TITLE PAGE

Title: Limited evidence that competitive food and beverage practices affect adolescent consumption behaviors

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A healthy diet is the cornerstone of overall good health. Poor nutrition is linked to a number of unfavorable outcomes including obesity.[1] Obesity, a level of body fatness associated with type II diabetes, cancer, and other illnesses, has become a serious public health concern in the United States for adults and children. Public policy leaders in the Obama administration, Congress, state and local governments, and nonprofit and philanthropic organizations have begun to take action to diagnose and remediate the problem. This study examines the potential effects of one policy lever—regulating the sale of competitive foods and beverages in schools—policymakers may use to positively influence children's consumption behaviors to reduce the prevalence of obesity among children. This is a particularly timely issue because the Healthy, Hunger-Free Kids Act of 2010 provides the U.S. Department of Agriculture (USDA) with increased capacity to regulate in this area.

There is increasing concern as to whether the school food environment is contributing to poor dietary habits, resulting in increased obesity prevalence. The sale of competitive foods and beverages (i.e., foods and beverages sold in school that are not part of a USDA-reimbursable school meal), found in such places as vending machines, a la carte lines, and school stores, is particularly contentious. USDA regulations of competitive foods are currently limited, restricting only foods of minimal nutritional value, such as hard candy and soda, from sale in the lunch area during lunchtime. Research has shown that competitive foods and beverages are pervasive in schools (2,3), often low in nutritional value (2,4,5), and frequently consumed by children and adolescents (2).

There is a growing body of literature examining the relationship between competitive foods and beverages and children's dietary behaviors. Results are mixed. A number of studies have found *some* relationships between offering competitive foods and beverages in school and

children's consumption behaviors. For instance, some studies have found access to less nutrient dense foods and beverages (e.g., candy, chips, soda) in schools is associated with decreases in children's consumption of healthy foods and beverages (e.g., fruits, vegetables, milk, 100 percent fruit juice) and access to more nutrient dense foods and beverages is associated with increases in consumption of nutrient dense foods and beverages (4,6,7 ,8,9,10,11).

The evidence that food practices in school affect dietary behaviors, however, is tenuous. Many of these same studies have found a number of "null" findings, or no evidence of a link between the school food environment and consumption of healthy foods and beverages. Given these mixed results, policymakers are left with no clear evidence of an effect, positive or negative, of competitive food and beverage policy on adolescent consumption patterns.

Utility of prior research has generally been limited either because the studies were narrow in geographic or demographic scope or they were based on cross-sectional data, limiting causal inferences. The unique contribution of this paper is that it uses a longitudinal, nationally-representative dataset with relevant information about school competitive food and beverage practices and student's consumption of key food and beverage items. Additionally, prior research using nationally representative data has not attempted to control for potentially confounding characteristics of the neighborhood food environment. This study attempts to mitigate this threat by controlling for some aspects of the neighborhood food environment by merging in outside datasets with information on key neighborhood characteristics, such as availability of grocery stores and fast food restaurants and statewide prevalence of adult obesity and adult consumption of fruits and vegetables, using restricted-use data.

METHODS

Study Design and Sample

Guided by the socio-ecological theory of obesity causation, which asserts that influences of the physical environment, social environment, as well as individual behaviors and genetic predispositions affect health outcomes, this study uses nonexperimental methods and secondary data to estimate the relationship between competitive food and beverage policies and adolescent consumption of (1) fruits and vegetables and (2) soda and other sweetened beverages (hereafter referred to as sweetened beverages that exclude milk, 100% fruit juice, and water). Given that differences in obesity prevalence are apparent by gender, race/ethnicity, and poverty, separate models for each of these subgroups are estimated.

Adolescents in the eighth-grade in 2007 are the focus of this study. The sample in the analysis is limited to include only students who attend schools that report offering the National School Lunch Program (NSLP) because by definition a competitive food is a food that competes with the school lunch program. To minimize sample loss due to missing values on some control variables, missing data for these variables are imputed using multiple imputation. The sample size for the study is 5,530. Unweighted sample sizes reported have been rounded to the nearest 10, per U.S. Department of Education disclosure rules.

Data

The Early Childhood Longitudinal Study, Kindergarten Class of 1998-1999 (ECLS-K), the primary source of data used in this research, is a study conducted by the U.S. Department of Education with funding from a variety of other government agencies with the purpose of understanding children's development and educational attainment during childhood and early adolescence. The ECLS-K is a nationally representative sample of 22,666 kindergarteners from

the 1998–1999 school year. The study surveys children as well as their parents, teachers, and school administrators when children were in kindergarten, first, third, fifth, and eighth grades. Data from the fifth and eighth grade rounds of the survey are used in this analysis.

The ECLS-K uses a complex survey design to sample children. Individual students are nested within schools, which are nested within larger geographic units (often counties). To account for the complex survey design, all models are estimated using survey weights and a statistical software package, SAS (version 9.1.3, 2006, SAS Institute Inc, Cary, NC), that adjusts the standard errors to account for clustering.

While the ECLS-K is an incredibly rich data source, it lacks information on the neighborhood food environment. To account for such factors as availability of food vendors, obesity prevalence, and population-level consumption of fruits and vegetables, other data sources (Census Zip Business Patterns and the Behavioral Risk Factor Surveillance System) at different levels of geography (e.g., zip code, state) are merged into the analysis file using the restricted-use version of the ECLS-K data. This study was deemed exempt by The George Washington University Institutional Review Board.

Key Constructs

Two continuous outcome variables are examined in this analysis: 1) weekly frequency of fruit and vegetable consumption; and 2) weekly frequency of sweetened beverage consumption. Data supporting each of these variables come from Spring Student Questionnaire of the Early Childhood Longitudinal Survey, Kindergarten Class of 1998-1999 (ECLS-K) administered in the eighth-grade round of the ECLS-K (12). Weekly frequency of fruit and vegetable consumption is based on adolescents' categorical responses to four questions asked about the number of times

they ate vegetables (green salad, carrots, and other vegetables not including potatoes) and fruit over the last 7 days. The categorical responses for each of the questions were summed together to create one continuous measure of fruit and vegetable consumption over the course of 7 days. Similarly, adolescents' were asked one question about how often in the last 7 days they drank soda pop, sports drinks, or fruit drinks that were not 100% fruit juice. The categorical response to this question was transformed into one continuous measure of weekly frequency of sweetened beverage consumption.

Competitive foods and beverage practices in the fifth and eighth grades are the primary independent variables in the analysis. School administrators responded to questions about whether competitive foods and beverages were sold in their schools and what types were sold (e.g., fruits and vegetables, soda and other sweetened beverages). Administrator responses to these questions were used to construct sets of competitive food and practice variables.

Estimation Strategy

Borrowing from the education literature, this study uses value-added models to estimate the effects of competitive food and beverage practices on adolescent consumption of two outcomes: 1) fruits and vegetables; and 2) sweetened beverages. In the education literature, value-added models are used to isolate the effects of educational inputs, such as schools or teachers, on student test scores, using prior-year test scores as controls for unobserved effects, such as other school characteristics and student background (13). This same empirical strategy is used in this research to attempt to disentangle the effects of competitive food and beverage practices from unobserved factors that may also influence consumption behaviors (e.g., tastes and preferences, cost of competitive foods and beverages relative to school lunch and lunch

brought from home, etc.) using fifth grade food and beverage consumption measures of fruits and vegetables and sweetened beverages.

The general notation is as follows: there are a set of individuals (i = 1, …, I) who attend a set of schools (j = 1, …, J). The dependent variable, times consumed fruits and vegetables in the prior week, is y. The independent variables in the models include school competitive food practices in the eighth grade, x1; school competitive food practices in the fifth grade, x2; a set of key characteristics of children in the sample, their families, schools, and neighborhoods that may affect weight, x3; and prior year fruit and vegetable consumption, x4. Controls representing x3 include individual characteristics (i.e., gender, race, and height); family characteristics (i.e., evening meal routines, television-watching rules, choice of school child attends, parent employment, parent marital status, and family poverty status); school characteristics (i.e., school type and cafeteria overcrowding); and neighborhood characteristics (i.e., grocery store availability and share of the state population who consume fewer than 5 fruits and vegetables each day). β1 through β4 are vectors of coefficients, and β0 is an intercept term. ε represents error in the model that is uncorrelated with y. Model 1 depicts these relationships.

1. $y_{ij} = \beta 0 + \beta 1 x1_{ij} + \beta 2 x2_{ij} + \beta 3 x3_{ij} + \beta 4 x4_{ij} + \varepsilon_{ij}$

A second model is estimated with times consumed sweetened beverages in prior week as the dependent variable and competitive beverage policy as the key independent variable. Control variables are identical in this model specification with the exception of the proxies for the neighborhood food environment: fast food availability and prevalence of adult obesity in the state are used instead of grocery store availability and share of the adult population in the state who consume fewer than five fruits and vegetables each day. For both outcomes, separate

models are estimated to examine potential subgroup differences (i.e., gender, race, poverty) in the effects of competitive food and beverage practices on consumption behaviors.

A key advantage of this modeling strategy over a simple OLS model that does not include prior measures of fruit and vegetable consumption is that unobserved characteristics that may bias the coefficient estimates may be accounted for (e.g., child and family preferences in food). This identification strategy also accounts for prior year competitive food and beverage practices. Multiple years of "exposure" to competitive foods could affect tastes and preferences towards fruits and vegetables. The chief potential limitation of this approach is compromised internal validity—how well-founded any causal inferences drawn from the data are—if important unobserved characteristics obscure the relationship between competitive food and beverage practices and adolescent consumption behaviors.

STUDY FINDINGS

Competitive foods and beverages are pervasive in middle school. Nearly 80 percent (78.1%) of eighth graders in 2007 had access to competitive foods. Most youth, three-quarters, who had access to competitive foods had access to fruits and vegetables as well as other snacks; one-quarter of youth with access to competitive foods did not have access to competitive foods that included fruit and vegetable options. A higher share, 85.1 percent, of youth had access to competitive beverages in the eighth grade. Nearly all, 97.9 percent, of children with access to competitive beverages had milk and juice options available. Only 2.1 percent of eighth graders with access to competitive foods did not have milk and juice as competitive beverage options. In the sections that follow, results of models estimating the relationship between competitive food and beverage policies and eighth graders consumption of fruits and vegetables and soda and

sweetened beverages are examined. Estimates discussed are statistically significant unless otherwise noted.

Fruit and Vegetable Consumption

On average, results reveal no statistically significant associations between competitive food practices and fruit and vegetable consumption by eighth graders in 2007 (see Exhibit 1). All else equal, eighth graders who had no access to competitive foods in the fifth grade and gained access in the eighth grade reported eating fruits and vegetables 2.5 percent more times per week than eighth graders who lacked access in either year, but this estimate was not statistically significant. In contrast, eighth graders who had access to competitive foods in the fifth grade, but did not have access in the eighth grade reported eating fruits and vegetables 2.3 percent fewer times per week than eighth graders who lacked access to competitive foods in both years; this estimate was also not statistically significant.

Types of competitive foods offered do not appear to be associated with adolescent consumption of fruits and vegetables (see Exhibit 2). Estimates for students who had access to competitive foods including fruits and vegetables and those who had access to competitive foods that did not include fruits and vegetables were similar. Compared with children who did not have access to competitive foods in the fifth and eighth grades, those who lacked access in the fifth grade and gained access in the eighth grade reported consuming fruits and vegetables about 2 percent more times per week. This association, however, is not statistically significant.

Models were also estimated on subpopulations by gender, race, and family poverty status in the eighth grade. Similar to the results for the entire sample, competitive food offerings at school do not appear to be associated with eighth graders' consumption of fruits and vegetables,

with one exception: eighth grade students whose families lived below the poverty line in 2007 and who lost access to competitive foods in school between the fifth and eighth grades, consumed fruits and vegetables 26.2 percent fewer times per week than poor students who lacked access to competitive foods in either year. This estimate is more striking when differentiating by the types of competitive foods offered by the school. In schools that offered fruits and vegetables as competitive food options, poor students who lost access to competitive foods reported consuming fruits and vegetables 31.1 percent fewer times per week (see Exhibit 2). There was not a statistically significant difference between poor students who lost access to competitive foods that did not include fruit and vegetable options and poor children who had no access to competitive foods in either school year.

Sweetened Beverage Consumption

On average, competitive beverage practices in the eighth grade are not associated with consumption of soda and other sweetened beverages, all else equal (see Exhibit 1). Estimates suggest that compared with students who lacked access to competitive beverages in fifth and eighth grade, those who gained access in the eighth grade consumed soda and sweetened beverages more times per week and those who lost access in the eighth grade consumed soda and sweetened beverages fewer times per week. Though the direction of these effects is in the hypothesized direction, the coefficient estimates are not statically significant.

Differences in competitive beverage offerings may be associated with consumption of soda and other sweetened beverages. Students who did not have access to competitive beverages in the fifth grade and gained access to soda and other sweetened beverages in the eighth grade consumed soda and other sweetened beverages 31.0 percent more per week than students who

lacked access to competitive beverages in the fifth and eighth grades. This result, however, was not statistically significant, likely because of small sample sizes (n = 30). Losing access to soda and sweetened beverages in the eighth grade had the reverse effect: students who lost access to soda and sweetened beverages in the eighth grade consumed soda and sweetened beverages 9.1 percent fewer times per week than students who did not have access to competitive beverages in the fifth and eighth grades. This finding is also not statistically significant, however.

Closer examination of subgroups reveals striking findings. Among males, those who gain access to competitive beverages consume soda and sweetened beverages more times per week than those who lack access to competitive beverages in fifth and eighth grades, holding all else constant. Gaining access to milk, juice, and sweetened beverages as competitive beverage options in the eighth grade is associated with a 20.7 percent increase in number of times sweetened beverages are consumed by males compared with males who have no access to competitive beverages in the fifth and eighth grades.

Minority and eighth graders living in households below the poverty line may also by affected by competitive beverage policies. Minority youth and youth living in households below the poverty line gaining access to soda and sweetened beverages in the eighth grade (with no access to milk and juice as competitive beverage options) consumed soda and sweetened beverages 61.4 and 68.6 percent, respectively, more times per week than youth who lacked access to competitive beverages in the fifth and eighth grades. Minority and poor youth may also experience declines in the percent of times consuming sweetened beverages over the course of a week when they lost access to competitive beverages between the fifth and eighth grades, though these coefficient estimates were not statistically significant.

DISCUSSION

Prior literature provides no clear evidence of a link between school competitive food and beverage practices and student's dietary behaviors. This research provides more evidence that competitive food practices as they were implemented in 2007 likely had little effect on average consumption of fruits and vegetables. Adolescents living below the poverty line are the exception, with those losing access to competitive foods between the fifth and eighth grade consuming fruits and vegetables fewer times per week than those who lacked access to competitive foods in both the fifth and eighth grades. More research is needed, however, to understand if strategic food and beverage policies can positively affect students' consumption of fruits and vegetables.

This study provides some evidence that competitive beverage policies, particularly those that do not offer milk and juice as competitive beverage options, may increase consumption of sweetened beverages for males, minorities, and those living in poverty. Results for all youth, though not statistically significant, also suggest that offering sweetened beverages in school without healthy options could increase student's overall consumption of sweetened beverages. Given the literature connecting sweetened beverage consumption to obesity, these findings are cause for concern.

As with any study with "null" results, it cannot be definitively concluded that competitive foods and beverages policies in schools are not associated with children's consumption patterns, that is, the null hypothesis cannot be proven. Further, it may be that competitive food and beverage policies matter, but only in concert with other environmental changes. One study found that when competitive food options improved with regard to nutrition content, students brought unhealthy options from home (14). Another study evaluated a comprehensive initiative to

reduce the prevalence of obesity among school children in Philadelphia that included a school self-assessment, nutrition education, nutrition policy, social marketing and parent outreach. Results from the evaluation were impressive, with students in treatment schools experiencing a 50 percent reduction in the incidence of overweight compared with students in control schools (15). Results from these studies suggest that targeting the school food environment alone may not alter dietary behavior in any real way for most students, but a comprehensive strategy could be effective.

CONCLUSIONS

Using a value-added estimation strategy with ECLS-K data supplemented with other data sources, this study examines the potential role that school competitive food and beverage practices may play in affecting student dietary choices. This study finds limited evidence that competitive food practices affect student's weekly consumption of fruits and vegetables. There is more evidence that competitive beverage policies influence adolescents to consume more sweetened beverages. With the passage of the Healthy, Hunger-Free Children Act of 2010, Congress has bestowed upon the U.S. Department of Agriculture additional capacity to regulate competitive foods and beverages in schools. After these regulations are developed and implementation begins, it will be important to assess whether strategic choices in competitive food and beverage offerings can improve students' diets in an effort to reduce the prevalence of childhood, and later adulthood, obesity. Additional efforts to improve the food and activity environments of children and evaluations of these efforts will help the field to better understand how the causal mechanisms work and how best to positively alter behavior to improve health outcomes for children.

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Exhibit 1. Estimated association between of school competitive food practices and 8th graders' consumption patterns over 7 days[a]

	Full Sample (n=5,530)	Female (n=2,800)	Male (n=2,730	White (n=3,810)	Non-White (n=1,710)	Poverty (n=760)	Above Poverty (n=4,770)
	coefficient estimate ± standard error						
Estimated association between competitive foods offered and frequency of fruit and vegetable consumption over 7 days (logged)							
Competitive foods offered							
8th grade	0.025±0.041	0.009±0.055	0.022±0.074	-0.008±0.061	0.070±0.064	0.043±0.091	-0.004±0.046
5th grade	-0.023±0.034	0.008±0.045	-0.077±0.044	-0.003±0.034	-0.021±0.063	-0.262±0.126*	0.039±0.034
Mean of dependent variable	2.56	2.57	2.54	2.60	2.50	2.51	2.57
R^2	0.110	0.174	0.109	0.145	0.092	0.086	0.147
Estimated association between competitive beverages offered and frequency of sweetened beverage consumption over 7 days (logged)							
Competitive beverages offered							
8th grade	0.032±0.066	-0.101±0.077	0.207±0.083*	-0.017±0.069	0.054±0.110	0.136±0.137	0.011±0.075
5th grade	-0.026±0.041	-0.047±0.055	0.001±0.052	-0.069±0.048	0.034±0.075	0.094±0.105	-0.056±0.044
Mean of dependent variable	1.45	1.39	1.51	1.44	1.47	1.51	1.43
R^2	0.075	0.094	0.069	0.111	0.043	0.046	0.105

[a]Data are from the Early Childhood Longitudinal Study, Kindergarten Class of 1998-1999, fifth and eighth grade waves, 2007 Census Zip Business Patterns, and 2007 Behavioral Risk Factor Surveillance System. Tabulations are weighted using survey weights to be nationally representative of children eligible to attend kindergarten in the 1998-1999 school year. Sample sizes are unweighted. Per U.S. Department of Education disclosure rules, unweighted sample sizes have been rounded to the nearest 10. Estimates are based on imputed data using multiple imputation; standard errors have been adjusted to account for the imputation process. Coefficient estimates were derived from regression models that included a full set of child, family, school and neighborhood controls.

*Estimated coefficient significantly different from zero at 0.05 level, based on two-tailed test.

**Estimated coefficient significantly different from zero at 0.01 level, based on two-tailed test.

Exhibit 2. Estimated association between types of competitive foods and beverages offered and 8th graders' consumption patterns over 7 days[a]							
	Everyone (n=5,530)	Female (n=2,800)	Male (n=2,730)	White (n=3,810)	Non-White (n=1,710)	Poverty (n=760)	Above Poverty (n=4,770)
	coefficient estimate ± standard error						
Estimated association between competitive foods offered and frequency of fruit and vegetable consumption over 7 days (logged)							
Types of competitive foods offered (no competitive foods offered excluded)							
Fruits and vegetables, 8th grade	0.024±0.044	0.026±0.058	-0.000±0.073	-0.016±0.065	0.091±0.071	0.037±0.112	-0.003±0.048
Non fruit and vegetable snacks only, 8th grade	0.022±0.053	-0.040±0.071	0.076±0.087	0.011±0.065	0.017±0.088	0.065±0.103	-0.009±0.059
Fruits and vegetables, 5th grade	-0.002±0.038	0.019±0.052	-0.041±0.048	0.015±0.036	-0.002±0.068	-0.311±0.141*	0.068±0.039
Non fruit and vegetable snacks only, 5th grade	-0.057±0.046	-0.016±0.054	-0.129±0.069	-0.034±0.053	-0.057±0.091	-0.190±0.156	-0.012±0.046
Mean of dependent variable	2.56	2.57	2.54	2.60	2.50	2.51	2.57
R^2	0.110	0.175	0.109	0.146	0.089	0.088	0.148
Estimated association between competitive beverages offered and frequency of sweetened beverage consumption over 7 days (logged)							
Types of competitive beverages offered (no competitive beverages offered excluded)							

Milk and juice, 8th grade	0.024±0.065	-0.114±0.077	0.200±0.084*	-0.017±0.069	0.037±0.109	0.119±0.137	0.004±0.074
Non milk and juice beverages only, 8th grade	0.310±0.177	0.252±0.198	0.368±0.295	-0.01±0.181	0.614±0.280*	0.686±0.256**	0.222±0.213
Milk and juice, 5th grade	-0.020±0.041	-0.038±0.056	0.005±0.053	-0.070±0.049	0.050±0.076	0.118±0.107	-0.051±0.046
Non milk and juice beverages only, 5th grade	-0.091±0.102	-0.037±0.098	-0.088±0.182	-0.070±0.098	-0.197±0.240	-0.227±0.267	-0.079±0.107
Mean of dependent variable	1.45	1.39	1.51	1.44	1.47	1.51	1.43
R^2	0.077	0.097	0.069	0.112	0.052	0.058	0.107

[a]Data are from the Early Childhood Longitudinal Study, Kindergarten Class of 1998-1999, fifth and eighth grade waves, 2007 Census Zip Business Patterns, and 2007 Behavioral Risk Factor Surveillance System. Tabulations are weighted using survey weights to be nationally representative of children eligible to attend kindergarten in the 1998-1999 school year. Sample sizes are unweighted. Per U.S. Department of Education disclosure rules, unweighted sample sizes have been rounded to the nearest 10. Estimates are based on imputed data using multiple imputation; standard errors have been adjusted to account for the imputation process. Coefficient estimates were derived from regression models that included a full set of child, family, school and neighborhood controls.

*Estimated coefficient significantly different from zero at 0.05 level, based on two-tailed test.

**Estimated coefficient significantly different from zero at 0.01 level, based on two-tailed test.