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Socioeconomic differences in the association between competitive food laws and the school food environment

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Abstract

BACKGROUND—Schools of low socioeconomic status (SES) tend to sell fewer healthy competitive foods/beverages. This study examined whether state competitive food laws may reduce such disparities.

METHODS—Fifth- and 8th-grade school administrators reported foods and beverages sold in school; index measures of the food/beverage environments were constructed from these data.

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Human Subjects' Approval Statement

The study was approved by the Institutional Review Boards of the University of Illinois at Chicago and the University of Texas Health Science Center at Houston.

Schools were classified into SES tertiles based on median household income of students' ZIP code. Regression models were used to estimate SES differences in: (1) Healthy School Food Environment Index (HSFEI) score, Healthy School Beverage Environment Index (HSBEI) score, and specific food/beverage sales, and (2) associations between state competitive food/beverage laws and HSFEI score, HSBEI score, and specific food/beverage sales.

RESULTS—Strong competitive food laws were positively associated with HSFEI in 8th grade, regardless of SES. Strong competitive beverage laws were positively associated with HSBEI particularly in low-SES schools in 8th grade. These associations were attributable to schools selling fewer unhealthy items, not providing healthy alternatives. High-SES schools sold more healthy items than low-SES schools regardless of state laws.

CONCLUSIONS—Strong competitive food laws may reduce access to unhealthy foods/beverages in middle schools, but additional initiatives are needed to provide students with healthy options, particularly in low-SES areas.

Keywords

Nutrition & diet; health policy; public health; child & adolescent health; evaluation

Over the past decade, many states and school districts in the United States (U.S.) have enacted policies to regulate the nutrition content of foods and beverages sold in schools, commonly known as 'competitive foods'.[1,2] Policy changes were spurred by the high prevalence of childhood obesity (16.9% among 2- to 19-year-olds in 2011–12)[3] and evidence that competitive foods tend to include sugar-sweetened beverages (SSBs), candy, and other foods and beverages of low nutritional value.[4,5] Experts believe that the availability of unhealthy competitive foods in schools contributed to the rapid increase in obesity over time.[6] Further, there is growing evidence that policies setting nutrition standards for competitive foods have led to healthier school food environments, student dietary intake, and student weight status.[7–15]

To date, most research on competitive food policies has focused on the general population; few studies have analyzed policy effects on health disparities. This gap in the literature is crucial given that eliminating persistent socioeconomic disparities[16] in health is a prominent goal of *Healthy People 2020.*[17] Socioeconomic status (SES) is inversely associated with obesity risk among children.[18] Some studies have further suggested that socioeconomic disparities in childhood obesity grew in the U.S. in recent years,[19–21] during the same period in which the overall prevalence stabilized.[3]

These patterns exemplify the challenges of achieving two goals at once – improving the health of the general population and reducing health disparities.[22,23] To achieve both goals, interventions must target social and environmental determinants of health that disproportionately affect disadvantaged communities and contribute to socioeconomic disparities.[24] Competitive foods could be an effective target because nationally representative data suggest that high-SES secondary schools tend to have more healthy competitive foods available,[25] though competitive food access generally did not vary by SES at the elementary school level.[26] To date, however, few studies have directly examined

whether competitive food policies – particularly state laws – may reduce socioeconomic disparities in competitive food access. The only studies that examined this topic focused either on specific states[27] or specific food/beverage groups.[8] Both studies generally reported modest or no evidence that state competitive food law effects differed by SES (defined by the proportion of students in the school who were eligible for free/reduced-price lunches). A recent study reported that other school nutrition policy changes – specifically, updated standards for national school lunch programs – may have been most effective in low-SES schools.[28]

This study was designed to conduct a comprehensive assessment of socioeconomic differences in: (1) the school food and beverage environment, and (2) the association between state competitive food laws and the school food/beverage environment. Using data from 40 states, we analyzed index measures of the overall school environment, as well as data on the availability of specific food/beverage groups, including both healthy and unhealthy options, within school. This enabled us to determine how schools adhered to competitive food laws – for example, did schools offer fewer unhealthy items or offer more healthy items – and whether adherence methods or the school food environment in general differed in high- versus low-income areas.

METHODS

This study linked 5th and 8th grade data from the Early Childhood Longitudinal Study-Kindergarten Class (ECLS-K) with state law data from the National Cancer Institute's Classification of Laws Associated with School Students (CLASS). Data sources are described in detail below. School was the unit of analysis, and all analyses were cross-sectional.

Participants

Data on the school food environment were obtained from ECLS-K, a cohort study conducted by the National Center for Education Statistics.[29] ECLS-K began in Fall 1998 with a nationally representative sample of kindergarten students, including private school students, who were subsequently followed through seven rounds of data collection. This study utilized data from public schools in Round 6 (collected in Spring 2004) and Round 7 (Spring 2007), when students were in 5th and 8th grade, respectively. Additional details on the ECLS-K design can be found elsewhere.[29]

For the purpose of this study, schools were classified into tertiles of SES. Median household income was used as a measure of SES. Median household income data were obtained from the 2000 U.S. Census and matched to the ZIP code in which ECLS-K student participants resided. An overall measure of school SES was created based on a weighted average of study participants' median household income. In 5th grade analyses, schools were classified into tertiles (low-, medium-, high-income) based on the distribution of median income in the 5th-grade sample. For consistency, the cut-offs that were used to define low-, medium-, and high-income categories in 5th grade were also used to categorize schools in 8th grade.

Tertile cut-offs were determined in the 5th grade sample after excluding schools that were missing data on school type (N=30), any food/beverage items (N=370), school locale (N=150), or average median household income (N=80). Schools that were excluded due to missing data did not differ from the study sample in terms of the Healthy School Food Environment Index (described in the following section), state competitive food/beverage laws, state median income, or state obesity prevalence; however, they tended to have higher Healthy School Beverage Environment Index scores ($p<.001$), were more likely to be in suburban areas ($p<.01$), and were more likely to be in the South ($p<.01$). Eighth-grade schools were excluded based on the same criteria (n=50, 360, 240, and 220, respectively.) Schools excluded in 8th grade tended to be in states with stronger competitive food/beverage laws ($p<.01$), were more likely to be in urban areas ($p<.01$), and were more likely to be in the South ($p<.01$). The final study samples included 1410 and 1430 schools in 5th and 8th grade, respectively.

Instrumentation

The school food environment was measured through a questionnaire completed by school administrators. The questionnaire included a list of food/beverage items, such as bottled water, or general categories, such as “salty snacks that are not low in fat,” and asked administrators to report which ones were sold in school. The same list was used in both survey rounds. Note that, although ECLS-K was a cohort study, most students changed schools between rounds.

We combined individual food and beverage groups to create index measures of the food environment, beverage environment, and overall environment. Indices are described briefly here and in more detail in the Appendix. First, the number of specific unhealthy groups that were sold was subtracted from the number of specific healthy groups that were sold. This was conducted for foods and beverages both separately and collectively. Raw scores could theoretically range from −4 to 5 for foods, −2 to 4 for beverages, and −6 to 9 combined. Each index measure was then standardized (mean=0, standard deviation=1) to make them more comparable to each other. A higher score was indicative of a healthier environment, and therefore we refer to these as the Healthy School Food Environment Index (HSFEI), Healthy School Beverage Environment Index (HSBEI), and Healthy School Overall Environment Index (HSOEI).

State Law Data – CLASS

CLASS is a database of empirical ratings for state codified laws regarding nutrition standards for competitive foods and beverages, among other policy domains.[30] Analyses in this study were based on six different categories of law – those governing the nutrition content of foods sold in: (1) vending machines, (2) cafeterias (a la carte), and (3) school stores and other venues, and those governing the nutrition content of beverages in the same three locations.

Beginning in 2003, statutory and administrative laws were compiled from the Westlaw subscription-based legal research database using primary legal research methods.[31] Each law was analyzed and rated annually on a scale of 0–6; each year’s rating reflects laws that

were in place as of December 31 of that year. Ratings were based on the strength of language, specificity, and comprehensiveness of laws, in accordance with standards and recommendations established by the Institute of Medicine and U.S. Department of Agriculture, with higher ratings reflective of more stringent laws. Laws governing elementary, middle, and high schools were rated separately.

For our purpose, states were categorized as having 'strong' laws if their average rating was >2.0. States were categorized as having no law if the average rating was 0, and 'weak' laws if the average rating was 1–2. The cut-off to distinguish between 'strong' and 'weak' was chosen because ratings of 1 or 2 reflected laws with standards that were not required or contained ambiguous language, such as 'healthy' foods. Additional details on the law ratings criteria can be found elsewhere.[30] States were categorized with respect to food laws and beverage laws independently, and with respect to all six laws combined.

Data Analysis

All analyses were conducted at the school level in the 5th and 8th grade samples independently. First, ordinary lease squares (OLS) regression models were used to estimate differences between school SES tertiles in the average Healthy Index scores, using indicator variables to represent medium- and high-SES schools. A positive coefficient would indicate a healthier environment in medium- or high-SES schools relative to low-SES schools, the reference group. Models adjusted for school locale (urban, suburban, rural/township); Census region (South vs. other); state adult obesity prevalence; and state median income. Census region was modeled as a binary variable due to the lack of geographic variation in competitive food laws. Adult obesity prevalence and state median income data were obtained from the Behavioral Risk Factor Surveillance System (BRFSS) and U.S. Census, respectively. BRFSS and Census data from 2003 and 2006 were used in 5th and 8th grade analyses, respectively. All models used a robust standard error to adjust for in-state clustering.

Second, logistic regression models were used to model the association between SES tertile and the sale of specific food/beverage items, adjusted for the same covariates that were included in OLS models. Following each logistic model, the 'margin' command in Stata, Version 13, was used to estimate the average difference between SES tertiles in the probability of offering specific foods/beverages.[32] A positive coefficient would indicate that medium- or high-SES schools were more likely to sell that specific food/beverage. Again, a robust standard error was used in each model.

Finally, to determine if the associations between state laws and school food environment varied by school SES, we added 2 indicator variables for state law categories (weak and strong laws) and 4 interaction terms between state law categories and school SES tertiles. Fifth-grade analyses used 2003 elementary school laws; 8th-grade analyses used 2006 middle school laws. Competitive food law categories were used when modeling HSFEI scores and specific food items; competitive beverage law categories were used when modeling HSBEI scores and specific beverage items. Overall law categories were used when modeling HSOEI scores. A positive coefficient for the main effect of law categories would indicate that laws were associated with a healthier environment in low-SES schools. A

positive coefficient for the interaction terms would suggest that this association was stronger in medium- or high-SES schools. When interaction terms were not statistically significant (α=0.05), models were repeated without the interaction terms to estimate the association between state laws and the school food environment in the total sample.

We conducted sensitivity analyses to assess how self-report bias may influence our results. Administrator data on SSB availability were compared to data from students, who were also asked whether SSBs were sold in school (SSBs were the only survey item that was measured identically in administrator and student surveys.) In a series of three sensitivity analyses, schools were excluded if they did not meet minimum criteria for "concordance" – that is, the proportion of students whose response on SSB availability was the same as the response from their school administrator – using three different cut-offs for concordance (50%, 67%, and 75%). These criteria excluded 330, 440, and 490 schools, respectively, in 5th grade, and 560, 690, and 760 schools, respectively, in 8th grade. Analyses of SSB availability and index measures were repeated in these 3 reduced samples. Results of the sensitivity analyses are not shown here, but we found that the association between competitive beverage laws and SSB sales was stronger in samples with higher concordance, whereas the associations between state laws and index measures were unaffected. In short, there was no evidence that measurement error biased results away from the null. This pattern was observed in the total sample and within every SES tertile. Therefore, we used the full sample in all analyses.

RESULTS

Descriptive statistics of food/beverage access, competitive food/beverage laws, school locale, and Census region, stratified by grade and school SES, are shown in Table 1. There were large differences by SES tertile in school locale and Census region. Low-SES schools were more likely to be in urban areas, particularly in 5th grade (61.8%), whereas high-SES schools were more likely to be in suburban areas (66.0% and 69.3% in 5th and 8th grade, respectively). Low-SES schools were more commonly located in the South (40.5% and 41.6% in 5th and 8th grade, respectively) than high-SES schools (21.9% and 25.6%, respectively.) High-SES schools tended to sell more items of all types in both grade levels. The distribution of overall law categories (none, weak, strong) was similar across SES tertiles in both grades.

The associations between school SES and the school food environment are displayed by grade level in Table 2. In 5th grade, each Healthy Index measure was approximately equal across SES tertiles, but there were differences in the availability of specific food/beverage groups. High-SES schools tended to sell more of everything, including healthy and unhealthy groups. Baked goods, for example, were more likely to be sold in high- versus low-SES schools, regardless of whether the baked goods were low-fat (adjusted prevalence=30.6% vs 18.8%, respectively; AME=0.12, 95% CI: 0.05, 0.19) or not (44.3% vs 26.7%, AME=0.18, 95% CI: 0.07, 0.28). In contrast, disparities in Healthy Index scores were observed in 8th grade, when high-SES schools tended to have a healthier overall environment (AME=0.26, 95% CI: 0.12, 0.40). In 8th grade, differences in unhealthy items tended to be smaller than they were in 5th grade, whereas differences in healthy items were larger. In both grades, medium-SES schools also tended to sell more of all foods/beverages

than low-SES schools, but differences were smaller and the Healthy Index scores were approximately equal in both grades.

Table 3 displays the associations between strong competitive food/beverage laws and index measures. (The results for weak laws are omitted due to space constraints and because, consistently, there was no association between weak laws and the school food environment.) Strong laws were not associated with index scores in 5th grade in the overall sample, nor did these associations vary by school SES. By 8th grade, however, states with strong laws tended to have higher HSFEI and HSOEI scores, regardless of school SES. There was also evidence that competitive beverage laws had a stronger association with HSBEI scores in low-SES schools compared to medium- or high-SES schools in 8th grade.

When modeling specific food/beverage items, there was no evidence of interactions between state laws and school SES in either 5th or 8th grade. As a result, Table 4 displays results for the overall sample. There were no associations between strong laws and any food/beverage item in 5th grade, but as in Table 3, there were several associations in 8th grade. Interestingly, the associations were only observed when modeling unhealthy food/beverage groups – e.g., SSBs and food items that were not low-fat. (Note that positive associations indicate higher availability, and therefore strong laws would ideally be expected to have a positive association for healthy items and a negative association for unhealthy items.) In the case of baked goods, for example, strong food laws were associated with lower access to baked goods that were not low-fat, but strong laws were not associated with access to low-fat baked goods. Strong laws were not positively associated with access to any healthy food/beverage group.

To illustrate these results further, Figure 1 displays the adjusted proportion of schools that sold regular and low-fat baked goods in states with no competitive food laws versus states with strong laws, by school SES, in 8th grade. The availability of regular baked goods was lower in states with strong laws, regardless of SES; conversely, the availability of low-fat baked goods was not associated with state laws in any SES category, but it was consistently higher in high-SES schools than low-SES schools. Baked goods are used as an example, but results were similar for other food items that could be sold as regular or low-fat versions.

DISCUSSION

The evidence base for competitive food policies has grown over the past decade,[7–15] but little research has focused on socioeconomic differences in policy effects. This study provided encouraging evidence that competitive food laws improved the nutritional quality of the school food environment in middle schools, regardless of local income. It also shed light on how schools were adhering to laws and why additional steps are needed to promote student health and reduce disparities.

Two results stood out in our analyses of competitive food laws: (1) how the association between laws and the school food environment differed across grades, and (2) the fact that associations were attributable to unhealthy food/beverage groups, not healthy alternatives. In 2004, when ECLS-K students were in 5th grade, there was no evidence that competitive food

laws improved the school food environment regardless of school SES; by 2007, when ECLS-K students were in 8th grade, competitive food laws were strongly associated with healthier index scores. This change could be a function of grade level or secular trends. Students were transitioning from elementary to middle school during this time, and state laws could theoretically have a bigger impact in middle schools, where local policies tend to be less restrictive.[1] Alternatively, existing laws may have been enforced more in the 2006–07 school year, when school districts that participated in federal school meal programs were first required to implement wellness policies targeting nutrition and physical activity.[33]

It is encouraging that food and beverage laws appeared to be effective in low-income areas. The caveat, however, is that schools tended to adhere to laws by eliminating unhealthy items, not replacing them with healthy items such as fruits and vegetables or low-fat snacks. Similar substitution patterns have been reported in studies of specific states. Multiple studies of California's competitive food laws reported that schools adhered to laws by eliminating unhealthy items and replacing them with items that were compliant but had limited nutritional value.[15,27] Cullen et al. likewise reported that school nutrition policy changes in Texas initially led to a decline in sales of chips but no difference in sales of fruits/vegetables.[34]

If schools only eliminate unhealthy items, competitive food laws would not address the general lack of healthy competitive foods in low-SES schools.[25] The ultimate effect that laws have on students' diet, and SES disparities in students' diet, would depend on how students compensate for not having healthy foods/beverages available in school. If, for example, students compensate by leaving campus to purchase foods and beverages from convenience stores, fast food outlets, or other food establishments, it could disproportionately affect students in low-income areas who tend to have less access to healthy foods in the community.[35] This would have important implications for open campus policies or zoning codes that regulate where such establishments can be built. Future research should examine how students compensate when no healthy alternatives are available in school.

The lack of effect that competitive food laws had on healthy items may help explain why socioeconomic disparities in index measures were greater in 8th grade than 5th grade. At both grade levels, high-SES schools overall were more likely to sell healthy foods/beverages than low-SES schools. These disparities existed in both grades but tended to be greater as the cohort of students progressed from 5th to 8th grade. National surveillance data have similarly indicated that high-SES secondary schools are more likely to sell healthy items.[25] Though our Table 3 results indicated that the associations between state competitive food laws and the overall school food environment did not vary by SES, and may have even been stronger in the case of beverage laws, there was no evidence that competitive food laws reduced disparities in the availability of healthy items.

Limitations

A key limitation of this study was the reliance on school administrator-reported measures of the school food environment. Exploratory analyses revealed that there were many cases where student data on SSB access differed from administrator-reported data on SSB access.

We conducted sensitivity analyses to assess how measurement error might bias our results, and the sensitivity analyses suggested that, if we excluded schools in which administrator-reported data were particularly questionable, the association between laws and SSB availability was stronger. We conservatively chose to include the full sample in which the association was weaker. Nonetheless, we emphasize measurement error here because it may explain why studies that relied on administrator-reported data of the school food environment reported no association between the environment and BMI change.[36] Validation studies that that compare school administrator-reported data to objective observational data would help to understand the accuracy of such data and whether potential biases in reporting exist.

Another limitation of our study is that, as with any observational study, the possibility of unmeasured confounding precludes use from concluding whether state laws were the cause of any differences in the school food environment. The cross-sectional design of this study makes it particularly vulnerable to confounding. It should be pointed out that other federal and local policies were being enacted during the period when study data were collected,[37,38] and the high correlation among laws within states makes it impossible to pinpoint whether one particular law accounts for any differences in the school food environment. Our analyses also did not include local district policies that may strengthen the effect of state laws.[8] Misclassification of school SES is another limitation given that we relied upon 2000 Census data of median income. Finally, our study was limited to school-level analyses, as we did not examine whether state laws were associated with student dietary behaviors or weight status.

Conclusion

Over time, competitive food laws have succeeded in improving the nutritional quality of foods and beverages that are sold in school.[7–15] Our results indicated that this success extends to both low- and high-income areas, specifically by removing high-fat, high-sugar foods and beverages. Policy initiatives should build on their initial success by providing healthier foods/beverages in school, particularly in low-income areas, and addresses the social and economic barriers to healthy food in the community.

IMPLICATIONS FOR SCHOOL HEALTH

These results reflect both the strengths and limitations of competitive food policies as an intervention to improve school nutrition. As a recent systematic review concluded, competitive food policies are “doing what they were intended to do” by reducing the availability of unhealthy items,[7] and our study adds to the evidence that competitive food policies have achieved this objective. There is little evidence that competitive food policies promote healthy alternatives, however. Other school policies may overcome this limitation, including recent updates to National School Lunch Program (NSLP) standards that were explicitly designed to require healthy items.[39] Early evidence suggested that NSLP changes increased students’ average fruit/vegetable consumption,[40] and administrators have reported that NSLP changes increased school meal consumption in low-SES schools.[28] Comprehensive policy changes that address school meals and competitive foods may be more effective at improving overall student health while simultaneously reducing disparities.

At this stage, though, there is little knowledge about the cumulative effect of school meal and competitive food policies, or how changes to certain venues affect other venues. Schools, policymakers, and researchers need to collaborate to recognize the strengths and limitations of different types of policies, and explore methods to overcome their respective limitations.

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APPENDIX 1 – Construction of food/beverage indices

Administrators were asked to report whether the following food/beverage items were sold in schools: chocolate candy; other kinds of candy; baked goods that were not low-fat; baked goods that were low-fat; salty snacks that were not low-fat; salty snacks that were low-fat; ice cream or frozen yogurt that were not low-fat; ice cream or frozen yogurt that were low-fat; low-fat or non-fat yogurt; fruits or vegetables (not juice); bread products (bread sticks, rolls, bagels, pita bread); 2% or whole milk; 1% or skim milk; bottled water; 100% fruit juice; 100% vegetable juice; and SSBs (soda, sports drinks, or fruit drinks that are not 100% juice.) Survey questions were identical in 5^{th} and 8^{th} grade.

For our purpose, some of these items were combined into general categories. Chocolate candy and other candy were combined into one measure, and 100% fruit juice and 100% vegetable juice were combined into one measure. Subsequently, we classified candy, high-fat baked goods, high-fat snacks, and high-fat ice cream/frozen yogurt as “unhealthy,” and classified low-fat baked goods, low-fat snacks, low-fat ice cream/frozen yogurt, low-fat yogurt, and fruits/vegetables as “healthy.” Bread products were excluded because the measure was too ambiguous. The Healthy School Food Environment Index was then calculated by subtracting the total number of unhealthy items from the total number of healthy items, and then standardizing the raw scores (mean=0, SD=1).

The Healthy School Beverage Environment Index (HSBEI) was calculated in a similar manner. SSBs and 2%/whole milk were classified as “unhealthy” and bottled water, 1%/skim milk, and 100% fruit/vegetable juice were classified as “healthy.” The HSBEI was calculated by standardizing the total raw scores for foods and beverages combined.

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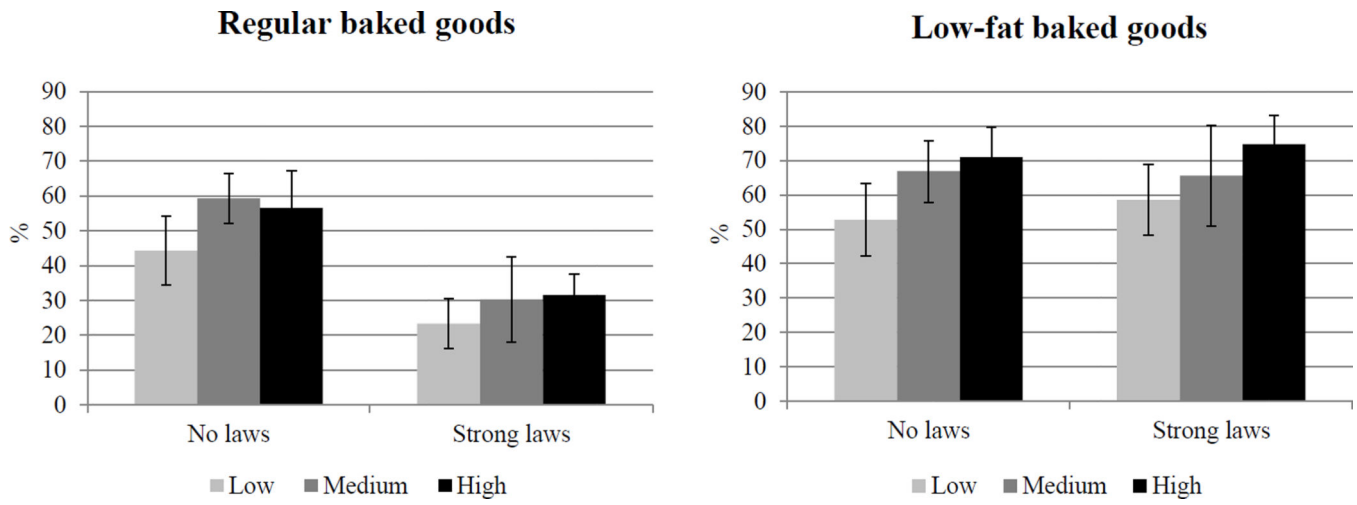

Figure 1.

Adjusted Proportion of Schools That Sell Regular and Low-Fat Baked Goods, By State Competitive Food Laws and School SES Tertile, 8th grade Sample*

* Adjusted for school locale, Census region, state obesity prevalence, and state median household income

Table 1

Sample Descriptive Statistics, By Grade and School SES Tertile (Low-, Medium-, High-Income)*

	5th grade			8th grade		
	Low	**Medium**	**High**	**Low**	**Medium**	**High**
N	470	470	470	420	480	540
Locale (%)						
Urban	61.8	45.7	24.3	44.5	39.6	22.4
Suburban	18.1	38.9	66.0	22.7	40.6	69.3
Township/rural	20.0	15.3	9.8	32.8	19.8	8.3
Census region						
Northeast	18.1	15.7	20.6	13.9	15.2	21.9
Midwest	18.1	27.7	24.7	23.7	28.4	27.8
South	40.5	31.9	21.9	41.6	35.0	25.6
West	23.2	24.7	32.8	20.8	21.5	24.8
# healthy items (mean)						
Food (range: 0–5)	1.1	1.3	1.6	2.4	2.9	3.4
Beverage (range: 0–4)	1.2	1.4	1.5	2.2	2.4	2.7
# unhealthy items (mean)						
Food (range: 0–4)	0.9	1.1	1.4	1.0	1.4	1.5
Beverage (range: 0–2)	0.8	0.9	1.0	0.9	1.1	1.2
State competitive food laws† (%)						
None	48.8	50.2	43.8	35.9	36.0	36.3
Weak	25.3	28.7	33.4	28.2	31.4	31.5
Strong	25.6	21.1	22.8	35.9	32.6	32.2
State competitive beverage laws† (%)						
None	48.4	49.4	42.3	35.2	34.1	33.5
Weak	25.8	27.5	34.9	25.6	26.5	29.4
Strong	25.8	23.2	22.8	39.2	39.4	37.0

*Average median household income tertiles: <$36,317 = “low”; $36,317 – $48,337 = “medium”; >$48,337 = “high”

†2003 elementary school laws for 5th grade; 2006 middle school laws for 8th grade

Table 2

Adjusted Associations Between School SES (Medium- or High-Income, Relative to Low-Income) and the School Food Environment, 5th Grade and 8th Grade

	5th grade						8th grade					
	Medium			High			Medium			High		
Measure	**AME***	**SE**	**p**	**AME***	**SE**	**p**	**AME***	**SE**	**p**	**AME***	**SE**	**p**
Healthy Index (mean)†												
Food environment	0.01	0.07	.87	0.00	0.09	.96	0.07	0.08	.35	0.24	0.07	.001
Beverage environment	0.01	0.07	.87	0.12	0.09	.21	−0.01	0.07	.92	0.19	0.06	.001
Overall environment	0.01	0.06	.82	0.07	0.09	.44	0.05	0.08	.54	0.26	0.07	<.001
Regular snacks (bin)												
Candy	0.00	0.02	.81	0.02	0.02	.32	0.03	0.02	.30	0.03	0.03	.28
Baked goods‡	0.09	0.04	.02	0.18	0.05	.001	0.11	0.03	.001	0.13	0.03	<.001
Salty snacks‡	0.06	0.04	.16	0.15	0.05	.004	0.07	0.04	.12	0.09	0.04	.01
Ice cream/frozen yogurt‡	0.08	0.03	.01	0.23	0.05	<.001	0.12	0.04	.002	0.17	0.04	<.001
Low-fat snacks (bin)												
Baked goods$^{\delta}$	0.03	0.03	.21	0.12	0.04	.001	0.12	0.04	.004	0.20	0.03	<.001
Salty snack$^{\delta}$	0.06	0.03	.08	0.12	0.05	.02	0.09	0.04	.03	0.17	0.04	<.001
Ice cream/frozen yogurt$^{\delta}$	0.01	0.03	.59	0.08	0.04	.05	0.05	0.04	.19	0.14	0.03	<.001
Yogurt$^{\delta}$	0.05	0.03	.06	0.12	0.04	.002	0.09	0.04	.02	0.17	0.04	<.001
Fruits/vegetables	0.08	0.04	.03	0.15	0.05	.002	0.10	0.03	.003	0.20	0.04	<.001
Beverages (bin)												
SSBs	0.07	0.03	.02	0.08	0.03	.02	0.10	0.04	.01	0.10	0.03	.004
Milk, 2% or whole	0.12	0.03	<.001	0.17	0.03	<.001	0.11	0.05	.02	0.09	0.05	.08
Milk, 1% or skim	0.16	0.03	<.001	0.20	0.03	<.001	0.10	0.04	.02	0.16	0.04	<.001
100% fruit juice	0.01	0.04	.73	0.11	0.04	.01	0.04	0.03	.15	0.10	0.02	<.001
100% vegetable juice	0.00	0.02	.99	0.01	0.02	.58	0.01	0.03	.67	0.04	0.03	.16
Bottled water	0.02	0.04	.51	0.06	0.04	.18	0.05	0.04	.19	0.10	0.02	<.001

[*] AME = Average marginal effect; difference between SES tertiles (ref: low-income) in the index score or the probability of selling specific food/beverage items, adjusted for school locale, Census region, state obesity prevalence, and state median household income

[†] A higher index score represents a healthier environment; a positive coefficient indicates that medium- or high-SES schools had a healthier environment, on average, than low-SES schools

[‡] Specifically described as “not low in fat”

[δ] Specifically described as “low-fat”

Table 3

Adjusted Associations Between Strong Competitive Food/Beverage Laws and the Healthy School Food/Beverage Environment Index, Overall and By School SES Tertile

					SES tertile					
		Overall			Low		Medium		High	
Grade	Healthy Index	AME*	SE	p	AME*	SE	AME*	SE	AME*	SE
5th										
	Food	−0.07	0.11	.53	0.01	0.14	−0.07	0.17	−0.28	0.12
	Beverages	0.06	0.12	.64	0.13	0.14	0.03	0.16	−0.03	0.23
	Overall	0.02	0.10	.86	0.09	0.15	0.06	0.16	−0.18	0.12
8th										
	Food	0.45	0.13	.001	0.39	0.13	0.37	0.19	0.58	0.15
	Beverages	0.16	0.10	.10	0.35	0.11	0.03†	0.13	0.11†	0.11
	Overall	0.41	0.10	<.001	0.46	0.12	0.31	0.17	0.47	0.11

*AME = Average marginal effect; average difference in index measure associated with strong state competitive food/beverage laws (ref: states with no competitive food laws) adjusted for locale, Census region, state obesity prevalence, and state median household income; analysis of overall sample also adjusted for school SES tertile

†Statistically significant interaction (p<.05) – i.e., the association between strong competitive food laws and index score was significantly weaker in medium- or high-SES schools, relative to low-SES schools

Table 4

Adjusted Associations Between Strong Competitive Food/Beverage Laws and In-School Access to Specific Food/Beverage Groups

	5th grade			8th grade		
Food/beverage	**AME***	**95% CI**	**p**	**AME***	**95% CI**	**p**
Regular snacks						
Candy	−0.01	−0.08, 0.05	.70	−0.13	−0.23, −0.03	.01
Baked goods†	−0.06	−0.19, 0.07	.34	−0.25	−0.36, −0.15	<.001
Salty snacks†	−0.07	−0.22, 0.07	.33	−0.16	−0.27, −0.05	.01
Ice cream/frozen yogurt†	−0.07	−0.25, 0.10	.43	−0.14	−0.25, −0.03	.01
Low-fat snacks						
Baked goods‡	−0.06	−0.15, 0.02	.12	0.02	−0.09, 0.14	.68
Salty snacks‡	−0.05	−0.18, 0.07	.43	0.01	−0.10, 0.12	.87
Ice cream/frozen yogurt‡	−0.05	−0.14, 0.04	.26	0.04	−0.05, 0.13	.40
Yogurt‡	−0.06	−0.14, 0.03	.18	0.04	−0.04, 0.11	.34
Fruits/vegetables	−0.09	−0.22, 0.03	.16	0.04	−0.09, 0.16	.55
Beverages						
SSBs	−0.10	−0.18, −0.02	.01	−0.17	−0.28, −0.05	.004
Milk, 2% or whole	−0.06	−0.14, 0.02	.14	−0.04	−0.12, 0.04	.33
Milk, 1% or skim	−0.04	−0.13, 0.04	.31	0.04	−0.06, 0.14	.44
100% fruit juice	−0.07	−0.18, 0.05	.26	−0.01	−0.06, 0.05	.75
100% vegetable juice	0.02	−0.02, 0.06	.33	−0.05	−0.10, 0.00	.04
Bottled water	−0.02	−0.12, 0.09	.76	−0.02	−0.08, 0.05	.65

*AME = Average marginal effect: average difference in the probability of selling specific food/beverage items associated with strong competitive food/beverage laws, adjusted for school SES tertile, locale, Census region, state obesity prevalence, and state median household income

†Specifically described as “not low in fat”

‡Specifically described as “low-fat”