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School Breakfast Receipt and Obesity among American Fifth- and Eighth-Graders

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Abstract

Background—School breakfast consumption can improve children's nutrition, but the implications of breakfast at school for children's weight remains unclear.

Objective—The aim of this study was to determine whether receiving breakfast at school is related to changes in children's weight between the fifth and eighth grades, and whether the relationship between school breakfasts and obesity varies for children of different socioeconomic backgrounds.

Design—This was a longitudinal study of children observed in the fifth and eighth grades.

Participants—Data are from the Early Childhood Longitudinal Study, Kindergarten Class of 1998-99, a nationally representative prospective cohort of children in the United States. The analytic sample consisted of 6,495 children interviewed in the fifth and eighth grades.

Main outcome measure—Standard thresholds from the Centers for Disease Control and Prevention were used to classify children as not obese or obese based on direct-measured height and weight.

Statistical analyses performed—Difference-in-difference propensity score matching and fixed-effect logistic regression models were used to estimate the relationship between receipt of school breakfast and change in obesity between the fifth and eighth grades, adjusting for child, household, and school characteristics.

Results—School breakfast receipt was not associated with a change in obesity status between the fifth and eighth grades for children overall (odds ratio=1.31; $P=0.129$). In the propensity score model, receiving school breakfasts more than doubled the odds of becoming obese (odds

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ratio=2.31; $P=0.0108$) for children from families below the federal poverty line compared with children of similar socioeconomic backgrounds who did not regularly receive school breakfasts.

Conclusions—School breakfast receipt was not independently related to obesity for most children. Receiving school breakfasts in the fifth grade may be associated with weight gain between the fifth and eighth grades for children from families below the federal poverty line compared with children of similar socioeconomic status who did not receive breakfasts.

Keywords

Childhood obesity; School breakfast; Nutrition

Childhood obesity is one of the most pressing health concerns today and has been linked with diabetes and cardiovascular disease.^{1, 2} According to recent estimates, 17% of American children are obese.³ School is a key environment for children, where many behaviors relevant to weight develop⁴ and where children consume, on average, 35% of their daily calories.⁵ Therefore, regulations requiring better nutrition in schools offer a promising strategy for improving health among American children.⁶

Eating breakfast has been associated with better nutrition. A nationally representative study of children aged 5 to 16 years in the United States found that children who ate breakfast had lower daily dietary fat intake and healthier levels of serum vitamin C and folate than those who did not.⁷ Eating breakfast has also been associated with healthier eating patterns. For example, a study of preschoolers in Quebec, Canada, found that children who skipped breakfast at least once a week ate larger lunches, dinners, and more snacks than those who ate breakfast.⁸ Eating breakfast can also reduce the risk of unhealthy weight. Another study of preschool children in Quebec reported that not eating breakfast nearly doubled the odds for obesity at age 4.5 years.⁹ Among Belgian elementary school students, frequency of eating breakfast was negatively associated with body mass index (BMI) z scores.¹⁰ Among American teenagers, frequency of eating breakfast was negatively associated with BMI.¹¹

Despite the potential benefits of eating breakfast, it is still the meal most often skipped by young people.¹² Offering breakfast at school can improve nutrition-related health by encouraging children to eat breakfast regularly. In the United States, many schools offer breakfast through the School Breakfast Program (SBP); 72.2% of eighth-grade children attend participating schools (authors' calculations). Still, not all schools participate in the SBP, and even children at SBP schools can purchase and consume breakfast outside of the SBP program.¹³ To date, three studies have examined the relationship between school breakfast and children's weight in the United States, with all three focused on the SBP. Due to differences in scope and data, the findings from these articles leave uncertain the potential of school breakfast as an anti-obesity strategy.

Using the nationally representative cross-sectional School Nutrition Dietary Assessment Study, Gleason and Dodd¹⁴ found that 1st- through 12th-grade children who ate SBP school breakfasts had lower raw BMIs and BMI z scores than those who did not; however, they did not find an association between SBP school breakfast and obesity. Using cross-sectional data, the study could not identify the relationship between breakfast consumption and

changes in weight over time. Bhattacharya and colleagues⁷ used data from the 1988 and 1992 National Health and Nutrition Examination Survey to study the relationship between SBP availability at school and nutrition-related outcomes for children aged 5 to 16 years. The study used a difference-in-difference approach with cross-sectional data comparing the difference in weight of children interviewed during and outside the school year for children attending schools that did and did not participate in the SBP. The study did not find a relationship between attending an SBP-participating school and BMI z score or overweight. However, the periods when school is and is not in session might be too short for changes in weight categories to occur. Millimet and colleagues¹⁵ used data from the nationally representative Early Childhood Longitudinal Study, Kindergarten cohort of 1998-99 (ECLS-K) to estimate the relationship between availability of SBP breakfasts at schools and change in children's weight between first and third grade. Children attending schools participating in the SBP grew heavier between the 2 years compared with those attending schools without the program. However, when the authors simulated the effect of different levels of unmeasured selection of heavier children into schools where the SBP is offered, they found that with moderate levels of selection (between 10% and 20%), attending a school participating in the SBP was related to a decrease in weight. This study made an important advance in studying the relationship between the school environment and obesity, suggesting that some of the lack of associations reported in the previous studies might be due to selective placement of breakfast programs. The primary focus of the study was on the policy impact of the SBP on children's weight and, as such, the authors focused on SBP availability, not receipt of school breakfast.

The current study provides new evidence on the relationship between school breakfast and children's weight. In contrast to Bhattacharya and colleagues⁷ and Millimet and colleagues,¹⁵ we focus on children's receipt of school breakfast rather than on the availability of the SBP at the child's school. Adding to the cross-sectional associations found by Gleason and Dodd¹⁴ and Bhattacharya and colleagues, longitudinal data were used to examine change in weight over time and to adjust for unobserved differences between children. This study also uses more recent data than the previous three articles and focuses on older children at the ages when children have increasing food autonomy and are more likely to skip breakfast.^{16,17} Using the ECLS-K, the aim of this study was to determine whether school breakfast receipt is related to changes in children's weight between the fifth and eighth grades.

Methods

Data are from the ECLS-K,¹⁸ a nationally representative multistage probability sample of children first interviewed as kindergarteners in 1998 and followed to the end of eighth grade.¹⁹ Data for this study are from waves 6 and 7 of data collection, when the children were in the fifth and eighth grade, and include all children with valid information on school breakfast receipt, BMI, age, sex, and race/ethnicity.

The height and weight of children were measured twice per wave by trained assessors and averaged to ensure accurate measurement. For this analysis, each child's BMI z score was calculated and standardized to the 2000 Centers for Disease Control and Prevention Growth

Reference population for the child's age and sex.²⁰ Dichotomous indicators for whether a child was obese were created for the fifth and eighth grades. The Centers for Disease Control and Prevention cutoffs were used to classify children as obese (≥ 95th percentile) or not obese. Underweight, overweight, and healthy-weight children were classified as not obese. The primary dependent variable was the change in obesity status between the two grades. Results are consistent when using a linear measure of BMI z score and a dichotomous indicator of overweight or obese (≥ 85th percentile).

Based on the following ECLS-K question to parents—“During the last five days (child) was in school, how many school breakfasts did (he/she) receive?”—a dichotomous indicator of school breakfast receipt was created if a child received any school breakfast in the past week. In alternative analyses, a measure of the availability of school breakfasts was used by creating a dichotomous indicator equal to one if parents answered yes to the question, “Does (child)'s school offer breakfast for its students?” The ECLS-K does not ask parents whether the breakfast received was through the SBP, but 96% of children who received breakfast attended a school with the SBP (authors' calculations).

Multivariate models were adjusted for the following child, household, and school characteristics that may be associated with both weight and breakfast consumption: sex; race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and non-Hispanic Asian/other race); age (9.2 to 10.9, 11 to 11.4, and 11.5 to 13.8 years); number of days in the past week the child exercised ≥ 20 minutes (0 to 7); family socioeconomic status (SES) quintile (0 to 5); whether the child's family was below the federal poverty line (0/1); whether the child's parents were married (0/1); whether the child's mother was employed full-time (0/1), part-time (0/1), or unemployed (0/1); number of breakfasts and dinners the family ate together in a typical week (both range from 0 to 7); school type (public/private); census region (Midwest, South, Northeast, West); and urbanicity (large/mid-size city; large/mid-size suburb and large town; small town/rural). Family SES quintiles were created in the ECLS-K using a composite of father/male guardian's education, mother/female guardian's education, father/male guardian's occupation, mother/female guardian's occupation, and household income.

Of the 7,304 children with information on school breakfast receipt for the fifth- and eighth-grade waves, 809 children were dropped due to missing information on these covariates, for an analytic sample of 6,495 children (88.9%).

Descriptive statistics were calculated for weight status and school breakfast receipt. Bivariate associations were tested using two sample *t* tests to determine which child, household, and school characteristics were significantly different between children who did and did not receive school breakfast. Because many of these characteristics might be related to both school breakfast receipt and obesity, multivariate models were used to determine whether school breakfast receipt was related to obesity net of confounding from observed characteristics.

In addition to observed differences between children, associations between school breakfast receipt and obesity can be affected by unobserved selection. For example, children who

receive school breakfasts might be more likely to be from low SES families and have poor overall diets, so observed relationships between school breakfast and obesity could be due to unobserved characteristics of children who receive school breakfasts. A strong approach to reduce bias from unobserved selection is to utilize longitudinal data to difference out unobserved time-invariant characteristics between children who did and did not receive school breakfasts. This approach was applied through two analytic strategies: propensity score matching and fixed-effects logistic regression.

Propensity Score Matching

Propensity score matching seeks to simulate a randomized controlled trial by matching children who received school breakfasts to children who did not receive school breakfasts, but are otherwise similar on observed characteristics. The “effect” of school breakfast receipt on obesity is then a function of the difference in obesity status across the matched sets. In a randomized trial, this effect could be interpreted as causal because the randomization process would ensure that children who did and did not receive school breakfasts were similar on all observed and unobserved characteristics. In an observational setting, the propensity score estimate may still be affected by unobserved differences between children. To address this problem, the longitudinal structure of the data was used to difference out bias from unobserved characteristics: children who did and did not consume breakfast were first matched on their fifth-grade obesity status and the observed child, household, and school characteristics using an “optimal full match” algorithm. This algorithm forms matched sets of children who did and did not receive school breakfasts, while minimizing the mean within-matched set difference for observed characteristics. Covariate balance was then examined by comparing the standardized mean difference in each covariate between children who did and did not receive school breakfasts across the matched sets. Balance was considered acceptable when the standardized difference of a covariate between children who did and did not receive school breakfasts was <0.2 (Table 1, available online at www.andjrn.org). Then, the odds of obesity in the eighth grade were estimated using a Mantel-Haenszel odds ratio (OR). By matching on fifth-grade obesity, the Mantel-Haenszel estimate is a difference-in-difference estimate of the effect of school breakfast receipt on the change in obesity status between the fifth and eighth grades accounting for unobserved differences between children.

The benefit of school breakfast might be concentrated among children who are at risk for poor nutrition, as school breakfasts are often made available specifically to address their needs. To determine whether the effect of school breakfast receipt differed for children according to the SES of their household, the Mantel-Haenszel OR was then estimated separately for children from the following risk groups: children from families below the federal poverty line, children from families above the federal poverty line, children from families in the bottom two SES quintiles, and children from families in the top three SES quintiles. The four risk groups are not mutually exclusive; children from families above and below the federal poverty line were present across SES quintiles, so poverty and SES capture different dimensions of social and economic well-being, motivating the need to examine both groups of children.

Regression Analysis

Although the propensity score approach adjusts for time-invariant differences between children, children who did and did not receive school breakfast may experience different individual and structural changes between the fifth and eighth grade, such as changes in parents' marital status or employment, which might also be related to their health. Multivariate longitudinal fixed-effects models were used to estimate the effect of a change in school breakfast receipt on the change in obesity status between the fifth and eighth grades, both overall and by socioeconomic risk group. These models adjust for both observed and unobserved time-invariant differences between children who did and did not receive school breakfasts. The models also adjust for the following observed time-varying characteristics: whether the child's parents were married, number of breakfasts and dinners the family ate together in a typical week, mother's employment status, school type, urban status, and grade.

Analyses were conducted in Stata (release 12, 2011, Stata-Corp LP) and R (version 3.0.3, 2014, R Core Team) using the packages *optmatch* (version 0.9-5, 2015, Ben B. Hansen, PhD, and colleagues) and *RIttools* (version 0.1-11, 2014, Jake Bowers, PhD, and colleagues). This study was exempt from Institutional Review Board approval because it used publically available de-identified data. All the results were survey weighted to be representative of children who had been in kindergarten in 1998 or in first grade in 1999 in the United States.

Results

When children were in both the fifth and eighth grades, the prevalence of obesity was around 12% (Table 2). School breakfasts were positively associated with obesity: in both grades, children who received breakfast at school were more likely to be obese than children who did not.

Children who were and were not obese in fifth grade also experienced different weight trajectories over time (Table 3): children who were not obese were far less likely to change weight categories between the fifth and eighth grades. Of the 12.4% of students who were obese in the fifth grade, 74.7% remained obese in the eighth grade and 25.3% became not obese. Nearly all the children who were not obese in the fifth grade remained not obese, with only 3.5% becoming obese by the eighth grade.

Table 4 describes school breakfast receipt among fifth-graders. Although most of the children attended schools that offered school breakfasts (75.8%), less than one-quarter of the children had eaten a school breakfast in the past week (23.1%) and, on average, children only had about one school breakfast per week (1.05). These results highlight that the availability of school breakfasts does not necessarily mean that children are consuming them.

Table 5 presents child, household, and school characteristics for children in the fifth grade who did and did not have school breakfasts. On average, children who received at least one school breakfast were nearly 7 percentage points more likely to be obese compared with children who did not receive any school breakfasts (17.8% vs 10.8%; $P<0.001$). There are large socioeconomic differences in the receipt of school breakfasts, with disadvantaged

students more often receiving school breakfasts. For example, children who received school breakfast were >45 percentage points more likely to be below the federal poverty line (55.4% vs 9.4%; $P<0.001$) and 30 percentage points more likely to be in the lowest wealth quintile compared with children who did not receive school breakfasts (47.9% vs 9.4%; $P<0.001$). Children who received school breakfasts were more likely to be non-Hispanic black or Hispanic (both, $P<0.001$) and were less likely to have married parents and more likely to have an unemployed mother (both, $P<0.001$). They were more likely to attend schools in large and mid-sized cities ($P<0.001$) in poorer regions of the country (21.1% points more likely to attend a school in the South; $P<0.001$). These patterns underscore the importance of adjusting for differences between children when testing whether school breakfast affects obesity.

Propensity Score Matching

Table 6 presents the results from the propensity score matching analysis for the overall sample and separately for each of the four risk groups. The coefficients in the table are the OR of obesity in the eighth grade for children who received breakfast at school compared with children who did not. After adjusting for time-invariant differences and comparing children who only differed on whether they received school breakfasts, results indicate that receipt of school breakfast was not associated with obesity (OR=1.31; $P=0.129$).

Table 6 also presents the relationship between school breakfast receipt and obesity within four socioeconomic risk groups. The goal of this stratified analysis is to determine whether the effect of school breakfast receipt on obesity was different for children from different socioeconomic backgrounds. The magnitude of the OR was very similar for children above the federal poverty line, children in the bottom two SES quintiles, and children in the top three SES quintiles (OR=1.41, 1.44, and 1.55, respectively). Although these ORs were not significantly different from 1, the direction of the OR suggests that receiving breakfast may increase the odds of becoming obese. For children from families below the federal poverty line, receipt of school breakfast more than doubled the odds of becoming obese (OR=2.31; $P=0.0108$) compared with children of similar SES who did not receive school breakfast.

Multivariate Fixed-Effects Regression

Table 7 shows the results of multivariate longitudinal fixed-effects models estimating the effect of a change in school breakfast receipt on the change in obesity status between the fifth and eighth grades. After adjusting for both observed time varying and unobserved time-invariant differences between children, a change in school breakfast receipt was not statistically associated with a change in weight status overall (OR=0.72; $P=0.285$) or for any of the risk groups.

Other characteristics were associated with the odds of children becoming obese between fifth and eighth grade. For example, an increase in the number of dinners a family ate together increased the odds of becoming obese (OR=1.12; $P=0.029$) while a child's parents marrying between the two grades greatly reduced the odds of becoming obese (OR=0.51; $P=0.035$).

Sensitivity Analyses

Sensitivity analyses were conducted, and the results are available on request. Our finding of no relationship between receiving school breakfasts and children's weight was consistent when using a continuous measure of BMI *z* score and a dichotomous indicator of overweight or obese as outcome variables (Table 8, available online at www.andjrn.org). These results were also unchanged when a continuous variable for the number of school breakfasts received per week was used instead of a dichotomous indicator for any breakfast (Table 8, available online at www.andjrn.org). Results were also consistent when using school breakfast availability as the exposure. In propensity score models, the increased odds of becoming obese for children below the federal poverty line were consistent when children were not matched on family SES quintiles. Results were consistent for the logistic regression model when estimated for only children attending schools that participated in the SBP (Table 9, available online at www.andjrn.org). In the propensity score model, relationship between breakfast and obesity was positive but not significant when estimated for only children attending schools that participated in the SBP (Table 10, available online at www.andjrn.org).

Discussion

Providing breakfast to children at school may be an opportunity to address obesity by improving nutrition. This study used longitudinal data from a nationally representative cohort of children in US schools in their early teens to assess whether breakfast at school is related to changes in children's weight between the fifth and eighth grades. Children who received school breakfasts were more often obese compared with children who did not regularly receive breakfast at school; however, after adjusting for differences between children, eating breakfast at school was not related to changes in weight between the fifth and eighth grades for most students. Children from families below the federal poverty line were the exception; in some models, regular receipt of at least one school breakfast per week increased the odds of becoming obese between the fifth and eighth grades compared with children who had similar parental characteristics and were from families below the poverty line but did not receive school breakfast.

The results of this study are consistent with those from previous studies that did not find an association between school breakfast and obesity in children using cross-sectional data.^{7,14} The finding that school breakfast receipt increased the odds of obesity for children in poverty is consistent with the findings of a previous study showing that consumption of school lunches was related to an increase in obesity for children below the federal poverty line.²¹ While another longitudinal study of the ECLS-K cohort at younger ages reported that school breakfast may be protective against obesity, that study was focused on availability of the SBP at a child's school rather than a child's receipt of breakfast at school¹⁵; the results here have shown that many children attend schools with the SBP, but do not regularly receive school breakfast.

This study has some limitations. The analysis relied on parents' reports of children's school breakfast receipt. If parents do not know how many breakfasts their child received or whether they actually ate those meals, results might be downwardly biased by error in the

measurement of school breakfast receipt. Using data from both parents and children about children's school breakfast consumption, Gleason and Dodd¹⁴ found that parent reports are highly correlated with children's reports, still, both children's and parents' reports can be inaccurate. This study did not have access to information on the type and quantity of food consumed by children. The result that receipt of school breakfast increased the odds of obesity for children below the poverty line could be explained by differences in food quality across schools or by differences in the quality or quantity of food eaten during the course of the day by children. The results should be interpreted as an average effect over an unknown distribution of quality and quantity of school breakfasts and the other food children consume during the day.

By taking a long-term perspective focused on change over 3 years, our analysis does not capture shorter-term fluctuations in weight. The null associations can result if the effect of breakfast patterns in the fifth grade disappeared by the time children reached the eighth grade. This analysis relies on the classic difference-in-difference assumption that the trends in obesity and characteristics related to obesity for children who did and did not receive school breakfasts were parallel before the fifth grade. Because poverty status was measured once in the fifth grade, this analysis could not explore the relationship between a change in poverty and a change in obesity using fixed-effects regressions. While the propensity score exploited the longitudinal data for the outcome, it did not utilize change in the explanatory variables. This might explain differences in the results between the two modeling approaches. Finally, BMI and obesity are imperfect indicators of adiposity, but when combined with age and sex as we did here, they are closely related to adiposity in children^{22,23} and are feasible to collect in large-scale studies like the ECLS-K.²⁴

This analysis presents several advances. The ECLS-K is the only nationally representative, longitudinal dataset to include direct measures of weight and height for school-aged children and the only study of its size to collect detailed information on both meal availability and children's receipt of breakfast at school. Extending prior research, this analysis utilized measures of the receipt of breakfast rather than the availability of breakfasts at school; also, it focused on older children in early adolescence, an age when children are increasingly autonomous and are more likely to skip meals. Using longitudinal data, we estimated the relationship between school breakfast receipt and the change in weight between fifth and eighth grade in a national cohort, adjusting for unobserved differences between children who did and did not receive school breakfast. By stratifying the analysis into socioeconomic risk groups, this analysis examined the effect of school breakfast receipt across children with different risks of poor nutrition.

Future research would benefit from investigating the dietary quality and quantity of breakfasts consumed in school, especially if children at disadvantaged schools are more likely to consume lower-quality breakfasts compared with children at less disadvantaged schools. In addition, data on breakfasts from home would help separate the effect of school breakfast.

Conclusions

Children in the fifth and eighth grades who received breakfast at school were more often obese than children who did not. After considering differences between children who did and did not receive school breakfast, receiving school breakfast was not related to changes in obesity for most children. However, for children from families below the federal poverty line, receiving school breakfast in the fifth grade may be linked with unhealthy weight gain between the fifth and eighth grades.

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Table 2
Prevalence of obesity by breakfast receipt in the fifth and eighth grade among a cohort of American children (n=6,495)^a

	Fifth Grade			Eighth Grade		
	n ^b	% ^c	SE ^d	n ^b	% ^c	SE
Obese ^e						
Total	757	12.4	0.6	678	12.3	0.7
No breakfast receipt	564	10.8	0.6	498 ^f	10.6	0.7
Any breakfast receipt	193	17.8	1.8	168 ^f	19.3	2.4

^aData from the Early Childhood Longitudinal Study, Kindergarten Class of 1998-1999.

^bCounts are unweighted.

^cThe prevalence of obesity is weighted to be nationally representative of American fifth- and eighth-grade children.

^dSE=standard error.

^eChildren were classified as obese if their body mass index z score was in the 95th percentile or greater.

^fTwelve individuals were missing information on breakfast receipt in the eighth grade.

Table 3
Changes in obesity status between fifth and eighth grade among a cohort of American children (n=6,495)^a

Obesity status	Nonobese in Eighth Grade		Obese in Eighth Grade	
	n ^b	% ^c	SE ^d	n ^b
Nonobese in fifth grade ^{e,f}	5,579	96.5	0.4	159
Obese in fifth grade ^{e,f}	238	25.3	2.2	519

^aData from the Early Childhood Longitudinal Study, Kindergarten Class of 1998-1999.

^bCounts are unweighted.

^cThe prevalence of obesity is weighted to be nationally representative of American fifth- and eighth-grade children.

^dSE=standard error.

^eChildren were classified as obese if their body mass index *z* score was in the 95th percentile or greater.

^fPercentages and counts shown are among children who were nonobese/obese in the fifth grade.

Table 4
School breakfast availability and receipt among a cohort of American fifth graders
(n=6,495)^a

	n^b	% or Mean^c	Standard error
Child attends a school that serves breakfasts ^d	4,289	75.8%	1.4%
Child received any school breakfasts in the past week	1,106	23.1%	1.5%
No. of school breakfasts received per week	—	1.05	0.07

^aData from the Early Childhood Longitudinal Study, Kindergarten Class of 1998-1999.

^bCounts are unweighted.

^cPercentages and means are weighted to be nationally representative of American fifth-grade children.

^dOnly 6,410 children had information on the availability of school breakfasts.

Table 5
Child, household, and school characteristics stratified by school breakfast receipt among
a cohort of American fifth-grade children (n=6,495)^{a,b}

	Overall	No breakfast receipt ^c	Any breakfast receipt ^c	<i>P</i> value ^d
	% (standard error)			
Child characteristics				
Obese ^e	12.44 (0.6)	10.84 (0.59)	17.78 (1.83)	<0.001
Male	50.33 (1.02)	49.13 (1.12)	54.25 (2.42)	0.059
Age groups				
9.2 to 10.9 y	30.96 (1.11)	30.65 (1.24)	32.00 (2.35)	0.609
11 to 11.4 y	45.33 (1.32)	45.86 (1.46)	43.56 (2.16)	0.332
11.5 to 13.8 y	23.71 (1.15)	23.49 (1.27)	24.44 (2.06)	0.677
Race/ethnicity				
Non-Hispanic white	58.71 (1.77)	68.40 (1.43)	26.40 (3.21)	<0.001
Non-Hispanic black	16.31 (1.3)	10.43 (1.02)	35.93 (4.03)	<0.001
Hispanic	17.99 (1.37)	14.35 (1.17)	30.12 (2.98)	<0.001
Non-Hispanic Asian and other ^f	6.99 (0.94)	6.82 (0.55)	7.54 (3.16)	0.814
	mean (standard error)			
Days child exercised in a week	3.75 (0.04)	3.76 (0.04)	3.72 (0.10)	0.67
Household characteristics				
	% (standard error)			
Below the federal poverty line SES ^g quintiles ^h	19.87 (1.50)	9.37 (0.66)	55.38 (3.36)	<0.001
1 (lowest)	18.28 (1.32)	9.40 (0.73)	47.91 (3.11)	<0.001
2	18.19 (0.87)	16.37 (0.98)	24.26 (2.11)	0.001
3	19.32 (0.79)	19.77 (0.90)	17.80 (1.84)	0.348
4	21.39 (0.88)	25.54 (0.96)	7.58 (1.29)	<0.001
5 (highest)	22.82 (1.07)	28.93 (1.17)	2.45 (0.82)	<0.001
Parents are married	71.95 (1.44)	79.41 (1.07)	47.58 (2.96)	<0.001
	mean (standard error)			
Breakfasts family ate together in a week	3.53 (0.05)	3.83 (0.06)	2.53 (0.09)	<0.001
Dinners family ate together in a week	5.44 (0.03)	5.40 (0.04)	5.60 (0.08)	0.044
	% (standard error)			
Mother's employment status				
Unemployed	25.33 (1.01)	22.37 (0.95)	35.18 (2.36)	<0.001
Part time	22.57 (0.89)	24.78 (0.97)	15.23 (1.71)	<0.001
Full time	52.10 (1.05)	52.85 (1.25)	49.59 (2.12)	0.204
School characteristics				
Public school	87.67 (0.88)	84.33 (1.14)	98.73 (0.65)	<0.001
Census region				
Northeast	19.10 (1.18)	21.71 (1.38)	10.41 (1.70)	<0.001
Midwest	25.31 (1.47)	27.66 (1.56)	17.48 (3.29)	0.004

	Overall	No breakfast receipt ^c	Any breakfast receipt ^c	P value ^d
South	36.97 (1.53)	32.10 (1.70)	53.21 (3.73)	<0.001
West	18.61 (0.96)	18.52 (1.04)	18.91 (2.38)	0.884
	% (standard error)			
Urban status				
Large and mid-sized city	34.52 (1.59)	32.13 (1.74)	42.51 (3.72)	0.01
Large and mid-sized suburb and large town	41.49 (3.07)	45.77 (2.68)	27.22 (5.29)	<0.001
Small town and rural	23.99 (2.91)	22.10 (2.09)	30.27 (6.49)	0.123

^aData from the Early Childhood Longitudinal Study, Kindergarten Class of 1998-1999.

^bAll results were weighted to be nationally representative of American fifth- and eighth-grade children.

^cAny breakfast receipt was defined if parents reported that their child received at least one school breakfast in the past week.

^dP value is for a test in the difference in means/percentages of each variable between children who did and did not receive school breakfasts.

^eChildren were classified as obese if their body mass index *z* score was in the 95th percentile or greater.

^fThe other group included multiracial children and Native Americans.

^gSES=socioeconomic status.

^hFamily socioeconomic status quintiles were created by the Early Childhood Longitudinal Study, Kindergarten Class of 1998-1999 using a composite of father/male guardian's education, mother/female guardian's education, father/male guardian's occupation, mother/female guardian's occupation, and household income.

Table 6
Difference-in-difference propensity score matching estimates of associations between school breakfast receipt and obesity, overall and stratified by socioeconomic status, among a cohort of American fifth- and eighth-graders^{a,b}

Outcome=obesity in eighth grade	SES ^c Quintile			Poverty Line	
	Overall	Bottom 2	Top 3	Below	Above
odds ratio ^d (95% CI)					
Any school breakfasts received in the last week	1.31 (0.92-1.87)	1.40 (0.92-2.14)	1.55 (0.85-2.81)	2.31 ^{**} (1.25-4.28)	1.44 (0.87-2.34)
n ^e	6,495	1,955	4,540	963	5,532

^aData from the Early Childhood Longitudinal Study, Kindergarten Class of 1998-1999.

^bChildren are matched on obesity status in fifth grade, age, sex, race, exercise level, socioeconomic status quintiles, poverty status, parental marital status, number of breakfasts family eats together, the number of dinners family eats together, mother's employment status, public/private school, census region, and urban status.

^cSES=socioeconomic status.

^dMantel-Haenszel.

^eSample sizes shown are the total number of children used in each match; the number of matched sets varies for each match.

^{**} $P < 0.01$.

Table 7

Logistic longitudinal fixed-effects regression of the change in school breakfast receipt on the change in obesity between the fifth and eighth grade, overall and stratified by socioeconomic status, for a cohort of American children^{a,b,c}

Outcome=obese	Wealth Quintiles			Poverty Line	
	Overall	Bottom 2	Top 3	Below	Above
Any school breakfasts received in the past week	0.72 (0.39-1.31)	0.63 (0.29-1.37)	odds ratio (95% CI)		0.51 (0.21-1.26)
Household characteristics					
Parents are married	0.51 * (0.27-0.95)	0.74 (0.31-1.74)	0.36 (0.13-1.01)	0.54 (0.17-1.77)	0.47 (0.21-1.03)
No. of breakfasts family ate together in a week	0.92 (0.84-1.01)	0.93 (0.81-1.08)	0.88 * (0.78-0.99)	1.04 (0.87-1.24)	0.90 * (0.81-1.00)
No. of dinners family ate together in a week	1.12 * (1.01-1.24)	1.02 (0.88-1.18)	1.25 ** (1.08-1.45)	1.05 (0.87-1.25)	1.17 * (1.03-1.33)
Mother's employment status (ref: unemployed)					
Part time	0.99 (0.51-1.91)	1.13 (0.45-2.84)	0.82 (0.29-2.31)	1.93 (0.67-5.60)	0.60 (0.24-1.48)
Full time	0.79 (0.41-1.53)	0.95 (0.38-2.37)	0.54 (0.18-1.59)	1.12 (0.37-3.44)	0.60 (0.25-1.44)
School characteristics					
Public school	0.50 (0.17-1.49)	0.60 (0.05-7.43)	0.73 (0.19-2.81)	— ^d	0.34 (0.10-1.20)
Urban status (ref: large and midsize city)					
Large and mid-size suburb and small town	0.78 (0.30-2.03)	0.52 (0.12-2.23)	0.80 (0.20-3.13)	— ^d	1.29 (0.39-4.22)
Small town and rural	0.42 (0.11-1.60)	0.39 (0.06-2.76)	0.28 (0.04-1.93)	— ^d	0.49 (0.08-2.89)
Eighth grade	0.67 *** (0.53-0.83)	0.85 (0.60-1.21)	0.48 *** (0.35-0.66)	0.86 (0.54-1.35)	0.62 *** (0.47-0.81)
n	742	278	438	186	556

^aData from the Early Childhood Longitudinal Study, Kindergarten Class of 1998-1999.

^bOnly time-variant covariates were included because time-invariant characteristics are automatically dropped due to no variation between the fifth and eighth grade.

^cFixed-effects models are only identified for the subset of children who switched obesity status between the fifth and eighth grade.

^dOmitted due to no variation.

* $P < 0.05$.

** $P < 0.01$.

$P < 0.0001$

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