2002-2003	6	b,e,f,g,k,m	274	58	7 (3-10)	2 (1-4)	2 (0-4)

[a] Although there were 13 schools total in the four studies, no school was in each of the four studies. Therefore, the table provides school codes to indicate which of the 13 schools were in which study (or studies).

[b] Nametag records were created by research staff and were completed during school-meal observations to indicate which children (identified by the nametags they wore) participated in the School Breakfast Program and the National School Lunch Program — that is, obtained breakfast and lunch provided by the school.

Table 2

Information about body mass index (BMI) percentile category[a] for fourth-grade children from four cross-sectional studies in Augusta, GA during four school years (1999-2000 through 2002-2003), by study and race for the total sample and for the subset[b].

BMI percentile category[a]	Study A n = 329			Study B n = 570			Study C n = 362			Study D n = 274		
	Total[c]	Black	White	Total[c]	Black	White	Total[c]	Black	White	Total[c]	Black	White
	Percent											
Underweight & healthy weight	60	24	36	61	30	31	59	24	35	55	37	18
Overweight	15	6	9	16	9	7	18	9	9	17	10	7
Obese	21	11	10	18	9	9	17	9	8	19	13	6
Severely obese	4	2	1	5	3	2	5	5	1	9	5	4

	Subset of Study A n = 98			Subset of Study B n = 121			Subset of Study C n = 67			Subset of Study D n = 56		
	Total[c]	Black	White	Total[c]	Black	White	Total[c]	Black	White	Total[c]	Black	White
	Percent											
Underweight & healthy weight	54	18	36	61	30	31	61	31	30	57	46	11
Overweight	20	9	11	17	9	8	18	8	10	18	7	11
Obese	22	18	4	16	8	8	18	10	8	20	18	2
Severely obese	3	2	1	5	2	2	3	3	0	5	3	2

[a] Children were categorized as *underweight* (< 5th percentile), *healthy weight* (≥ 5th to < 85th percentiles), *overweight* (≥ 85th to < 95th percentiles), *obese* (≥ 95th to < 99th percentiles), and *severely obese* (≥ 99th percentile) (25). For this article, the underweight and healthy weight categories were combined.

[b] Each child in the subset was observed eating school-provided breakfast and school-provided lunch on one or more school days.

[c] Percents were rounded to the nearest whole number, so "Total" values (across columns or rows) may not sum exactly.

Table 3

Output summary of regression model used to investigate the effect on the possible relationship of fourth-grade children's body mass index with school-meal participation when observed energy intake was included in the analyses (n = 342 fourth-grade children during the 1999-2000, 2000-2001, 2001-2002, and 2002-2003 school years in Augusta, GA).

	Estimate	*P* value
Breakfast[a]		
Breakfast participation	−0.014 kg/m^2	0.351
Lunch participation	−0.022 kg/m^2	0.364
Combined participation[b]	−0.007 kg/m^2	0.675
Observed energy intake[a]	0.580 kg/m^2	<0.01
Race	1.610 kg/m^2	<0.001
Sex	1.144 kg/m^2	<0.05
Age	0.066 kg/m^2	<0.05
Lunch[a]		
Breakfast participation	−0.015 kg/m^2	0.317
Lunch participation	−0.032 kg/m^2	0.181
Combined participation[b]	−0.008 kg/m^2	0.625
Observed energy intake[a]	0.700 kg/m^2	<0.0001
Race	1.563 kg/m^2	<0.01
Sex	0.915 kg/m^2	0.052
Age	0.055 kg/m^2	<0.05
Combined (breakfast and lunch on the same day)[a]		
Breakfast participation	−0.017 kg/m^2	0.258
Lunch participation	−0.028 kg/m^2	0.266
Combined participation[b]	−0.008 kg/m^2	0.630
Observed energy intake[a]	0.500 kg/m^2	<0.0001
Race	1.624 kg/m^2	<0.001

	Estimate	*P* value
Sex	1.155 kg/m^2	<0.05
Age	0.056 kg/m^2	<0.05

[a]This table has three sub-sections of rows showing results for three independent variables — observed energy intake for breakfast, observed energy intake for lunch, and observed energy intake for combined (breakfast and lunch on the same day).

[b]Combined participation was when a child participated in (i.e., obtained) both school-provided breakfast and school-provided lunch on the same day.