Potential Impact of National School Nutritional Environment Policies
Cross-sectional Associations With US Secondary Student Overweight/Obesity, 2008-2012

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IMPORTANCE The latest US Department of Agriculture school meal and competitive venue standards (USDA standards) aim to improve student nutrition and health. However, significant opposition has been raised to their implementation.

OBJECTIVE To examine (1) the percentages of US middle and high school students who currently attend schools that have specific components of the USDA standards; (2) evidence that the identified USDA standard components may be associated with student overweight/obesity; and (3) evidence of sociodemographic differences in the observed associations.

DESIGN, SETTING, AND PARTICIPANTS We used data from annual nationally representative cross-sectional studies of students and school administrators in US public middle and high schools from the 2007-2008 through 2011-2012 school years.

EXPOSURES Administrator-reported school meal and competitive venue food and beverage availability.

MAIN OUTCOMES AND MEASURES Body mass index and overweight/obesity calculated from student self-reported height and weight.

RESULTS Analytical samples included 22,716 eighth grade students in 313 schools and 30,596 tenth and 12th grade students in 511 schools. The mean student response rate was 86.5%; mean school administrator response rate, 83.1%. During the study period, 21.1% of middle school and 30.1% of high school students attended schools without any of the identified components; all 5 identified components were in schools attended by only 1.8% and 0.3% of middle school and high school students, respectively. No significant associations between standard components and self-reported overweight/obesity were observed among middle school students overall. Among high school students, significantly lower odds of overweight/obesity were associated with having fruits or vegetables available wherever foods were sold (adjusted odds ratio [AOR], 0.86 [95% CI, 0.77-0.96]; \( P = .009 \)), the absence of milk with higher fat levels (AOR, 0.92 [95% CI, 0.85-1.00]; \( P = .04 \)), and having 3 or more USDA standard components (AOR, 0.89 [95% CI, 0.79-1.00]; \( P = .04 \)). A significant association between the absence of sugar-sweetened beverages and lower overweight/obesity was found for Hispanic middle school students (AOR, 0.65 [95% CI, 0.51-0.82]; \( P < .001 \)) and nonwhite high school students (AOR, 0.80 [95% CI, 0.70-0.91]; \( P = .001 \)).

CONCLUSIONS AND RELEVANCE Because only 2% of middle school and less than 1% of high school students attended schools with all 5 identified USDA standard components in place, full implementation has the potential to substantially improve school nutritional environments. Some USDA standard components were associated with a lower risk for student overweight/obesity, especially for high school and nonwhite students.

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The US Department of Agriculture (USDA) recently issued updated standards to improve the nutrition of federally reimbursable meal programs (the National School Lunch Program and the School Breakfast Program). Most lunch standards were implemented at the beginning of the 2012-2013 school year; breakfast requirements started gradual implementation beginning in the 2013-2014 school year. Beginning with the 2014-2015 school year, schools participating in federally reimbursable meal programs are required to implement nutritional standards for foods and beverages sold in “competitive venues” (vending machines, stores/snack bars/carts, and à la carte cafeteria lines). The school meal and competitive venue standards (hereinafter referred to as the USDA standards) limit levels of fat, sodium, sugar, and calories; final implementation essentially will remove student access to candy, salty snacks and sugary treats with regular levels of fat, milk with higher levels of fat (whole/2%), savory foods with high levels of fat and calories, and sugar-sweetened beverages (SSBs). Reimbursable meals must contain a fruits or vegetable; availability of fruits and vegetables in competitive venues is encouraged.

The USDA standards were developed in response to rising overweight/obesity among US children and adolescents and were based on the Dietary Guidelines for Americans, 2010, and the recommendations of the Institute of Medicine. Competitive standards for food nutrient content set by states have been significantly associated with nutrient and caloric intake by secondary school students. The USDA standards are expected to have significant effects on health; however, some experts oppose their implementation. At present, we can compare overweight/obesity rates between students attending schools with and without specific USDA standard components. This study uses 5 years of data from nationally representative samples of middle school and high school students and their school administrators to examine the following 3 research questions: (1) What percentage of US secondary school students attended schools with specific USDA standard components from 2008 through 2012? (2) Does evidence suggest that the components were associated with student overweight/obesity? (3) Is there evidence of differences in component-by-overweight/obesity associations based on sociodemographic characteristics?

Methods
Sample
The Monitoring the Future and Youth, Education, and Society studies were conducted by the Institute for Social Research at the University of Michigan, Ann Arbor. Approval for this study was obtained from the institutional review board of the University of Michigan. For the Monitoring the Future study, informed consent was obtained using school-specific protocols. The Youth, Education, and Society study was deemed exempt.

Student data were obtained from the Monitoring the Future study using annual nationally representative cross-sectional samples of 8th, 10th, and 12th grade students from 2008 through 2012. Self-completed, optically scanned questionnaires were administered in classrooms by study personnel during a normal class period (only 1 grade per school was surveyed). Detailed descriptions of the methods used in the Monitoring the Future study can be found elsewhere. From 2008 through 2012, an original or a replacement school was obtained in 97% of the sample units; mean student response rates were 89.6%, 87.4%, and 82.4% for the 8th, 10th, and 12th grades, respectively. Final response rates were 86.9%, 84.8%, and 79.9% for the 8th, 10th, and 12th grades, respectively. Absenteeism was the primary reason for nonresponse; less than 1% of students refused to participate.

School data were obtained from administrators of the schools participating in the Monitoring the Future study through the Youth, Education, and Society study using mailed questionnaires (with a modest monetary incentive) sent to each school in the spring of the same year in which student data were collected (detailed information about the methods used by the Youth, Education, and Society study can be found elsewhere). Mean school response rates were 83.1%. Principals or other administrators completed items on general school characteristics. Questionnaire directions suggested that food service personnel complete detailed questions concerning venue and food and beverage availability, a process that occurred in 46.8% of schools. Schools providing incomplete or inconsistent answers were contacted as needed to clarify or complete requested information.

Measures
Student Overweight/Obesity
Students self-reported their height (in feet and inches) and weight (in pounds) using precoded, close-ended response alternatives. Body mass index (BMI) was calculated from these data. We used age- and sex-specific growth curves produced by the Centers for Disease Control and Prevention to categorize students as overweight or obese (≥85th BMI percentile).

School Nutritional Environment
Administrators indicated whether students had access to a variety of food and beverage items in competitive venues and/or the school lunch. Levels of calories, fat, and sodium content and limitations were not measured. Obtained data allowed development of 4 dichotomous nutritional environment components in schools based on the following USDA standards: (1) no SSBs, (2) no whole/2% milk, (3) no candy or regular-fat snacks, and (4) no french fries (Box). A fifth dichotomous component, encouraged but not required by the USDA standards, identified schools making fruits or vegetables available wherever foods were sold. Schools were classified as having each component (hereinafter referred to as positive nutritional environment components) only if the school lunch and all available competitive venues met the noted requirement. Finally, a nutritional environment scale was calculated by summing the 5 components.

Control Variables
Student-level controls shown to be associated with adolescent dietary consumption included self-reported sex, race/
Statistical Analysis

We conducted the analyses using commercially available software (STATA, version 12.1; StataCorp) with survey commands (svy: means/logistic/reg) accounting for school clustering and sample design in SE estimates; all analyses were also weighted to adjust for differential selection probability. Multivariate models included year dummy variables. Models investigating interactions of sex, race/ethnicity, and mean parental educational level with school nutritional environment and student overweight/obesity associations used the products of dichotomous sociodemographic terms and dichotomous specific nutritional environment components or the continuous nutritional environment scale. Results are presented separately for middle school (8th grade) and high school (10th and 12th grades). After cases with missing control or outcome data were removed, analytical sample sizes were 22,716 eighth grade students in 313 schools and 30,596 tenth and 12th grade students in 511 schools.

Results

Prevalence of Overweight/Obesity and School Nutritional Components

Descriptive statistics are provided in Table 1. From 2008 through 2012, a mean of 26.4% of middle school and 27.1% of high school students in the analytical sample were classified as overweight/obese. The positive nutritional environment component most often present in schools was the absence of french fries (57.7% of middle school and 44.9% of high school students attended schools without french fries). Less than one-third of students attended schools with any other component. The components present in schools attended by the smallest percentage of students were the absence of candy or regular-fat snacks (20.3% of middle school and 17.0% of high school students) and having fruits or vegetables available wherever foods were sold (24.8% of middle school and 16.4% of high school students). Middle school students were significantly more likely than high school students to attend schools in which fruits or vegetables were available wherever foods were sold (P = .02) and in which SSBs and french fries were absent (P = .008 and P = .004, respectively).

Evidence of significant change over time was observed only for the absence of whole/2% milk. In 2008, 15.2% of middle school and 14.8% of high school students attended schools without whole/2% milk compared with 57.8% of middle school (design-based Pearson \( \chi^2 \) test of independence corrected for survey design \( F_{1,104}, 19.1; P < .001 \)) and 40.9% of high school students (design-based Pearson \( F_{1,180}, 8.3; P = .004 \)) in 2012.

The mean number of positive nutritional environment components across 2008 through 2012 was small at 1.59 for middle school students and significantly smaller (1.27) for high school students. The mean number increased significantly for middle schools over time (from 1.22 in 2008 to 2.10 in 2012; linear coefficient \([SE], 0.22 [0.06]; P < .001\)). The mean number also increased for high schools, but not significantly (from 1.09 in 2008 to 1.45 in 2012; \( P = .12 \)). Approximately one-fifth (21.1%) of middle school and 30.1% of high school students attended schools without any nutritional environment components; 22.7% of middle school and 15.3% of high school students attended schools with 3 or more components. Almost no students attended schools with all 5 components (1.8% of middle school and 0.3% of high school students).

### Box. School Nutritional Environment Classifications

**Positive Components of the Nutritional Environment**

Fruits or vegetables available wherever foods were sold

- At least 1 of the following items available in all venues in which foods were sold:
  1. Fresh fruit
  2. Other fruit (such as dried or canned fruit)
  3. Vegetables (such as carrot sticks or celery sticks)

No candy or regular-fat snacks

- None of the following items available in any venue in which foods were sold:
  1. Candy
  2. Salty snacks that are not low in fat, such as regular potato chips
  3. Cookies, crackers, cakes, or other baked goods that are not low in fat
  4. Ice cream or frozen yogurt that is not low in fat

No SSBs

- None of the following items available in any venue in which beverages were sold:
  1. Regular soft drinks (such as Coke [Coca-Cola Company], Pepsi [PepsiCo], or Dr Pepper [Dr Pepper Snapple Group])
  2. Fruit drinks that are not 100% fruit juice and that are high in calories (such as Hawaiian Punch [Dr Pepper Snapple Group], Sunny Delight [Sunny Delight Beverages Co], or Hi-C [Coca-Cola Company])

3. To be classified as a school with no SSBs, middle schools also required to not have sports drinks (such as Gatorade [PepsiCo] or Powerade [Coca-Cola Company]) available in any venue in which beverages were sold. This distinction was based on grade-specific differences in the USDA competitive venue nutritional standards.

No whole or 2% milk

- Whole milk or 2% milk, including flavored or unflavored milk, not available in any venue in which foods were sold

No french fries

- Deep-fried fries (including fries that are just reheated) not available in any venue in which foods were sold

**Nutritional Environment Scale**

Sum of all of the above specific components (0-5)

Abbreviations: SSBs, sugar-sweetened beverages; USDA, US Department of Agriculture.
Positive Nutritional Environment and Student Overweight/Obesity Associations

Bivariate and multivariate models indicated no significant associations between positive nutritional environment components and overweight/obesity among middle school students. Several significant associations were found at the high school level (Table 2). Having fruits or vegetables available wherever foods were sold and the absence of whole/2% milk showed significant bivariate associations with lower odds of overweight/obesity among high school students. Bivariate analyses also indicated that a greater number of positive nutritional environment components was associated with lower odds of student overweight/obesity, with an indication of a threshold at 3 components based on initial separate model-
ing. In multivariate models controlling for student and school characteristics that included only 1 positive nutritional environment component at a time, these associations continued to be significant. Multivariate model-predicted probabilities indicated that where fruits or vegetables were available in all food venues, 24.7% of students were overweight/obese compared with 27.5% of students in schools without such availability. The multivariate model predicted probabilities of overweight/obesity of 26.0% in schools where whole/2% milk was absent compared with 27.5% in schools where such milk was present. A higher number of positive nutritional environment components also continued to be associated with lower odds of student overweight/obesity in multivariate models. Predicted probabilities indicated that 27.7% of students were overweight/obese in schools without any nutritional environment components; 27.5% were overweight/obese in schools with a single component. This percentage decreased nonsignificantly to 26.7% in schools with 2 components and then significantly decreased to 25.4% in schools with 3 to 5 components.

Evidence of Sociodemographic Interactions
Significant multivariate model interactions were found only for race/ethnicity. For middle school students, the Hispanic/no SSB interaction term was significant relative to the white/no SSB interaction term (P = .02). Models including only Hispanic middle school students showed that the absence of SSBs was associated with significantly lower odds of overweight/obesity (adjusted odds ratio [AOR], 0.65 [95% CI, 0.51-0.82]; P < .001). The model including only white middle school students showed no significant association. Predicted probabilities among Hispanic middle school students were 32.2% for overweight/obesity in schools with SSBs compared with 23.7% in schools without SSBs. For high school students, the African American/no SSB interaction term approached significance relative to the white/no SSB interaction term (P = .06); the Hispanic/no SSB and other race/no SSB interaction terms were significantly different (P = .045 and P = .002, respectively). Group-specific models of white and nonwhite high school students showed that nonwhite students were significantly less likely to report overweight/obesity if they attended schools without SSBs (AOR, 0.80 [95% CI, 0.70-0.91]; P = .001); no associations were observed for white high school students. Predicted probabilities among nonwhite high school students were 29.9% for overweight/obesity in schools with SSBs compared with 25.5% in schools without SSBs.

Discussion
From 2008 through 2012, middle school students attended schools with a mean of 1.59 positive nutritional environment components; high school students attended schools with a mean of 1.27 such components. Significant increases in the number of components over time were seen for middle school but not high school students. Among high school students, having fruits or vegetables available wherever foods were sold, the absence of whole/2% milk, and increasing the number of positive nutritional environment components were associated with significantly lower odds of overweight/obesity. The absence of SSBs was associated with lower levels of overweight/obesity for middle school and high school students of minority ethnicity/race.

The relatively small mean number of positive nutritional environment components reported for middle school and high school students suggests that—if implemented fully—USDA standards will make measurable differences in US schools. The potential impact is especially strong for high schools. State- and district-level nutritional policies decrease in strength as the grade level increases; such policy disparities may partially explain the weaker high school nutritional environment observed in these analyses.

The primary foods and beverages offered through competitive venues in schools have historically been low in nutrients yet energy dense; competitive venues have been associated with higher school SSB consumption and more purchases of unhealthy snacks and beverages. If imple-
mented fully, the USDA standards will remove unhealthy choices and increase access to healthy school meal and competitive venue options. The finding of the present study that having fruits or vegetables available wherever foods were sold was associated with significantly reduced odds of student overweight/obesity underscores the importance of providing healthy options and not merely removing unhealthy items. A 2-year follow-up study among low-income Michigan middle school children showed competitive venue programs in which almost all options were healthy choices (salads, fruits, and whole-grain snacks) were associated with significantly increased intake of fiber, vitamins, fruit, and vegetables. In a nationally representative cross-sectional study of secondary school students, greater accessibility to salad, fruit, and vegetables at school was associated with significantly higher consumption of fruits and vegetables by students. Fruit and vegetable consumption possibly contributes to healthy weight maintenance through displacement of more energy-dense foods.

A greater number of positive nutritional environment components was associated with significantly reduced odds of high school student overweight/obesity, with a possible threshold effect. A threshold effect has been suggested in other research. The low-income middle school study found that, when schools implemented 3 or more changes in nutritional practices and established 3 or more nutritional policies regarding competitive venues, student nutritional and food group intake measurably improved. The comprehensiveness and strength of existing school district wellness policies for school meals and competitive venues remain weak. Because only 22.7% of middle school and 15.3% of high school students attended schools with 3 or more of the nutritional environment components studied in the present analyses, national USDA standard implementation has the potential to bring comprehensive improvements to nutritional environments in all schools. However, full implementation of the USDA standards will not be easy and will likely necessitate additional training, support, and incentives from the states and the federal government. Furthermore, the observed association between nutritional environment components and high school student overweight/obesity was modest (a 2.3-percentage point difference in the predicted probability of overweight/obesity). These modest estimates are in line with those obtained from previous research. Although the potential impact of such small differences at the population level can be substantial, our results underscore the need to address additional aspects of the school environment to increase the potential of US schools to be less obesogenic.

Unexpectedly, this study found no significant associations between the positive nutritional environment components included and overall middle school student overweight/obesity. Early reviews of associations between competitive food and beverage options in schools and student weight indicated that nutritional choices in competitive venues were associated with overweight or body fat, but observed associations were more likely among middle school than high school students. More recent studies examining state school nutritional environment policies have also found significant associations with middle school student obesity. However, the present study is not the first to find a lack of associations (or inconsistent associations) between policies concerning the school nutritional environment and outcomes among middle school students. The combined associations of nutritional options from school meals and competitive venues may be stronger for high school than middle school students owing to lower parental involvement in decisions concerning nutritional intake and the greater disposable income needed to purchase snacks from competitive venues. Access of high school students to unhealthy items in any venue and access to competitive venues of any type have been consistently greater than for middle school students. Given the greater access of high school students to unhealthy items, efforts to remove unhealthy choices and to provide healthy options in school nutritional environments may have a stronger association with overweight/obesity among this group. The USDA standards might still be associated with outcomes among middle school students. Many aspects of the USDA standards were not captured in the present analyses (eg, limits on levels of fat, sodium, sugar, and calories). Analyses incorporating such measures may find associations among middle school students overall that we did not observe. Previous research has indicated that schoolwide food practices not included in the present study, such as foods used for fundraising and in the classroom as incentives and rewards, have been associated with higher BMI in middle school students.

Analyses indicated that SSB absence resulted in significantly different associations for white than for nonwhite students (Hispanic middle school and nonwhite high school students). Racial/ethnic minorities have been shown to be more likely to make purchases from school vending machines and state policies targeting competitive venues and the overall availability of sodas in schools have been found to be associated more strongly with student behavior among minority groups.

These findings should be viewed within the context of study limitations. Data are cross-sectional and preclude causal interpretation. Student overweight/obesity was based on self-reported height and weight data. Large studies on self-reported adolescent height and weight data have found generally strong correlations between objective and self-reported data and have concluded that using self-reported height and weight data provide valuable insights into adolescent obesity trends, correlates, antecedents, and sequelae. Although such studies support using self-report data for research—particularly for relational analyses of the kind reported herein—evidence of bias remains in absolute levels, particularly underreporting. School nutritional environment data are based on school administrator responses to self-administered questionnaires, raising the possibility of social desirability bias and reporting error. To minimize social desirability bias, respondents were guaranteed that they and their schools would not be identified. To minimize response error, questionnaire directions called for different questionnaire segments to be completed by personnel most knowledgeable about the subject matter, that is, principals for policy-related measures and food service managers for measures of food and beverage availability. In addition, follow-up calls were made to clarify incomplete or inconsistent responses. An additional concern deals with possible confounding between healthier school nutritional environments...
and SES. These analyses used mean parental educational level as a proxy for student SES and the percentage of the student body eligible for free and reduced-price lunch to indicate school SES. Multivariate models control for both SES indicators. Interactions with parental educational level and school nutritional environment components were significant; however, analyses using more detailed student SES measures may yield different results. Models were run to explore possible differences in the likelihood of having any of the specific nutritional environment components or the continuous nutritional environment scale based on school SES; no significant differences were observed among low-, medium-, and high-SES schools.

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