

Original Investigation

Estimating Impacts of a Breakfast in the Classroom Program on School Outcomes

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IMPORTANCE Short-term impacts of breakfast consumption on diet quality and cognitive functioning have been reported, but more evidence is needed to draw causal inferences about long-term impacts of school breakfast on indicators of school engagement and academic achievement.

OBJECTIVE To estimate the impact of a Breakfast in the Classroom (BIC) program on School Breakfast Program participation, school attendance, and academic achievement.

DESIGN, SETTING, AND PARTICIPANTS This quasi-experimental study included a sample of 446 public elementary schools from a large, urban US school district that served predominantly low-income, racial/ethnic minority students.

INTERVENTIONS A total of 257 schools (57.6%) implemented a BIC program during the 2012-2013 academic year, whereas 189 (42.4%) did not.

MAIN OUTCOMES AND MEASURES School- and grade-level data from 2012-2013 and grade-level achievement data from the prior year were collected from school district records across the elementary schools. Hypotheses that a BIC program would improve school breakfast participation at the school level, school attendance at the grade level (kindergarten through sixth grade), and academic achievement at the grade level (second through sixth grades) were tested using propensity score weights to adjust for demographic differences between the BIC and non-BIC schools.

RESULTS The BIC program was linked with increased breakfast participation during the academic year ($F_{10,414} = 136.90, P < .001$), with mean participation rates of 73.7% in the BIC group vs 42.9% in the non-BIC group. The BIC program was also linked with greater overall school attendance rates (95.5% vs 95.3% in the non-BIC group; $F_{1,2772} = 8.40, P = .004$). When performing attendance analyses in the subset of grade levels for which achievement data were available, results were mostly consistent, although there was a group \times time interaction ($F_{10,1891} = 1.94, P = .04$) such that differences between least squares means in the BIC vs non-BIC groups did not reach statistical significance at every month. There were no group differences in standardized test performance in math (57.9% in the BIC group vs 57.4% in the non-BIC group; $F_{1,1890} = 0.41, P = .52$) or reading (44.9% in the BIC group vs 44.7% in the non-BIC group; $F_{1,1890} = 0.15, P = .70$).

CONCLUSIONS AND RELEVANCE Findings add to the evidence that BIC can increase school breakfast participation substantially and suggest that it has the potential to improve overall school attendance rates. Additional research is needed to explore the generalizability of these findings and the potential impacts on achievement for longer periods and on additional outcomes, such as weight status.

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The national School Breakfast Program (SBP) makes it possible for most US schoolchildren to access a nutritious breakfast every school day, yet many underserved children who are eligible for free or reduced-price breakfasts do not participate in the program. Low SBP participation has been attributed to stigma and logistical difficulties that accompany the traditional SBP delivery model,¹ in which breakfast is served in the cafeteria before school. Many low-income school districts have implemented alternate SBP delivery models in an attempt to address these barriers, such as grab-and-go breakfast, in which students pick up a prepackaged breakfast and take it with them, and Breakfast in the Classroom (BIC), in which breakfast is served in the classroom at the start of the school day, typically as a universal-free meal.² Evidence suggesting that breakfast may improve myriad child outcomes,³⁻⁷ including cognitive functioning,^{4,8,9} has been used to argue for the expansion of such programs as a potential opportunity to narrow the achievement gap between underserved children and their more affluent counterparts.^{10,11} However, more evidence is needed to draw causal inferences about long-term impacts of school breakfast on academic outcomes.

A previously published review⁵ presented evidence supporting positive impacts of the SBP on academic achievement. Positive associations between school breakfast and school attendance have been discussed as a mechanism that may explain such impacts, in addition to or above nutritional mechanisms.^{5,10,12} However, conflicting results exist,¹³⁻¹⁵ and many studies⁵ linking the SBP, school attendance, and academic achievement have been small, cross-sectional, and/or subject to demographic confounders. Inconsistent results across studies¹³⁻¹⁵ may be due to characteristics of the sample (eg, impacts may vary depending on whether children would be consuming no breakfast, an unhealthy breakfast, or a healthy breakfast in the absence of the SBP). It has been argued that increasing school breakfast participation among underserved children is especially important given their increased risks of skipping breakfast and negative outcomes across developmental domains^{10,16} and evidence suggesting that breakfast's benefits may be greatest among these children.^{4,10,17} In addition to sample characteristics, inconsistent results across studies¹³⁻¹⁵ that link school breakfast and academic outcomes could also be due to variability in the independent variable, or SBP delivery model(s), studied.

Impacts of school breakfast have often been estimated by comparing outcomes across schools with different forms of the SBP (eg, by comparing schools offering universal-free meals with those that do not and/or by comparing schools with different SBP delivery models). When a universal-free BIC program began in select Maryland schools, participation in the SBP increased from 25% to 78% of students in these schools during 1 year,¹⁸ and standardized test scores improved to a greater degree than in comparison schools.¹⁹ In a study²⁰ that examined the impact of the BIC program in a large urban school district in the Southwest, increases in participation in the SBP were estimated to be sizeable, and positive effects on standardized test scores were found. Findings differed in a large experimental evaluation of the School Breakfast Pilot Program, in which

universal-free school breakfast was provided to treatment group schools via varying delivery models.¹³ Increases in participation in the SBP were modest in this trial, with a participation rate of 40% in the treatment group after the first year compared with 16% among controls.²¹ Although some results were promising, such as fewer morning nurse office visits in the treatment group,¹³ effects were small, and many other outcomes, such as dietary intake, school attendance, and academic achievement, were not affected.^{13,21} In addition, there were no systematic impacts of universal-free school breakfast on academic outcomes in a study in New York,²² which also found limited increases in participation in the SBP. Observed effects of school breakfast may have been greater if group differences in participation in the SBP had been larger in these studies.

The BIC delivery model has been identified as one of the most promising models to increase participation in the SBP.^{10,19,23} It follows that impacts of the SBP could be magnified when implemented as a BIC program. The drastic increases in participation in the SBP that accompany the BIC program also mean that this delivery model expands the reach of the SBP to students who are otherwise unlikely to participate. Systematic studies of the effects of the BIC program are needed to understand the implications of these possibilities, especially given that the implementation of the BIC program is ongoing in many large US school districts.² Little research has focused on the impacts of the BIC delivery model specifically. Although one study²⁰ found academic impacts of the BIC program, most larger studies^{13,14} of the impact of the SBP have included a mixture of delivery models. The aim of this study was to examine school breakfast participation, school attendance, and academic achievement in elementary schools with vs without a BIC program in a large urban school district. These research questions can add to the evidence base on school breakfast and inform future efforts to study and expand the SBP.

Methods

Participants

Study procedures were approved by the Tufts University Institutional Review Board and by the large urban school district under study. No individual consent was required for this analysis of aggregate-level, deidentified data. The sample consisted of 446 public elementary schools within one large urban US school district. Of these schools, 257 (57.6%) offered the BIC program during the 2012-2013 academic year, and 189 (42.4%) did not. Half of the BIC schools implemented the program by November, three-quarters implemented it by January, and nearly 100% implemented it by March. Schools without the BIC program continued to offer the traditional SBP in the cafeteria, which yielded district-wide participation rates below 30% before the start of this study. School- and grade-level data in 2012-2013, as well as grade-level achievement data from the prior year, were collected from school district records across the elementary schools. Analyses included all 446 elementary schools except for those examining participation

in the SBP (participation data were available for 423 elementary schools). Most study schools included kindergarten through fifth grade; one-quarter also included sixth grade. The representation of grade levels did not differ across the BIC and non-BIC schools ($\chi^2_6 = 0.95, P = .99$). In 2012-2013, more than 80% of students in the school district were eligible for free- or reduced-price school meals, and more than 70% of the students were Hispanic/Latino.

Measures

Participation in the SBP

Participation in the SBP was calculated for each month of the 2012-2013 academic year at the school level by dividing average daily breakfast meal counts by total student enrollment.

School Attendance

Two indicators of attendance were available at the grade level during each month of the 2012-2013 academic year: (1) attendance rates were calculated by dividing total attended student-days by total enrolled student-days, and (2) high attendance was quantified as the percentage of students attending 96% or more of enrolled school days. Grade level nested within schools served as the identification variable in models that examined attendance, with kindergarten through sixth grade included.

Academic Achievement

Achievement was measured yearly via state standardized tests. Data were available at the grade level in spring 2013 and spring 2012. Percentages of students in each grade who achieved state benchmarks in reading and math were used to indicate academic achievement. Grade level nested within schools served as the identification variable in models that examined achievement, with second through sixth grade included because these were the grades in which standardized tests were administered.

Demographics

Baseline demographic variables were collected in August 2012 and included the number of students enrolled in each elementary school and the percentage of students in each school who were eligible for free or reduced-price school meals, learning English as a second language, enrolled in special education, female, Hispanic, white, black, Asian, Filipino, Pacific Islander, and American Indian/Alaskan Native. In addition, indicators of whether schools were pilot schools that implemented the BIC program before 2012-2013 and whether they were participating in a technology initiative were collected (3.8% of schools in each case).

Statistical Analysis

Analyses were conducted with SAS statistical software, version 9.3 (SAS Institute Inc). Propensity score weighting was used to facilitate causal inferences about the impacts of the BIC program on school breakfast participation, school attendance, and academic achievement. All available school-level variables were tested for association with the grouping variable (the BIC vs non-BIC schools) and outcomes of interest. Vari-

ables that were associated with both (ie, potential confounders) were included in the propensity score model. These variables included free- or reduced-price meal eligibility, English language learner status, special education status, student enrollment, race/ethnicity variables, and prior reading and math achievement in spring 2012. The propensity score model, with the BIC group as the outcome and these 13 variables as predictors, was estimated using logistic regression. The question of interest was whether the treated group (the BIC schools) had different outcomes than they would have if not provided with the BIC program or the average treatment effect among the treated; propensity score weights were calculated accordingly, such that those in the BIC group received a weight of 1 and those in the non-BIC group received a weight of $\pi/(1 - \pi)$, where π is the propensity score.^{24,25} All outcome analyses included the propensity score weights to account for potential confounding by measured covariates.

Generalized linear mixed models were used to estimate the impact of the BIC program on outcomes of interest given the multilevel data. Models contained a random statement with the residual option and subject variable specified (school identification for the participation outcome; grade level nested within school for other outcomes) and with month specified when there were repeated measures (participation and attendance outcomes). For repeated-measures models, multiple covariance structures were tested (eg, compound symmetry and unstructured), and the best-fitting model was selected. Final models included generalized linear mixed models that estimated the impacts of the BIC program on school breakfast participation and school attendance over 10 months (August 2012 to June 2013), adjusting for school-level propensity score weights, with the BIC group, month, and interaction as predictors. Significant BIC group differences in least squares means were examined at each month or overall in the absence of a group \times time interaction. Final attendance analyses were repeated in the subset of grade levels for which achievement data were available (second through sixth grades). Models that estimated the impact of the BIC program on math and reading achievement in spring 2013 were also conducted, adjusting for the propensity score weights, and significant BIC group differences in least squares means were examined. Alternate analyses specifying a random intercept for schools in grade-level models were explored to examine robustness of the results.

Results

Descriptive Statistics

Initially, the BIC and non-BIC schools differed on measured covariates, as indicated by the unadjusted mean differences. Adjusting for propensity score weights balanced the groups on these covariates (Table).

Estimating the Impact of the BIC Program

Participation in the SBP

The BIC group predicted participation in the SBP over time, as indicated by a significant interaction between the BIC group

Table. School Characteristics and Standardized Mean Differences Before and After Propensity Score Adjustment^a

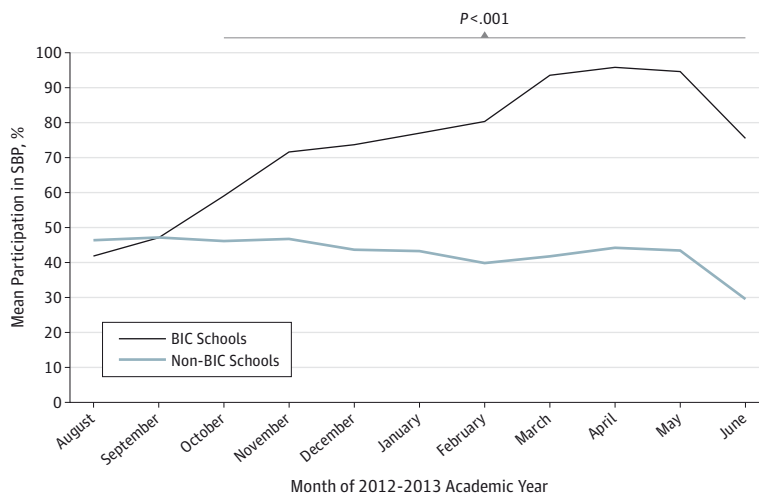
Characteristic	Unadjusted Values			Adjusted Standardized Mean Difference
	Non-BIC Schools, Mean (SD)	BIC Schools, Mean (SD)	Standardized Mean Difference	
Total student enrollment	467.17 (187.27)	605.65 (200.83)	0.69	0.07
Students who were, %				
Hispanic/Latino	54.48 (0.31)	85.27 (0.16)	1.97	0.05
Black	11.37 (0.18)	8.04 (0.13)	-0.26	0.05
White	23.64 (0.26)	2.48 (0.05)	-3.96	-0.01
Asian	6.61 (0.09)	2.50 (0.07)	-0.62	-0.16
American Indian/Alaskan Native	0.55 (0.01)	0.36 (0.00)	-0.39	-0.02
Pacific Islander	0.69 (0.01)	0.30 (0.01)	-0.49	-0.08
Filipino	2.68 (0.04)	1.07 (0.02)	-0.67	-0.10
Free- or reduced-price meal eligible	45.92 (0.31)	74.61 (0.31)	0.92	-0.12
English-language learners	20.24 (0.15)	37.88 (0.11)	1.65	0.01
Enrolled in special education	4.78 (0.02)	4.02 (0.02)	-0.48	0.02
High math achievers	68.16 (0.14)	56.34 (0.11)	-1.11	0.01
High reading achievers	61.62 (0.16)	45.99 (0.10)	-1.63	-0.05

Abbreviation: BIC, Breakfast in the Classroom.

^a Standardized mean differences were calculated as recommended by Lanza and colleagues.²⁴ Unadjusted values demonstrate that the BIC and non-BIC schools differed on these measured confounders, with all standardized mean differences greater than 0.20. Positive standardized mean differences demonstrate that values for the corresponding variable were higher in the BIC schools, and negative values demonstrate the reverse. As shown in the final column, all standardized mean differences were below the small effect size of

0.20 after propensity score adjustment, demonstrating that balance between the 2 groups was achieved. All these variables are at baseline, defined as August 2012, with the exception of achievement variables, which are from spring 2012, given that these are only available yearly. Balance was also confirmed in grade-level analytic data sets with all grades (kindergarten through sixth grade) and the subset of grades with achievement data (second through sixth grades).

Figure 1. School Breakfast Participation in Breakfast in the Classroom (BIC) vs Non-BIC Schools in Academic Year 2012-2013



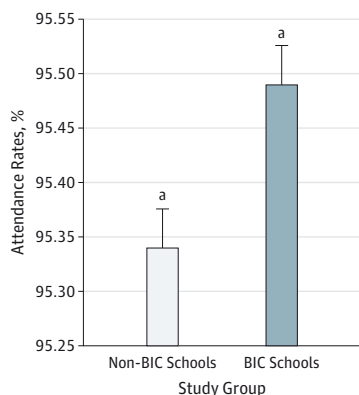
There was a significant interaction between the BIC group and month. The BIC schools had greater participation in the School Breakfast Program (SBP) than the non-BIC schools from October 1, 2012, and through the rest of the academic year ($P < .001$ for all between-group comparisons during these months). Participation in the SBP increased across the academic year as the BIC program was implemented in the BIC schools. Participation rates depicted are least squares means. Data are at the school level.

and month ($F_{10,414} = 136.90, P < .001$), with mean participation rates of 73.7% in the BIC group vs 42.9% in the non-BIC group. Participation in the SBP was greater in the BIC schools compared with the non-BIC schools, beginning in October and through the rest of the academic year ($P < .001$ for comparisons at each month from October, 2012 to June 2013). As shown in Figure 1, participation increased as the BIC program was implemented in the BIC schools, from 41.9% in August 2012 to 94.6% in May 2013 vs 46.4% and 43.4%, respectively, in the non-BIC schools.

School Attendance

There was a significant main effect of BIC on attendance, such that grade-level attendance rates were higher for the BIC schools compared with grade-level attendance rates in the non-BIC schools across the academic year (95.5% vs 95.3%, respectively; $F_{1,2772} = 8.40, P = .004$; Figure 2). There was also a main effect of month ($F_{10,2772} = 1884.02, P = .04$), such that overall attendance rates fluctuated across the year. These patterns did not differ by the BIC groups ($P = .70$ for the interaction). Results were similar when examining the percentage of stu-

Figure 2. Attendance in the Breakfast in the Classroom (BIC) vs Non-BIC Schools in Academic Year 2012-2013



Grade-level attendance rates were higher for the BIC schools than the non-BIC schools across the 2012-2013 academic year. All elementary grades (kindergarten through fifth grade and sixth grade where applicable) within the 446 study schools were included in these analyses, with grade level nested within school as the identification variable. Attendance rates depicted are least squares means for each group (the BIC vs non-BIC schools). The group differences reflect a mean difference of 76 student-days, or 76 more school days attended per month, across students in each grade in the BIC schools compared with the non-BIC schools. Error bars indicate SE.

^a $P < .01$.

dents with high attendance as the outcome, with consistent main effects of the BIC group ($F_{1,2772} = 4.24, P = .04$) and month ($F_{10,2772} = 1444.88, P < .001$) and a nonsignificant group \times month interaction ($P = .05$). When performing attendance analyses in the subset of grade levels for which achievement data were available, results were mostly consistent, although there was a group \times time interaction ($F_{10,1891} = 1.94, P = .04$ for attendance rate; $F_{10,1891} = 3.17, P < .001$ for high attendance), such that differences between least squares means in the BIC vs non-BIC groups did not reach statistical significance at all months.

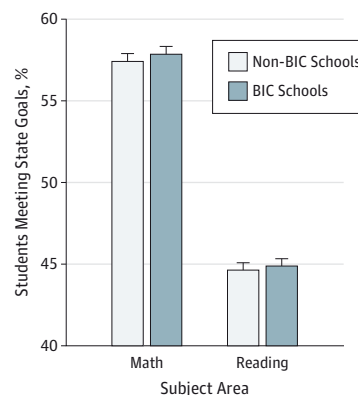
Achievement

As shown in **Figure 3**, there were no significant main effects of the BIC program on grade-level math (57.9% in the BIC group vs 57.4% in the non-BIC group; $F_{1,1890} = 0.41, P = .52$) or reading (44.9% in the BIC group vs 44.7% in the non-BIC group; $F_{1,1890} = 0.15, P = .70$) achievement.

Discussion

The goal of the current study was to draw causal inferences about the impacts of the BIC program on participation in the SBP, school attendance, and academic achievement in a large urban school district, in which approximately half of elementary schools offered the BIC program during 2012-2013. Analyses revealed that participation in the SBP and school attendance were higher in the BIC schools compared with the non-BIC schools, whereas math and reading achievement did not differ across the BIC and non-BIC schools.

Figure 3. Math and Reading Achievement in the Breakfast in the Classroom (BIC) vs Non-BIC Schools in Spring 2013



The percentages of students within a grade who met state benchmarks for math ($P = .52$) and reading ($P = .70$) did not differ between the BIC schools and the non-BIC schools. Second through sixth grades within the 446 study schools were included in this analysis, with grade level nested within school as the identification variable. Achievement rates depicted are least squares means. Error bars indicate SE.

Although findings that the BIC program increased participation in the SBP were not surprising, they provide confirmation that school breakfast exposure differed between the study groups. These findings also add to the evidence that the BIC program has the potential to increase participation in the SBP more than other delivery models, supporting the idea that the impact of this manipulation may be greater than those seen in previous studies of the SBP.^{13,14} Given this and given that the BIC program is currently being implemented² and promoted¹⁰ in many low-income school districts, it is important to understand its effects.

Therefore, we estimated the impacts of the BIC program on school attendance and achievement, finding that attendance was higher in the BIC group across the 2012-2013 academic year compared with the non-BIC group. These findings parallel research reporting that the SBP is associated with increased attendance,^{5,10} although some previous research examining this outcome has produced null results.^{13-15,20} Although group differences in attendance were not large in this study, their magnitude reflects 76 additional attended days per grade per month, and results were robust, with consistent findings across 2 indicators of attendance and no modification by time. Results were also similar in the subset of grade levels for which achievement data were available, although the BIC vs non-BIC group comparisons did not reach significance at every month in this follow-up analysis. These results may be attributable to smaller sample sizes in subset analyses.

Associations between the SBP and increased attendance have been discussed as a potential mechanism through which breakfast may benefit academic achievement.^{4,5,10} However, in the current study, the BIC group had higher attendance but did not differ on achievement compared with the non-BIC group. One interpretation of this result is that, despite concerns about potential decreased instructional time,²⁰ there

were no negative impacts of the BIC program on achievement. However, the achievement results should be interpreted with caution for multiple reasons. Although the participation and attendance results were robust to various model specifications tested, including alternate attendance models specifying random intercepts for schools, the achievement results were not. Furthermore, only one time point of achievement outcome data was available, and at the time of standardized testing, the BIC program had been recently implemented in some schools. It is possible that increased attendance may translate into increased academic performance during a longer period or using different measures of achievement. Standardized test scores may not reflect the BIC impacts if there are district-wide efforts to promote school meal consumption on testing days, which is a common practice nationwide.²⁶ It is also possible that the BIC program and/or increased attendance only translate into improved achievement in certain subgroups. This theory is consistent with the ideas that positive impacts of school breakfast^{5,10,27} and school attendance²⁸ may be greatest among underserved children and consistent with findings suggesting positive overall impacts of the BIC program on achievement in a sample in which 94% of students were economically disadvantaged and in which impacts were magnified among the highest-need students.²⁰ Confounding between school characteristics and the timing of implementation of the BIC program prevented an unbiased examination of effect moderation by demographics in the current study, but taken together, the extant research highlights that additional studies monitoring the BIC program's impacts on multiple measures of learning and achievement during longer periods and within different demographic subgroups is essential to understand the program impacts in different contexts.

Strengths of the current study include its specific focus on the timely BIC delivery model, as well as the use of propensity score methods to facilitate causal inferences. In addition,

data were obtained directly from the school district and were available over multiple time points and, in most cases, by grade level. Limitations of the study include the inability to examine actual consumption of school breakfast or broader dietary patterns and the possibility that there are additional unmeasured covariates that should be considered, such as mobility rates. In addition, these data do not allow examination of outcomes at the individual level, and results cannot be generalized beyond the current delivery model, sample characteristics, and outcomes. Our study did not include measures of physical health, dietary intake, physical activity, or weight status. These outcomes will be important to measure to determine the impacts of the BIC program on the whole child. In one study,²⁹ it was suggested that the BIC program may have an undesirable impact on weight outcomes through the increased likelihood of consuming 2 breakfasts, but total daily energy intake was not measured. At this time, the impact of the BIC program on energy balance is an open and important question.

Conclusions

The current study contributes evidence about school outcomes after implementation of the BIC program in a large urban school district with a substantial proportion of underserved children. Results confirm that the BIC program can increase school breakfast participation rates drastically and highlight potential positive impacts on school attendance, as well as the absence of negative impacts on academic achievement. Additional research is needed to examine impacts on academic achievement across different demographics and for longer periods and on outcomes in other domains, such as energy balance. Continuing the expansion of this evidence base can inform policy decisions and promote the health and well-being of the whole child.

ARTICLE INFORMATION

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Study concept and design: All authors.

Acquisition, analysis, or interpretation of data:

Anzman-Frasca, Halmo, Economos. *Drafting of the manuscript:* Anzman-Frasca.

Critical revision of the manuscript for important intellectual content: All authors.

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