Examining the Association Between School Vending Machines and Children's Body Mass Index by Socioeconomic Status

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ABSTRACT

Objective: To examine the association between vending machine availability in schools and body mass index (BMI) among subgroups of children based on gender, race/ethnicity, and socioeconomic status classifications.

Methods: First-difference multivariate regressions were estimated using longitudinal fifth- and eighth-grade data from the *Early Childhood Longitudinal Study*. The specifications were disaggregated by gender, race/ethnicity, and family socioeconomic status classifications.

Results: Vending machine availability had a positive association ($P < .10$) with BMI among Hispanic male children and low–income Hispanic children. Living in an urban location ($P < .05$) and hours watching television ($P < .05$) were also positively associated with BMI for these subgroups. Supplemental Nutrition Assistance Program enrollment was negatively associated with BMI for low–income Hispanic students ($P < .05$). These findings were not statistically significant when using Bonferroni adjusted critical values.

Conclusions and Implications: The results suggest that the school food environment could reinforce health disparities that exist for Hispanic male children and low–income Hispanic children.

Key Words: childhood obesity, schools, minority health (*J Nutr Educ Behav*. 2015;47:526–531.)

INTRODUCTION

Obesity rates are highest among children from racial/ethnic minority[1] and lower socioeconomic backgrounds.[2,3] Understanding whether the school food environment, which includes school meal programs and competitive foods sold outside meal programs, reinforces existing weight disparities is a priority because individual, interpersonal, and environmental influences on children's dietary choices vary by gender, race/ethnicity, and family socioeconomic status.[4] Students from racial/ethnic minority groups and low socioeconomic backgrounds are more likely to consume sweetened beverages or purchase snacks and beverages from school vending machines instead of school lunch.[5-7]

It is important to estimate whether there is an association between vending machine availability in schools and children's weight because historically, the most frequently purchased foods in school vending machines had minimal nutritional value, such as soft drinks, chips, and candy.[8-10] Between 2005 and 2006, the US Health Behavior in School Aged Children survey found that soft drinks were the most common item used to stock vending machines.[8] This raises public health concerns because they have been linked with weight gain,[11] metabolic disorders,[12] and dental caries.[13]

Studies examining associations between school vending machines and weight gain have mixed findings.[14-17] The study by Van Hook and Altman[17] is the only one among these that reported results by children's gender, race/ethnicity, and socioeconomic status, and it found no association between exposure to less nutrient-dense food and children's body mass index (BMI) for these subgroups.[17] However, Van Hook and Altman did not report testing for significance among disaggregated subsets of these populations, such as low-income females or Hispanic males. The purpose of this study was to estimate the association of school vending machine availability and BMI among subgroups of children based on gender, race/ethnicity, and socioeconomic status at a greater level of specificity than previously examined in the literature.

METHODS
Dataset

The authors used the *Early Childhood Longitudinal Study,* Kindergarten Class of 1998–99 (ECLS-K) panel dataset,

which has been used in previous studies.[16,17] The ECLS-K was administered by the National Center for Education Statistics at the US Department of Education and followed a nationally representative cohort of children from kindergarten through eighth grade, tracking the same children over time as they aged through the school system. Data on children's demographics, diet, physical activity, and weight were collected from children, parents, teachers, and school administrators. Children's height and weight were directly measured by study staff in all survey rounds.

The authors used data from the fifth- and eighth-grade surveys, because these were years when school administrators were asked about vending machine availability. These surveys were administered in 2004 and 2007, respectively. Institutional review board approval was not required for this study because the version of the ECLS-K dataset used by the authors is publicly available and does not reveal confidential information that can be identified to a particular child.

Measures

The outcome variable was the change in children's BMI between fifth and eighth grades. The explanatory variable of interest was a variable indicating a change in whether students could purchase food or beverages at vending machines at school between fifth and eighth grades.

The authors controlled for child-, household-, and school-level characteristics. Child-level characteristics included changes in the number of times per week the child ate breakfast with the family, ate dinner with the family, and exercised for 20 consecutive minutes; the number of hours per week the child watched television; and whether the child had a disability. Because BMI changes between the fifth and eighth grades could be attributed to changes in physiology from aging or other time-varying unobserved external influences, the authors also included a constant.

Household-level characteristics included changes in the number of individuals living in the household; whether the child lived with nonbio-

logical parents, a single mother, and a single father; whether the family received Supplemental Nutrition Assistance Program benefits; and the family's ratio of income to federal poverty guidelines (FPG). The authors used midpoints from the categorical variable of annual household income to represent the family's income, with families in the highest income category ($\geq$ \$200,001) categorized as having an income of \$200,001. The authors used household income and household size to calculate the ratio of family income to FPG for 2004 and 2007.[18,19] School-level characteristics included indicator variables reflecting a change in whether the school was located in urban (large/midsize city) and rural (small town) regions, with children living in a suburban region as the reference variable, as well as the percentage of minority students enrolled at school.

Data Analysis

To estimate whether the change in vending machine availability was associated with a change in BMI, the authors used first difference equations. These represent the lagged value of the observations ($t - 1$) subtracted from their current period value (t). In this equation, BMI is represented by y and the independent variables are represented by x. For each period t, the vector y has dimension $nx1$, where n is the number of students and the matrix x has dimension nxk, where k represents the number of independent variables. The vector of coefficients, β, has dimension $kx1$ and was estimated using ordinary least squares. First difference equations were used to control for the possibility that unobserved time-invariant individual effects may be correlated with the error term, ε:

$$y_t - y_{t-1} = (x_t - x_{t-1})\beta + \varepsilon_t - \varepsilon_{t-1}$$

The authors estimated this equation for all male students, all female students, and all low-income students, in addition to 6 subgroups each for white, African American, and Hispanic children: all children, males, females, all children from low-income families, males from low-income families, and

females from low-income families. This totals 21 specifications. Children were classified as being from low-income families if their family income was below 185% of FPG in both fifth and eighth grades.

Vending machines may be more likely to exist in schools in which there is a greater demand for them, and children's BMI could be systematically higher in such schools for reasons unrelated to vending machines. If so, vending machine availability would be an endogenous variable. The authors tested whether the change in vending machine availability was an endogenous variable following a similar procedure used in previous research on this topic.[16,17]

The researchers used robust standards errors to control for heteroscedasticity. Results were reported at the 5%, 10%, and 0.2% statistical significance levels. The latter critical value represents a Bonferroni correction equal to ratio of the .05 significance level and the number of specifications ($0.002 = .05/21$). The significance of parameter estimates with Bonferroni corrected critical values is reported because the probability of a Type I error (false positive) increases as a greater number of specifications are estimated from the same dataset. Subjects' data were eliminated that had missing values for included variables in either the fifth or eighth grade from the sample. Data analysis was conducted in Stata (version 13, StataCorp, College Station, TX, 2013).

RESULTS

The final sample included 2,263 students (Table 1). A total of 48% of students were female, 64% were white, 11% were African American, and 17% were Hispanic. The average BMI of students in the sample increased from 20.6 to 23.0 between the fifth and eighth grades. The percentage of overweight and obese children increased during this period from 26% and 12%, respectively, to 39% and 22%, respectively. Twenty-seven percent of fifth-graders had access to school vending machines, compared with 63% of eighth-graders.

Table 2 shows that the ability of students to purchase sweets, salty snacks, and sweetened beverages (ie,