

State Policies Targeting Junk Food in Schools: Racial/Ethnic Differences in the Effect of Policy Change on Soda Consumption

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Obesity among adolescents is associated with type 2 diabetes, hypertension, depressive symptoms, and other adverse outcomes.¹ It became one of the primary public health concerns in the United States in recent decades as the prevalence escalated from 5% in the years 1976 to 1980 to 18% in the period 2003 to 2006.² Soda is widely considered to be a contributor to the increase in obesity because it has been associated with excess energy intake and weight gain in several cross-sectional and prospective cohort studies.^{3,4} It became a larger source of energy intake among adolescents during the same period that obesity prevalence increased.⁵⁻⁷ Data from the 2005–2006 National Health and Nutrition Examination Survey indicated that soda accounted for 33% of the gram weight of beverages consumed by children (2–18 years), more than any other beverage.⁸

There has been a movement on several governing levels to remove soda and other foods and beverages of high caloric density from schools.⁹⁻¹³ Foods and beverages sold outside of federal school meal programs are not required to meet federal nutrition standards. Reviews by Larson and Story¹⁴ and Story et al.¹² demonstrated that such “competitive foods” are widely available in schools, have poor nutritional content, and have been associated with poor diet among youths. As such evidence has grown, policies to improve the nutritional content of school foods and beverages have become more prevalent.¹⁵ Much of the focus has been on the district level, particularly through the Child Nutrition and Women, Infants, and Children Reauthorization Act of 2004.¹⁶ This legislation mandated that by the start of the 2006–2007 school year, local education agencies participating in federal school meal and child nutrition programs must establish nutrition guidelines for foods and beverages sold outside of the school meal program

Objectives. We estimated the association between state policy changes and adolescent soda consumption and body mass index (BMI) percentile, overall and by race/ethnicity.

Methods. We obtained data on whether states required or recommended that schools prohibit junk food in vending machines, snack bars, concession stands, and parties from the 2000 and 2006 School Health Policies and Programs Study. We used linear mixed models to estimate the association between 2000–2006 policy changes and 2007 soda consumption and BMI percentile, as reported by 90730 students in 33 states and the District of Columbia in the Youth Risk Behavior Survey, and to test for racial/ethnic differences in the associations.

Results. Policy changes targeting concession stands were associated with 0.09 fewer servings of soda per day among students (95% confidence interval [CI]=−0.17, −0.01); the association was more pronounced among non-Hispanic Blacks (0.19 fewer servings per day). Policy changes targeting parties were associated with 0.07 fewer servings per day (95% CI=−0.13, 0.00). Policy changes were not associated with BMI percentile in any group.

Conclusions. State policies targeting junk food in schools may reduce racial/ethnic disparities in adolescent soda consumption, but their impact appears to be too weak to reduce adolescent BMI percentile. (*Am J Public Health.* 2011;101:1769–1775. doi:10.2105/AJPH.2011.300221)

as part of a wellness policy to address childhood obesity.

On the state level, policymakers introduced 213 bills and 25 resolutions targeting nutrition standards and vending machines in schools between 2003 and 2005.¹⁷ These included restricting access to vending machines and regulating the marketing of foods and beverages with high-caloric density and low-nutrient density. Kubik et al. found that state, not district, policies were associated with school practices regarding junk food availability,¹⁸ but little research has evaluated the effect of state policies on students’ soda consumption. Evaluations of state policy interventions in Texas¹⁹ and California²⁰ generally found improvements in school food environments and students’ dietary intake after the policy change, but neither study used another state as a control. It is therefore unknown whether the changes they reported were

attributable to policy change or secular trends. To our knowledge, no study has compared food or beverage intake, or weight status, in states that changed their policies and in those that did not.

Some authors have maintained that schools supply less than 15% of the calories students get from sugar-sweetened beverages⁷ and that students can easily compensate for policy changes by relying on other sources.^{21,22} Racial/ethnic minorities, in particular, have access to fast-food outlets, convenience stores, and other sources of energy-dense foods surrounding schools and in the community,^{22,23} which may negate the effect of policy changes. Disparities in policy effectiveness have not been explored, however, because existing policy research has generally focused on ethnic majority populations.²⁴ Comparing policy effectiveness across racial/ethnic groups is important given that the prevalence of obesity is higher among many

minority populations than among non-Hispanic Whites.²⁵

Our objective was to estimate (1) the associations between state policy changes targeting junk food in schools and soda consumption and percentile of body mass index (BMI; defined as weight in kilograms divided by height in meters squared) among adolescents overall and (2) the difference in these associations across racial/ethnic groups. We hypothesized that soda consumption would be lower among adolescents in states that changed school policies to restrict access to junk food than among adolescents in states that did not, and that this effect would be seen across all racial/ethnic groups in spite of the disadvantages that some face in the built environment outside of school.

METHODS

We combined student- and state-level data from multiple studies conducted by the Centers for Disease Control and Prevention to estimate the association between state policy changes that took place between 2000 and 2006 and student outcomes measured in 2007.

Measures

State policies. We obtained data on state policies regarding junk food in schools from the 2000 and 2006 School Health Policies and Programs Study (SHPPS), a national survey that collected data on school health policies and practices at the state, district, school, and classroom levels.²⁶ SHPPS has been conducted every 6 years since 1994. All states and the District of Columbia participated in SHPPS in both 2000 and 2006.

State policies were collected through computer-assisted telephone interviews or self-administered mailed questionnaires. The data in this study were provided by personnel who were identified by the state education agency or department of health as being most knowledgeable about food service policies. The official title of survey respondents varied by state, but it was normally the director of school nutrition, director of child nutrition, or a comparable position.

In both 2000 and 2006, respondents were asked if the state required or recommended that schools be prohibited from offering junk foods in several different settings around

school. Our analyses focused specifically on policies regarding vending machines; school stores, canteens, and snack bars; student parties; and concession stands. “Junk food” was defined in the 2000 survey as “foods that provide calories primarily through fats or added sugars and have minimal amounts of vitamins and minerals.”^{27a(p8)} The definition was slightly modified in 2006 (“foods or beverages that have low nutrient density, that they provide calories primarily through fats or added sugars and have minimal amounts of vitamins and minerals”).^{27b(p9)} Participants could answer “require,” “recommend,” or “neither” for each setting.

Student measures. We obtained student data from the 2007 state Youth Risk Behavior Survey (YRBS). YRBS is a biennial survey of 9th- to 12th-grade students, administered on the national, state, and local levels. Students were sampled by a 2-stage cluster sampling design, and data were weighted according to school and student response rates to produce estimates that were representative of the state jurisdiction.²⁸ Data were weighted only in states that provided appropriate documentation and had an overall response rate of 60% or higher. We excluded states from our study that did not meet these criteria ($n=5$), did not participate in the 2007 YRBS ($n=6$), did not measure soda consumption in 2007 ($n=1$), did not provide all relevant policy data ($n=2$), chose to not provide individual student data ($n=1$), or determined that their data were not representative ($n=2$). A total of 90 730 students from 33 states (AR, AZ, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, ME, MA, MS, MO, MI, NV, NH, NM, NY, NC, ND, OH, RI, SC, TN, TX, UT, VT, WV, WI, WY) and the District of Columbia met inclusion criteria.

Our outcomes of interest were total servings of soda per day and BMI percentile. Through use of a written questionnaire administered in class, students were asked, “During the past 7 days, how many times did you drink a can, bottle, or glass of soda or pop, such as Coke, Pepsi, or Sprite?” The question did not differentiate between soda consumed within and outside of school. Students also reported their height and weight, which was used to calculate BMI percentile. BMI percentile accounts for developmental differences between boys and girls of different ages by measuring each student’s BMI relative to a reference population

composed of children of the same age and gender in the United States.²⁹ Brener et al., in their study of the validity of self-reported height and weight data in the YRBS, found that students overreported their height by an average of 2.7 inches and underreported their weight by an average of 3.5 pounds, producing a correlation between measured and self-reported BMI of 0.89.³⁰

Students reported their gender, race (American Indian or Alaska Native, Asian, Black or African American, Native Hawaiian or other Pacific Islander, White), and ethnicity (Hispanic/Latino or non-Hispanic) on the questionnaire. Race and ethnicity were combined to create a 4-category measure: non-Hispanic White, non-Hispanic Black, Hispanic, and non-Hispanic other.

State covariates. State median income,³¹ political party of the state legislature,^{31,32} and obesity prevalence among adults³¹ have been associated with legislative activity targeting obesity. These variables can confound the effect of soda policy change through their association with other types of policies (e.g., physical education requirements). We obtained income data from the US Census,³³ the prevalence of obesity among adults from the state Behavioral Risk Factor Surveillance System,³⁴ and state legislature political party after the 2000 election from the National Conference of State Legislatures.³⁵

Statistical Analysis

Our primary analysis estimated the association between policy changes that took place between 2000 and 2006 and servings of soda per day in 2007. We based analyses on the general linear mixed model using a maximum likelihood estimator with robust standard errors. We adapted the notation for the model from Murray,³⁶ as follows:

$$(1) \text{Soda}_{i,j} = \beta_0 + \beta_1(\text{2006 policy}) + \beta_x X + S_j + \varepsilon_{ij}$$

$\text{Soda}_{i,j}$ represents servings of soda per day (using an identity link) for the i th individual nested within state j . Mixed models account for state clustering by estimating an overall intercept, β_0 , as well as a random intercept (S_j) by state, $\sim N(0, \sigma_s^2)$. X represents all student- and state-level covariates. We restricted models to states that reported neither “recommend” nor

“require” for the policy of interest in 2000; the coefficients for 2006 policy therefore represented the effect of policy changes that took place between 2000 and 2006. We analyzed changes in policies targeting different settings (e.g., vending machines, snack bars) in distinct models. Whenever possible, we compared states that reported “require” with states that reported “neither” in 2006, as well as states that reported “require” or “recommend” with states that reported “neither” in 2006.

We used a directed acyclic graph (Appendix 1, available as a supplement to the online version of this article at <http://www.ajph.org>) to select covariates for our models. Directed acyclic graphs are causal diagrams used to identify adjustment variables and avoid biases caused by overadjustment.^{37–39} Using Appendix 1 and systematic graphical criteria, we identified the following variables as the minimal set that was sufficient to control confounding: student gender and race/ethnicity, state log median income (continuous), state adult obesity prevalence (continuous), and whether both houses of the state legislature were controlled by the Democratic party (binary).

After estimating the overall association between policy change and soda consumption for each setting, we tested for differences in the association across racial/ethnic groups. We repeated the model after adding an interaction term between 2006 policy and each racial/ethnic group except non-Hispanic Whites. We used a likelihood ratio test to determine whether the overall interaction between race/ethnicity and policy was statistically significant ($\alpha=0.05$, $df=3$).

After modeling the associations between policy measures and soda consumption, we repeated each model with BMI percentile as the outcome. We conducted all analyses with Mplus Version 5.21 to incorporate the YRBS sampling weights.⁴⁰

RESULTS

Weighted descriptive statistics are provided in Table 1. Overall, the sample was 62% non-Hispanic White, 18% non-Hispanic Black, 15% Hispanic, and 5% non-Hispanic other. The racial/ethnic groups had similar distributions of age and gender. The distribution of soda consumption was positively skewed in all racial/

TABLE 1—Descriptive Statistics of Samples Included in Study of State Policy Changes Targeting Junk Food in Schools, Overall and by Race/Ethnicity: United States, 2000–2007

	Overall	White ^a	Black ^a	Hispanic	Other ^a
Student variables					
Sample size	90 730	51 285	13 051	15 444	8 450
Gender, %					
Male	50.7	50.5	49.8	50.6	53.1
Female	49.3	49.5	50.2	49.4	46.9
Age, y, %					
≤14	10.3	9.6	10.1	11.8	13.8
15	26.1	26.1	25.4	26.4	27.4
16	26.1	25.9	26.5	26.2	26.8
17	23.7	24.1	24.3	22.8	20.5
≥18	13.9	14.4	13.7	12.8	11.4
Soda consumption					
Servings/d, mean	0.978	0.965	1.06	0.979	0.876
>1 serving/d, %	32.1	33.0	31.6	31.6	27.0
Anthropometric variables					
BMI percentile, ^b mean	62.8	60.7	68.6	66.5	60.2
Obesity, %	12.9	11.4	15.7	16.3	13.4
State variables					
Student sample size, median	2081				
Student response rate, mean	79.4				
School response rate, mean	80.6				
Median income, ^c \$	40 706				
Obesity prevalence, ^{c,d} mean	20.3				
Legislature party, ^e %					
Democrat	30.3				
Republican	30.3				
Split	39.4				

Note. BMI = body mass index, defined as weight in kilograms divided by height in meters squared. Data on state policy change are from the 2000 and 2006 School Health Policies and Programs Study. Adolescent soda consumption and BMI percentile in 2007 are from the Youth Risk Behavior Survey. Thirty-three states and the District of Columbia are represented in the sample (AR, AZ, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, ME, MA, MS, MO, MI, NV, NH, NM, NY, NC, ND, OH, RI, SC, TN, TX, UT, VT, WV, WI, WY).

^aNon-Hispanic.

^bBMI relative to a reference population composed of children of the same age and gender in the United States from 1963 to 1994.

^cBased on 2000 data.

^dAdult obesity prevalence, based on data from Behavioral Risk Factor Surveillance System.

ethnic groups, with a median of 0.7 servings per day and a mean of 1.0. The mean number of servings of soda per day was highest among non-Hispanic Blacks. The prevalence of obesity ranged from 11.4% among non-Hispanic Whites to 16.3% among Hispanics.

School Policy Changes Between 2000 and 2006

For each of the settings that we examined, at least 28 of the 33 participating states and the District of Columbia reported that they neither

recommended nor required that schools be prohibited from offering junk food in 2000. A summary of 2000–2006 policy changes in these states can be found in Appendix 2 (available as a supplement to the online version of this article at <http://www.ajph.org>), which displays the distribution of 2006 policies among states that reported “neither” in 2000. Because only 1 state changed from “neither” to “require” for policies targeting concession stands and parties, we compared only states that reported “require” or “recommend” (combined)

with states that reported “neither” for these settings.

State Policy Changes and Soda Consumption

Only policy changes targeting concession stands and parties were associated with self-reported soda consumption (Table 2). The mean number of servings per day was 0.09 lower (95% confidence interval [CI]=−0.17, −0.01) among adolescents in states that required or recommended that junk food not be allowed in concession stands, relative to adolescents in states that did not. The effect size for parties was slightly weaker (difference=−0.07; 95% CI=−0.13, 0.00). For snack bars and vending machines, there was no association between policy changes and soda consumption regardless of whether we compared states that reported “require” with states that reported “neither” or states that reported “require” or “recommend” with states that reported “neither.”

Although most associations were null in the sample overall, they differed by race/ethnicity for each setting ($P<.001$), particularly between non-Hispanic Whites and non-Hispanic Blacks (Table 3). Across all settings, there was no

association among non-Hispanic Whites but a negative association among non-Hispanic Blacks. The coefficients for concession stands among non-Hispanic Blacks (difference=−0.19) suggests that adolescents whose state changed their school policies consumed approximately 1.33 fewer servings per week (7 days × 0.19) compared with those who resided in states that did not change their policies. The associations in other settings were slightly weaker. Across settings, the difference between non-Hispanic Whites and non-Hispanic Blacks in the association between policy change and soda consumption was similar to the difference in mean soda consumption between the 2 groups (Table 1). Among Hispanics, the estimated associations were slightly weaker and less precise than among non-Hispanic Blacks.

State Policy Changes and Body Mass Index Percentile

Table 4 displays the association between policy change and students’ BMI percentile in 2007, by race/ethnicity. Although the overall interaction between race/ethnicity and policy was statistically significant for each setting except school parties, this interaction was largely driven by unusually large associations

among adolescents in the “non-Hispanic other” group. BMI percentile was not associated with any policy change in any other racial/ethnic group or in the overall sample. We explored the association among “non-Hispanic other” adolescents in more detail and found evidence that it may be confounded by the distribution of individual racial/ethnic categories (American Indian/Alaska Native, Asian, Native Hawaiian/Pacific Islander, and multiple/non-Hispanic). Specifically, states that made policy changes had a higher proportion of American Indians/Alaska Natives and lower proportion of Asians than did states that made no changes, and the mean BMI percentile among American Indians/Alaska Natives was almost 10 units higher than it was among Asians (64.3 and 54.7, respectively).

DISCUSSION

To our knowledge, this was the first study to estimate the association between state policy changes targeting junk food in schools and adolescent soda consumption or BMI percentile in a national sample. Interestingly, we found that the association was generally restricted to non-Hispanic Blacks, among whom consumption of sugar-sweetened beverages has increased in recent years.⁷ The differences in effect sizes between non-Hispanic Blacks and non-Hispanic Whites suggest that state policies targeting junk food in schools may be a means to reduce disparities in soda consumption between these groups.

These results extend 2 earlier sets of cross-sectional studies: those that found school policies and practices to be associated with sugar-sweetened beverage exposure or consumption among students^{41,42} and those that reported improvements in students’ dietary intake following state policy change.^{19,20} This study builds on previous studies by using multiple years of policy data in 33 states and controlling for state variables that may have motivated policy change. These study features provide additional evidence that policy changes may lead to lower soda consumption, although causality cannot be inferred because of the observational design.

Our study also highlighted concession stands and parties as areas where states and schools may influence student soda consumption. In a study of adolescent alcohol consumption,

TABLE 2—Adjusted Mean Daily Servings of Soda Among 9th- to 12th-Grade Students in States With and Without Policy Changes Targeting Junk Food in Schools: United States, 2007

Setting	Servings by Policy Change Status		Difference, ^a Mean (95% CI)
	With	Without	
Vending machines			
Recommend or require ^b	1.00	0.95	0.04 (−0.05, 0.13)
Require ^c	0.98	0.96	0.02 (−0.07, 0.10)
Snack bars			
Recommend or require ^b	0.99	0.96	0.03 (−0.06, 0.12)
Require ^c	0.98	0.97	0.01 (−0.08, 0.11)
Concession stands ^b	0.91	1.00	−0.09 (−0.17, −0.01)
Parties ^b	0.92	0.99	−0.07 (−0.13, 0.00)

Note. CI = confidence interval. Data are adjusted for student gender and race/ethnicity and state-level log per capita income, obesity prevalence, and political party of state legislature. Data on state policy change are from the 2000 and 2006 School Health Policies and Programs Study. Adolescent soda consumption and BMI percentile in 2007 are from the Youth Risk Behavior Survey. Thirty-three states and the District of Columbia are represented in the sample (AR, AZ, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, ME, MA, MS, MO, MI, NV, NH, NM, NY, NC, ND, OH, RI, SC, TN, TX, UT, VT, WV, WI, WY).

^aThe difference in students’ daily servings of soda in states that required or recommended that schools prohibit junk food and states that did not, after adjustment for the covariates included in the model.

^b“Recommend” or “require” compared with “neither” (referent).

^c“Require” compared with “neither” (referent).

TABLE 3—Racial/Ethnic-Specific Association Between State Policy Changes Targeting Junk Food in Schools and Daily Soda Consumption Among 9th- to 12th-Grade Students: United States, 2007

Setting*	Non-Hispanic White, Difference ^a (SE)	Non-Hispanic Black, Difference ^a (SE)	Hispanic, Difference ^a (SE)	Non-Hispanic Other, Difference ^a (SE)
Vending machines				
Recommend or require ^b	0.08 (0.05)	-0.07 (0.06)	0.00 (0.09)	0.11 (0.07)
Require ^c	0.08 (0.05)	-0.12 (0.06)	-0.06 (0.09)	0.04 (0.07)
Snack bars				
Recommend or require ^b	0.06 (0.05)	-0.07 (0.06)	-0.02 (0.10)	0.13 (0.07)
Require ^c	0.06 (0.05)	-0.12 (0.06)	-0.08 (0.10)	0.09 (0.07)
Concession stands ^b	-0.07 (0.05)	-0.19 (0.06)	-0.11 (0.09)	-0.02 (0.08)
Parties ^b	-0.04 (0.04)	-0.14 (0.06)	-0.12 (0.08)	-0.03 (0.08)

Note. Data on state policy change are from the 2000 and 2006 School Health Policies and Programs Study. Adolescent soda consumption and BMI percentile in 2007 are from the Youth Risk Behavior Survey. Thirty-three states and the District of Columbia are represented in the sample (AR, AZ, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, ME, MA, MS, MO, MI, NV, NH, NM, NY, NC, ND, OH, RI, SC, TN, TX, UT, VT, WV, WI, WY).

^aThe difference in daily servings of soda among students between states that required or recommended that schools prohibit junk food and states that did not, adjusted for student gender and state-level log per capita income, obesity prevalence, and political party of state legislature.

^b"Recommend" or "require" compared with "neither" (referent).

^c"Require" compared with "neither" (referent).

* $P < .001$ for likelihood ratio test of interaction between race/ethnicity and policy change ($df=3$) for each setting.

Ellickson et al. examined the effect of advertising in several settings and found that concession stand advertising was associated with

alcohol consumption among ninth-grade students,⁴³ but concession stands and parties have generally been ignored in previous obesity policy

TABLE 4—Racial/Ethnic-Specific Association Between State Policy Changes Targeting Junk Food in Schools and Body Mass Index Percentile Among 9th- to 12th-Grade Students: United States, 2007

Setting	Non-Hispanic White, Difference ^a (SE)	Non-Hispanic Black, Difference ^a (SE)	Hispanic, Difference ^a (SE)	Non-Hispanic Other, Difference ^a (SE)	P^b
Vending machines					
Recommend or require ^c	-0.71 (1.34)	0.31 (1.64)	0.78 (2.06)	2.94 (3.57)	<.001
Require ^d	-1.09 (1.61)	-0.20 (1.88)	-0.34 (2.47)	4.09 (4.22)	<.001
Snack bars					
Recommend or require ^c	-0.51 (1.25)	0.83 (1.54)	0.76 (2.00)	4.47 (3.19)	<.001
Require ^d	-0.77 (1.43)	0.64 (1.72)	-0.29 (2.28)	5.48 (3.61)	<.001
Concession stands ^c	-0.88 (1.00)	-0.54 (1.46)	-1.91 (1.67)	1.69 (3.32)	.02
Parties ^c	-0.63 (0.92)	0.08 (1.32)	-1.29 (1.61)	1.34 (3.37)	.09

Note. Data on state policy change are from the 2000 and 2006 School Health Policies and Programs Study. Adolescent soda consumption and BMI percentile in 2007 are from the Youth Risk Behavior Survey. Thirty-three states and the District of Columbia are represented in the sample (AR, AZ, DE, FL, GA, HI, ID, IL, IN, IA, KS, KY, ME, MA, MS, MO, MI, NV, NH, NM, NY, NC, ND, OH, RI, SC, TN, TX, UT, VT, WV, WI, WY).

^aThe difference between student body mass index percentile in states that required or recommended that schools prohibit junk food and states that did not, adjusted for student gender and state-level log per capita income, obesity prevalence, and political party of state legislature.

^bLikelihood ratio test for interaction between race/ethnicity and policy ($df=3$).

^c"Recommend" or "require" compared with "neither" (referent).

^d"Require" compared with "neither" (referent).

research. Concession stands may include events that lie within a school's jurisdiction even though they take place outside of the school day (e.g., football games). Thus, our findings identify a means by which schools may influence adolescent soda consumption even if consumption primarily takes place outside of school hours. Additional research is needed to explore which sources students primarily rely on for soda and other energy-dense foods and beverages.

Despite the association between policy change and soda consumption among non-Hispanic Blacks, there was no association between policy change and BMI percentile. Cawley et al. reported similar null findings when studying the effect of state policies regarding physical education requirements.⁴⁴ State requirement policies were associated with minutes of activity during physical education, but there was no association between time spent active during physical education and obesity among boys or girls. The failure of policies to affect BMI or obesity, even if they change individual behaviors, may be an indication that the effect on behaviors is too small. The largest effect size in any racial/ethnic group in our study was only 0.19 servings per day. The serving sizes were not standardized, but if a serving represented a 20-ounce bottle, 0.19 servings would represent less than 50 kilocalories. In several studies, estimates of the energy gap that accounts for weight gain in the United States have ranged from 100 to 250 kilocalories per day.⁴⁵⁻⁴⁷ An effect size of 0.19 servings may therefore be insufficient to change BMI percentile.

Furthermore, students may be compensating for changes in soda consumption by consuming different kinds of junk foods or sugar-sweetened beverages (e.g., sports drinks). Cullen et al. reported that after policies restricted student access to certain junk foods from snack bars and vending machines, consumption of the targeted foods decreased, but consumption of other junk foods increased, and students obtained junk foods from different sources (e.g., home).^{19,48} This finding led the authors to conclude that all food environments must be targeted if policies are to have an impact. Hispanics, for example, are more likely to attend schools surrounded by convenience stores, restaurants, and other food outlets,^{22,23} allowing more opportunities to compensate for within-school policy changes.

These challenges have led several researchers and policymakers to call for comprehensive policy change at the federal, state, and local levels.^{9,12,49-51} District wellness policies were just starting to be implemented when the student data used in this study were collected, and the comprehensive effect of state and district policies may be more effective in reducing BMI and obesity. The Alliance School Beverage Guidelines, which were scheduled to be fully implemented by the 2009–2010 school year, were also designed to improve the nutritional content of school beverages.⁵² Future research should explore the cumulative effect of policy changes on different governing levels and continue to explore whether the effect of comprehensive change can reduce disparities in both soda consumption and obesity.

The large association between policy change and BMI percentile among “non-Hispanic other” adolescents was likely due to differences between policy categories in the racial/ethnic distribution. Nonetheless, we found no evidence that policy changes had a beneficial effect within this group, which is a concern given the high prevalence of obesity and type 2 diabetes among American Indian and Alaska Native youths in particular.⁵³ Future research should continue to explore racial/ethnic differences in policy effects in an effort to identify policies that are more effective in this population.

Limitations

Several limitations should be considered when interpreting these findings. Measurement error due to self-report may have biased our estimates because adolescents commonly overreport height³⁰ and underreport weight³⁰ and dietary intake.⁵⁴ The accuracy of self-reported height and weight may also vary by race/ethnicity.⁵⁵ The survey did not measure serving size, nor did it distinguish between diet and regular soda; both limitations precluded us from estimating differences in energy intake between policy groups. We also could not examine within-student change in soda consumption or BMI percentile because individual students were not followed over time nor could we measure exactly when policy changes took place. If policy changes occurred in 2006, there may not have been sufficient time for them to affect BMI percentile. State policies may also vary in the wording of the policies (e.g., different states

may restrict different types of beverages), and no study has evaluated the validity of SHPPS data by having an independent investigator compare surveys with policy documentation. Finally, survey weights were designed to represent individual states, but the analysis was restricted to 33 states and the District of Columbia, and thus results cannot be generalized to the United States as a whole.

Conclusions

This study provides evidence that changes in state policies restricting junk food in schools are associated with reduced soda consumption among adolescents, particularly non-Hispanic Blacks. The effect of individual policies, however, may be too weak to reduce adolescent obesity. Future research should evaluate the impact of comprehensive policy change, inside and outside of schools, on adolescent obesity. ■

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Contributors

D.R. Taber conceptualized and designed the study, conducted the analyses, and led the writing. J. Stevens supervised the study as doctoral dissertation chair, contributed to the study conceptualization and design, and assisted with the interpretation of results. K.R. Evenson, D.S. Ward, and R.C. Brownson contributed to the study conceptualization and interpretation of results. C. Poole, M.L. Maciejewski, and D.M. Murray contributed to the study design and statistical analyses. All authors participated in revising and editing the article.

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Human Participant Protection

This study was approved by the institutional review board of the University of North Carolina, Chapel Hill.

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