Weight Status Among Adolescents in States That Govern Competitive Food Nutrition Content

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KEY WORDS competitive foods, state laws, BMI, adolescent

ABSTRACT

Competitive foods, state laws, BMI, adolescent

WHAT’S KNOWN ON THIS SUBJECT: Policies that govern nutrition standards of foods and beverages sold outside of federal meal programs (“competitive foods”) have been associated with adolescent weight status in a small number of cross-sectional studies and pre-post analyses in individual states.

WHAT THIS STUDY ADDS: This longitudinal analysis of 6300 students in 40 states provides evidence that state competitive food laws are associated with lower within-student BMI change if laws contain strong language with specific standards and are consistent across grade levels.

OBJECTIVES: To determine if state laws regulating nutrition content of foods and beverages sold outside of federal school meal programs (“competitive foods”) are associated with lower adolescent weight gain.

METHODS: The Westlaw legal database identified state competitive food laws that were scored by using the Classification of Laws Associated with School Students criteria. States were classified as having strong, weak, or no competitive food laws in 2003 and 2006 based on law strength and comprehensiveness. Objective height and weight data were obtained from 6300 students in 40 states in fifth and eighth grade (2004 and 2007, respectively) within the Early Childhood Longitudinal Study—Kindergarten Class. General linear models estimated the association between baseline state laws (2003) and within-student changes in BMI, overweight status, and obesity status. Fixed-effect models estimated the association between law changes during follow-up (2003–2006) and within-student changes in BMI and weight status.

RESULTS: Students exposed to strong laws at baseline gained, on average, 0.25 fewer BMI units (95% confidence interval: −0.54, 0.03) and were less likely to remain overweight or obese over time than students in states with no laws. Students also gained fewer BMI units if exposed to consistently strong laws throughout follow-up (β = −0.44, 95% confidence interval: −0.71, −0.18). Conversely, students exposed to weaker laws in 2006 than 2003 had similar BMI gain as those not exposed in either year.

CONCLUSIONS: Laws that regulate competitive food nutrition content may reduce adolescent BMI change if they are comprehensive, contain strong language, and are enacted across grade levels. Pediatrics 2012;130:437–444
National medical organizations,1–3 policymakers,4,5 and the federal government6,7 have called for bold policy initiatives to reduce adolescent obesity in the United States. Nearly one-fifth of 12- to 19-year-olds in the United States were obese in 2009 to 2010 (18.4%),8 and the long-term effects of adolescent obesity on morbidity and premature mortality during adulthood are well documented.9 As the US population ages, the public health and economic burden of obesity is expected to grow.10–13

Numerous interventions have attempted to reduce adolescent obesity by educating adolescents to be active and consume a healthy diet, but education-based interventions have had little success.14,15 Experts argue that education will not suffice without changing the contemporary “obesogenic” environment in which adolescents have countless sources of high-caloric-density, low-nutrient-density foods and beverages.16–18 Schools have become a source of sugar-sweetened beverages (SSBs), candy, and other foods and beverages of minimal nutritional value.19–21 Particularly at higher grade levels, school food environments include widespread availability of “competitive foods”22 (foods and beverages sold outside of meal programs) that have historically been exempt from federal nutrition standards.2

The Healthy, Hunger-Free Kids Act of 2010 requires, among several provisions, that competitive foods be subject to standards set by the US Department of Agriculture (USDA) in schools that participate in federal meal programs.23 Some experts questioned the potential impact of such policies by noting that students consume a relatively small proportion of their daily calories at school and can compensate for school changes by obtaining energy-dense foods elsewhere.24–27 Furthermore, school nutrition regulations are politically controversial, as illustrated by recent debates in Congress regarding proposed USDA school meal standards that are intended to align standards with current nutrition science. Dialogue on the topic has been limited by the lack of longitudinal evidence regarding the association between school nutrition policies and student weight status. Research has suggested that competitive food policies are associated with improvements in the school food environment, student dietary intake, or weight outcomes,28–34 but most studies were cross-sectional or limited to individual states. A recent study reported no association between competitive food sales and weight gain, but it was based on school administrator surveys rather than independent review of codified laws.35 Studies that analyzed weight outcomes also generally relied on self-reported height and weight, which can be misreported.36

To address these limitations, this longitudinal study was designed to estimate the association between independently coded state laws governing competitive food nutrition content and within-student change in BMI and weight status, based on objective height and weight data collected from adolescents in 40 states. We estimated the association between baseline state laws and student weight change, as well as the association between changes in state laws over time and student weight change.

METHODS

Competitive Food Laws

State codified laws regarding the availability of high-caloric-density, low-nutrient-density foods and beverages in schools were obtained from the National Cancer Institute’s Classification of Laws Associated with School Students school nutrition scoring system.37,38 Statutory and administrative (regulatory) laws were compiled by using natural language and Boolean keyword searches of the full-text, table of contents, and indices for state laws available from Westlaw, a subscription-based legal research database. Our analyses were based on 6 different categories of laws: those governing nutrition content of competitive foods sold in (1) vending machines, (2) cafeterias (à la carte), and (3) other venues (eg, stores); and those governing nutrition content of competitive beverages in each of the 3 locations. Laws included regulations of specific nutrients (eg, fat content), specific beverage groups (eg, SSBs), and times of day when foods/beverages could be sold.

States were rated on a scale of 0 to 6 in each category of laws, independently and annually, beginning in 2003. Ratings reflected relative stringency, specificity, and strength of language of laws that were in place as of December 31 of that year. Laws governing different grade levels were rated separately. In any given year and grade level, most states applied the same laws across all venues rather than requiring restrictions only in specific venues. Because of the high within-state correlation, we used the average of the 6 ratings as a comprehensive measure of state competitive food laws.

For the purpose of this study, states were categorized as having “strong” competitive food laws if their average rating was >2.0. The cut point was chosen because ratings >2 represent laws with specific, required standards, as opposed to laws that contained weak language (eg, “recommended” standards) or no specific guidelines (eg, references to “healthy” foods). Additional details on the law ratings criteria can be found elsewhere.38 States with an average rating of 1 to 2 were categorized as having “weak” competitive food laws. We explored using a higher cut point to define strong laws (eg, 5.0), but there were not enough states with high ratings to support such an analysis.

Participants

Student data were obtained from the Early Childhood Longitudinal Study—Kindergarten Class (ECLS-K).39,40 ECLS-K
is a cohort that began as a nationally representative sample of kindergarten students in 1998 and was followed through 7 rounds of data collection. Analyses in this study were based on data from public school students measured in round 6 (fifth grade, Spring 2004) and round 7 (eighth grade, Spring 2007). Among the 8870 public school students who provided BMI data in fifth grade, 2570 were excluded from analyses because they enrolled in a private school (n = 130), moved states (n = 150), were missing data on eighth-grade school type (n = 220) or BMI (n = 390), or were lost to follow-up (n = 1680), leaving a final sample of 6300 students. Those excluded were less likely to be non-Hispanic white (P < .001) and more likely to live in an urban area (P < .001) or be below the poverty line in fifth grade (P < .001). They did not differ from the study sample in terms of fifth grade BMI, obesity prevalence, or overweight prevalence. Forty states were represented in the study sample; individual states cannot be listed because of data license restrictions. States that were not represented did not differ from the sample with respect to state median income, poverty rate, adult education, or obesity prevalence, but tended to have weaker laws.

ECLS-K researchers measured student weight and height in each survey round by using a digital scale and Shorr board, respectively. BMI was calculated (kg/m²) and students were categorized as overweight or obese if their BMI was greater than or equal to the age- and gender-specific 85th or 95th percentiles, respectively, of the 2000 Centers for Disease Control and Prevention growth charts.41 These years preceded the spring seasons when student data were collected. The dependent variables of interest were within-student changes in BMI (continuous), obesity status (binary), and overweight status (binary). Overweight status included students classified as obese. BMI was used in lieu of BMI percentile or z score because the variability of changes in BMI percentile and z score are associated with baseline values of these measures,42 which can bias SE estimates.

General linear models with an identity link were used to estimate differences across 2003 middle school law categories (strong, weak, none) in each dependent variable. Middle school laws were used because students were enrolled in middle school for most of the follow-up period. When modeling obesity, the sample was separated into 2 groups (students who were not obese in fifth grade and students who were obese in fifth grade) and eighth grade obesity status was modeled in each group to estimate incidence and maintenance of obesity, respectively. The same approach was used when modeling overweight status. Models adjusted for gender, age, race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, non-Hispanic other), socioeconomic status (SES; measured by using an index that combined data on parental education, occupation, and income),39 school locale (city, suburban, township/rural), Census region (South versus other), physical activity, and 2003 state adult obesity prevalence.43 Eighth-grade physical activity was measured by asking students to report the number of days they engaged in at least 20 minutes of activity that made them sweat or breathe hard in the past week (fifth-grade activity was parent reported and therefore not used in longitudinal analyses because of inconsistent measurement across waves.) A robust SE was used to account for within-state clustering.

When analyzing 2003 to 2006 law changes, states were categorized by using 2 criteria. First, states were categorized based on whether their average rating for 2006 middle school laws was equal, higher, or lower compared with their average rating for 2003 elementary school laws (“no change,” “new laws,” or “weaker laws,” respectively). The respective grade levels were chosen because our objective was to analyze the change that students experienced as they progressed from fifth to eighth grade, which represents a transition from elementary to middle school for most students. Second, the new laws category was subdivided into 2 categories (strong or weak) and the no change category was subdivided into 3 categories (strong, weak, none). The weaker laws category was not subdivided because of the small sample size. An individual-level fixed-effect model was used to estimate differences between categories in within-student changes in BMI, overweight, or obesity, adjusted for SES and locale.

As a supplementary analysis, we repeated these models by using changes in within-school purchasing of sweets, salty snacks, and SSBs as dependent variables (continuous). Each behavior was measured by asking students to report the number of times they purchased the food/beverage group in school within the past week. Analyses were conducted with Stata, Version 11 (StataCorp, College Station, TX).

RESULTS

Table 1 illustrates the differences between law categories in race/ethnicity, SES, and Census region. States with no 2003 laws had a relatively low proportion of students who were non-Hispanic black (9.0%) or in the lowest SES quintile (15.7%). States with weak 2003 laws had a relatively high proportion of students who were Hispanic (28.0%) or in the lowest SES quintile.
Nearly 70% of students in states with strong 2003 laws lived in the South, whereas only 5.7% lived in the West. Conversely, students exposed to weaker laws in 2006 were entirely from the South, whereas 65.5% of students exposed to new strong laws in 2006 were from the West.

Figure 1 displays the adjusted mean within-student BMI change by state law categories. Students in states with weak 2003 laws (i.e., laws that contained weak language or nonspecific standards) had, on average, a slightly smaller increase in BMI compared with students in states with no relevant laws ($b = -0.13$, 95% confidence interval [CI]: $-0.34$, $0.07$). The difference in BMI change was nearly twice as large when comparing students in states with strong 2003 laws (i.e., laws with specific, required standards) with those in states with no relevant laws ($b = -0.25$, 95% CI: $-0.54$, $0.03$). Results of 2003 law analyses were similar when modeling overweight or obesity maintenance (Table 2). Students in states with strong laws were less likely to remain overweight (risk difference $= -4.8$, 95% CI: $-9.4$, $-0.1$) or obese (risk difference $= -7.7$, 95% CI: $-16.0$, $0.6$) from fifth to eighth grade, but the same was not true in states with weak laws.

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**TABLE 1** Descriptive Statistics of Study Sample, Overall and by State Law Category

<table>
<thead>
<tr>
<th>Overall</th>
<th>2003–2006 Law Change</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2003 Law</td>
</tr>
<tr>
<td></td>
<td>None Weak Strong None Weak Strong Weak Strong</td>
</tr>
<tr>
<td>No. of states</td>
<td>40 27 7 6</td>
</tr>
<tr>
<td>Student variables</td>
<td></td>
</tr>
<tr>
<td>n</td>
<td>6300 3720 1620 960</td>
</tr>
<tr>
<td>Gender, %</td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>49.8 49.3 51.3 49.0</td>
</tr>
<tr>
<td>Race/ethnicity, %</td>
<td></td>
</tr>
<tr>
<td>White, non-Hispanic</td>
<td>58.9 64.1 45.5 61.9</td>
</tr>
<tr>
<td>Black, non-Hispanic</td>
<td>11.9 9.0 14.9 18.5</td>
</tr>
<tr>
<td>Hispanic</td>
<td>18.5 15.7 28.0 13.3</td>
</tr>
<tr>
<td>Other, non-Hispanic</td>
<td>10.7 11.2 11.8 6.4</td>
</tr>
<tr>
<td>SES quintile, %</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>18.1 15.2 23.8 17.8</td>
</tr>
<tr>
<td>2</td>
<td>20.2 20.5 18.6 21.2</td>
</tr>
<tr>
<td>3</td>
<td>19.6 20.5 17.4 19.5</td>
</tr>
<tr>
<td>4</td>
<td>21.3 22.7 18.5 20.8</td>
</tr>
<tr>
<td>5</td>
<td>20.9 20.6 21.7 20.7</td>
</tr>
<tr>
<td>Locale, %</td>
<td></td>
</tr>
<tr>
<td>City</td>
<td>31.8 30.0 37.3 26.7</td>
</tr>
<tr>
<td>Suburban</td>
<td>40.2 40.2 36.6 41.4</td>
</tr>
<tr>
<td>Township/Rural</td>
<td>28.2 29.5 23.1 30.2</td>
</tr>
<tr>
<td>Region, %</td>
<td></td>
</tr>
<tr>
<td>Northeast</td>
<td>18.9 15.0 22.1 25.7</td>
</tr>
<tr>
<td>Midwest</td>
<td>27.6 42.6 9.8 0.0</td>
</tr>
<tr>
<td>South</td>
<td>32.9 27.2 24.9 68.6</td>
</tr>
<tr>
<td>West</td>
<td>20.6 14.5 43.3 5.7</td>
</tr>
<tr>
<td>BMI, mean</td>
<td></td>
</tr>
<tr>
<td>5th grade</td>
<td>20.7 20.5 21.2 20.9</td>
</tr>
<tr>
<td>8th grade</td>
<td>23.1 22.9 23.5 23.1</td>
</tr>
<tr>
<td>Overweight, %</td>
<td></td>
</tr>
<tr>
<td>5th grade</td>
<td>40.1 36.9 46.0 42.1</td>
</tr>
<tr>
<td>8th grade</td>
<td>37.4 35.2 42.7 36.8</td>
</tr>
<tr>
<td>Obesity, %</td>
<td></td>
</tr>
<tr>
<td>5th grade</td>
<td>22.3 20.4 25.9 23.3</td>
</tr>
<tr>
<td>8th grade</td>
<td>20.3 18.9 23.3 20.6</td>
</tr>
</tbody>
</table>

**FIGURE 1**
Adjusted within-student BMI change, by 2003 state law* and 2003–2006 law change.†
TABLE 2 Maintenancesa and Incidenceb of Overweight or Obesity Status, by Strength of 2003 State Competitive Food Laws

<table>
<thead>
<tr>
<th>Weight Measure</th>
<th>2003 Law</th>
<th>Unadjusted</th>
<th>Adjusted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>%</td>
<td>95% CI</td>
</tr>
<tr>
<td>Maintenance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overweight</td>
<td>None</td>
<td>80.1</td>
<td>78.1, 82.1</td>
</tr>
<tr>
<td></td>
<td>Weak</td>
<td>79.0</td>
<td>77.4, 80.7</td>
</tr>
<tr>
<td></td>
<td>Strong</td>
<td>77.0</td>
<td>72.3, 81.8</td>
</tr>
<tr>
<td>Obesity</td>
<td>None</td>
<td>74.1</td>
<td>70.4, 77.8</td>
</tr>
<tr>
<td></td>
<td>Weak</td>
<td>74.5</td>
<td>71.9, 77.0</td>
</tr>
<tr>
<td></td>
<td>Strong</td>
<td>70.5</td>
<td>62.9, 78.2</td>
</tr>
<tr>
<td>Incidence</td>
<td>None</td>
<td>8.9</td>
<td>7.7, 10.1</td>
</tr>
<tr>
<td></td>
<td>Weak</td>
<td>11.7</td>
<td>9.3, 14.2</td>
</tr>
<tr>
<td></td>
<td>Strong</td>
<td>7.5</td>
<td>5.8, 9.3</td>
</tr>
</tbody>
</table>

—, referent category.

a Risk of remaining overweight/obese between fifth and eighth grade.
b Risk of developing overweight/obesity between fifth and eighth grade.
c Absolute difference in risk of maintaining or developing overweight/obesity, adjusted for race/ethnicity, gender, age, locale, SES, region, and 2003 state obesity prevalence.

Results from analyses of 2003 to 2006 law changes (Table 3) generally echoed analyses of 2003 laws. Students who were exposed to consistent, specific, required competitive food laws from 2003 to 2006 gained 0.44 fewer BMI units than students who were not exposed to any relevant laws over time (95% CI: −0.71, −0.18). Students exposed to weaker laws in 2006 had approximately the same BMI change as those who were not exposed to any relevant laws throughout follow-up (β = −0.04, 95% CI: −0.24, 0.15). Surprisingly, students exposed to new laws in 2006 gained fewer BMI units if new laws were weak (β = −0.39, 95% CI: −0.56, −0.22) but not if new laws were strong (β = −0.10, 95% CI: −0.33, 0.12). Law change categories were associated with lower probability of being overweight, with differences ranging from −2.8% to −4.5%, but were not associated with probability of being obese.

Students were estimated to have smaller increases in within-school purchasing of sweets if they resided in states with consistent laws from 2003 to 2006 (Supplemental Table 4). Associations between strong 2003 laws and changes in within-school purchasing behaviors were negative, as hypothesized, but not statistically significant. Likewise, categories of 2003 to 2006 law changes were associated with smaller increases in SSB purchasing, but associations were not statistically significant.

DISCUSSION

In this longitudinal analysis, state competitive food laws were associated with lower BMI change and lower risk of remaining overweight or obese over time in a racially and socioeconomically diverse sample of 6300 adolescents across 40 states. Law strength and consistency emerged as 2 key factors that influenced the association. Adjusted BMI gain was lowest among adolescents exposed to laws that contained specific, required standards that were consistent as students progressed from fifth to eighth grade, whereas adolescents exposed to weaker laws over time experienced the same BMI change as those never exposed to competitive food laws.

Law strength and consistency are salient to ongoing attempts to improve nutrition content of school foods. The stringency of school nutrition standards has been
a contentious topic among policy-
makers, and at the time of this study, the 
USDA was in the process of designing 
competitive food standards as part of 
Our results suggest that competitive 
food laws had a relatively weak associ-
ation with BMI change if they contained 
diluted nutrition standards that were 
nonspecific or not required. Consistency 
of competitive food standards is critical, 
given that competitive food policies tend 
to be weaker at higher grade levels.44 
Based on our results, elementary school 
laws may have a limited impact unless 
reinforced by strong codified laws at 
higher grade levels. 

Interestingly, strong baseline state 
laws were associated with within-
student BMI change and maintenance 
of overweight/obesity but not with 
incidence of overweight/obesity. This 
suggests that the association is not 
uniform across the BMI distribution. 
There could be heterogeneity in the 
impact of competitive food laws if, for 
example, some students compensate 
by adjusting their dietary behaviors 
outside of school. Future research 
could use alternative statistical meth-
ods (eg, quantile regression) to explore 
how the association between laws and 
weight change varies by baseline 
BMI. Another potential source of het-
erogeneity is student lunch source, as 
students who bring food from home 
may not benefit from competitive food 
laws as much as students who pur-
chase school foods. Either scenario 
would have implications for policy-
makers by suggesting who benefits 
from competitive food laws and 
whether laws must be complemented 
by initiatives in other sectors to tar-
get other students. 

The association between laws and 
changes in within-school dietary pur-
chases were in the hypothesized di-
rection, although not always statistically 
significant. This is not surprising for 
several reasons. Unlike BMI, purchasing 
data were self-reported and more vul-
nerable to measurement error,45 which 
may bias estimates toward the null. 
Different states with strong laws may 
target different food/beverage groups, 
thereby weakening the overall associ-
ation between laws and specific food/ 
beverage groups. Finally, questions 
about purchasing did not distinguish 
between specific types of foods, such as 
high-fat versus low-fat sweets, and 
questions measured frequency of in-
take but not extent of intake. Future re-
search should use more precise dietary 
assessment instruments (eg, 24-hour 
recall) to examine the association be-
tween competitive food laws and con-
sumption of specific foods, beverages, 
and nutrients. 

Our analyses incorporated 6 different 
laws targeting competitive foods and 
beverages in different settings. The 
results thus support policy evaluations 
that concluded that policies were ef-
fective if they addressed all aspects of 
the school food environment.29,33,34 The 
caveat, however, is that within-state 
correlation between laws makes it im-
possible to disentangle the 6 laws to 
identify the source of any effects. The 
observational design precludes us from 
making any causal inferences, but even 
if one could conclude that laws caused 
lower weight gain, one could not de-
termine if the cause was because of the 
laws’ cumulative impact or 1 law hav-
ing an exceptionally strong impact. Another 
factor to consider is that laws on dif-
ferent governing levels were being 
implemented during the same year that 
eighth-grade ECLS-K data were col-
clected. The Child Nutrition and WIC 
Reauthorization Act of 200446 and the 
Alliance for a Healthier Generation 
School Beverage Guidelines47 both re-
quired guidelines for competitive foods 
or beverages to be implemented during 
the 2006 to 2007 school year. Some local 
districts also implemented their own 
policies.48 Additional research is needed 
to determine if states with stronger 
laws were implementing federal or local 
policies more aggressively. 

Other limitations should be considered 
when assessing these results. A large 
proportion of students were lost to 
follow-up between fifth and eighth grade, 
and those lost were more likely to be 
racial/ethnic minorities or of low SES. 
Future research should examine whether 
competitive food law effectiveness varies 
by race/ethnicity or SES. Several student 
sociodemographic characteristics var-
ied across state law categories, as well. 

Although we used multiple statistical 
methods to control for such character-
istics, unmeasured time-varying con-
 founding factors cannot be ruled out. 
Physical activity was a potential con-
founder in analyses of law changes, as we 
could not control for it in these models 
owing to changes in activity measures 
across grades. We also were unable to 
assess whether any differences in weight 
gain are maintained during the summer 
when students are not in school. Finally, 
we did not analyze adherence to laws, 
although several studies have reported 
that state competitive food laws were 
associated with healthier school food 
environments.49–53 

We also encourage future studies to 
examine whether students who reside 
in states with particularly stringent 
standards (eg, lower limits on fat or 
sugar content) experience less BMI 
change. Few states had such stringent 
standards in 2003, prohibiting us from 
using stricter criteria to define strong 
laws. As laws continue to evolve, future 
studies could compare BMI change in 
states with different standards. 

CONCLUSIONS 
Several features of this study (objective 
measures of height, weight, and codi-
fied laws; longitudinal design; mixture 
of methodologies) built on existing re-
search and strengthened the evidence
that competitive food laws may improve adolescent weight status. The results of this study clearly indicate that strength of language, comprehensiveness, and consistency of new competitive food standards will be imperative if the

Healthy, Hunger-Free Kids Act of 2010 is to have success in reducing adolescent obesity.

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