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State Laws Governing School Meals and Disparities in Fruit/ Vegetable Intake

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Abstract

Background—Home access to fruits/vegetables (FV) is a consistent predictor of adolescent FV intake, but many adolescents face barriers to home access.

Purpose—To determine if state laws that require FV in school meals are positively associated with FV intake, particularly among students with limited home access to FV.

Methods—Student data on home food access and FV intake were obtained from the National Youth Physical Activity and Nutrition Study ($n=9574$) and linked to state laws regarding FV requirements for school meals. All data were collected in 2010. Ordinary least-squares models were utilized in 2012 to estimate differences in intake between states with different FV laws, overall and by whether students had access to various foods at home (FV, unhealthy snacks). Models were weighted to account for the sample design and controlled for race, gender, age, fast-food intake, and school lunches consumed per week.

Results—The association between FV requirement laws and FV intake was strongest among students without regular home access to FV. Particularly among students who had home access to only unhealthy snacks and who regularly consumed school meals, mean FV intake was 0.45 and 0.61 cups/day higher, respectively (95% CI=0.07, 0.84 and 0.21, 1.00) in states with FV requirements. Students with access to healthier foods at home tended to consume more FV, but such disparities in intake were smaller in states with FV laws.

Conclusions—Laws that require FV in school meals may improve FV intake, particularly among students with limited access to healthy foods at home.

Introduction

Enhancing the nutrition content of school foods has become a central goal of federal, state, and local policymakers due to the high prevalence of youth obesity¹ and the low proportion of children who meet dietary guidelines.^{2–5} Fruit and vegetable intake is a measure on which the vast majority of adolescents fall short of recommendations. In 2003–2004, only 0.9% of children aged 12–18 years consumed recommended levels of fruits and vegetables (FV).⁴ In 2010, 28.5% of high school students consumed <1 fruit per day and 33.2% consumed <1

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vegetable per day.² Establishing healthy dietary behaviors at a young age is critical because such behaviors tend to track into adulthood,^{6,7} when FV consumption is associated with coronary heart disease,⁸ stroke,⁹ and some types of cancer.¹⁰ The WHO reported that approximately 1.8% of the global burden of disease in the year 2000 was attributable to inadequate consumption of FV.¹¹

To promote greater FV intake, the U.S. Department of Agriculture (USDA) recently released new school meal nutrition standards that will require, among several provisions, that schools participating in the National School Lunch Program (NSLP) provide daily FV servings in school meals beginning in the 2012–2013 school year.¹² Prior to the recent update, NSLP standards were based on outdated science, and several studies found that NSLP meals were of poor nutritional quality.^{13–16} Finkelstein et al., for example, reported that only 55.3% of high schools offered fresh fruits or raw vegetables daily in 2005,¹⁵ although recent evidence suggests that school meals have become healthier.¹⁷

Policymakers have targeted schools as the primary setting for nutrition promotion,^{18–20} even though students tend to consume more than half of their calories at home.²¹ FV availability within the home is one of the most consistent correlates of FV intake.^{22,23} Many families face physical, social, and economic barriers to having healthy foods, however,^{24–26} and improving school meal standards may reduce disparities in diet by increasing FV intake among students who face such constraints. Identifying the optimal intervention targets requires research on how environmental determinants interact with one another.^{27,28} Studying whether school-based nutrition policies can offset disadvantages in home food availability—or, conversely, whether at-home disadvantages negate school policies—can help policymakers identify the most-promising interventions.

The objectives of this study were to determine: (1) if state laws that require a minimum number of FV in school meals were associated with greater overall FV intake (both at school and outside of school); and (2) if the associations were stronger or weaker among students without regular access to FV at home. The intervention group in this study consisted of two states, California and Mississippi, which share similar FV laws despite numerous demographic, political, and cultural differences. They present an opportunity to assess whether any impact of FV requirements is generalizable to various contexts.

Methods

This cross-sectional study linked data from a nationally representative sample of students in Grades 9–12, collected as part of the National Youth Physical Activity and Nutrition Study (NYPANS),²⁹ with data on state laws governing FV served in school meals, compiled as part of the Bridging the Gap research program.³⁰ All data were collected in 2010; data sources are described in detail below. The study was approved by the IRB of the University of Illinois at Chicago.

National Youth Physical Activity and Nutrition Study

The National Youth Physical Activity and Nutrition Study (NYPANS) was conducted by the CDC in Spring 2010 to measure diet, physical activity, and sedentary behaviors, and environmental determinants of such behaviors, among students in Grades 9–12. Students were sampled using a three-stage cluster sample design. The school response rate was 82%; the student response rate was 88%; and the overall response rate was 73%. Only public school students ($n=10,887$) were included in this study.

Behavioral, environmental, and demographic data were obtained from students using a written questionnaire that they completed in class. Data utilized in this study included daily

intake of FV; access to FV at home; access to chips, cookies, or cake (hereafter referred to as “unhealthy snacks”) at home; number of school meals and fast-food servings consumed per week; race/ethnicity; gender; and grade. For the purpose of this study, 1313 students were excluded from analyses because they were missing data on FV intake ($n=560$); home food access ($n=254$); number of lunches consumed at school ($n=264$); or covariates ($n=235$), leaving a study sample of 9574 students in 27 states. Students who were excluded did not differ from the study sample in terms of total mean FV intake, but they reported less home access to unhealthy snacks or FV, tended to consume more fast food, and were more likely to be black, Hispanic, or male.

Student-Level Measures

Intakes of FV were measured independently by asking students how many cups of FV they “eat or drink each day.” To assist students in estimating their usual intake, the questionnaire provided several examples of quantities of FV that equal 1 cup (e.g., 12 baby carrots). Both questions included seven response options, ranging from *none* to *4 or more*. For analysis purposes, responses that included a range (e.g., 2–3 cups per day) were coded using the midpoint (2.5). Students who reported *4 or more* were coded as 4.5. Students were also asked to report how often FV were available at home and how often unhealthy snacks were available at home. Both questions included five response options, ranging from *never* to *always*.

Legal Data

Primary legal research methods were used to compile state laws regarding FV requirements for school meals.^{31,32} “Laws” included codified state statutory and administrative (i.e., regulatory) laws effective as of September 2009. Laws were obtained from the subscription-based Westlaw and Lexis-Nexis legal research databases and are considered to include any formal laws and regulations adopted by state legislatures and state departments or boards of education. Each state’s law was double-coded by two trained coders and verified against secondary sources.^{33–36}

For the purpose of this study, states were categorized by whether their laws required high schools to provide a minimum number of FV in school meals during the 2009–2010 school year. California and Mississippi were the only states in the NYPANS sample that met this criterion. The other 25 states represented in NYPANS did not have specific FV standards for high school meals.

Data Analysis

Several modeling approaches were explored before concluding that ordinary least-squares (OLS) regression was the best method of estimating differences in FV intake. Intake for fruits versus vegetables were modeled separately. Unless otherwise noted, all models used the “svy” command in Stata, version 12, to account for the cluster sample design and oversampling of black and Hispanic students. Models controlled for race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, non-Hispanic other); grade; gender; fast-food consumption; and number of school meals consumed per week. Analyses were conducted in 2012.

First, OLS models were used to estimate the association between home food access and FV intake. Access to FV and access to unhealthy snacks were analyzed in the same model, using dummy variables to model each category minus the referent (students who reported always having access.) Subsequently, to analyze the overall home food environment, models were repeated after cross-classifying students based on whether they had regular access to FV and/or unhealthy snacks at home, with “regular” defined as usually or always having access.

Students with regular access to FV but not unhealthy snacks were the referent category and were compared to the other three categories: (1) students with regular access to both FV and unhealthy snacks; (2) students with regular access to only unhealthy snacks; and (3) students with regular access to neither.

Models were then used to estimate differences in FV intake between California/Mississippi versus states with no FV requirement laws. These models were repeated among students who obtained a school meal 4–5 days per week, a subsample that theoretically would benefit from school meal laws the most. Finally, to assess whether the association between FV laws and intake varied by the home food environment, an interaction term between laws and the home food environment was added. The interaction term estimated the association between FV laws and disparities in FV intake between students with access to different foods at home (e.g., whether California/Mississippi had a smaller gap in intake between students who had regular access to unhealthy snacks versus students who had regular access to FV). This model was also repeated among students who obtained a school meal 4–5 days per week.

Analyses were repeated for California and Mississippi separately. The objective was to ensure that any associations between state laws and intake were not attributable to one specific state, which would question both the internal and external validity. This analysis differed from the main analysis in two respects: (1) survey weights were not used because NYPANS was not designed to represent individual states; and (2) for the analysis for Mississippi, race/ethnicity was modeled as a binary variable (non-Hispanic black vs other) due to the limited racial distribution.

Results

Grade and gender distributions were similar in California/Mississippi compared to states with no FV requirements (Table 1), but the latter group had a higher proportion of non-Hispanic whites (61.1% vs 30.0%) and a lower proportion of Hispanics (15.5% vs 48.6%). Mean FV intakes were equal across state law categories (1.2 and 0.9 cups/day, respectively). The distributions of home food access suggest that students in California and Mississippi had healthier home food environments, but this was largely attributable to California. Students in California were more likely to report always having access to FV at home (unweighted proportions=37.0% in California, 28.8% in Mississippi, 33.0% in states with no requirements) and less likely to report always having access to unhealthy snacks (13.4%, 27.9%, and 21.0%, respectively).

On average, the less often students had access to FV at home, the fewer FV they consumed per day (Table 2). Vegetable intake ranged from 0.41 cups/day among students who never had access to FV at home, to 1.25 cups/day among students who always had access (difference= −0.84, 95% CI= −0.98, −0.70). Conversely, the less often students had access to unhealthy snacks, the more FV they tended to consume. Intake was highest among students who had regular access to only FV.

In the total sample, the association between FV requirement laws and FV intake was very weak. Students in California/Mississippi consumed 0.03 fewer cups of fruit (95% CI= −0.09, 0.03) and 0.04 more cups of vegetables (95% CI= −0.02, 0.11) per day, on average, compared to students in states that did not require FV in school meals. Among students who obtained school lunches 4–5 days per week, the association with fruit intake was unchanged, but the association with vegetable intake was slightly stronger ($\beta=0.09$, 95% CI=0.00, 0.18).

Although the overall associations between state laws and intake were weak, Table 3 shows that the associations were strongest among students who did not have regular access to FV at home. Particularly among students who obtained a school lunch 4–5 days per week, students

consumed 0.45 more cups of fruit (95% CI=0.07, 0.84) and 0.61 more cups of vegetables (95% CI=0.21, 1.00), on average, if they resided in California/Mississippi versus states with no FV requirements. Conversely, there was little difference in FV intake between students in California/Mississippi versus other states among students with regular access to FV at home.

Due to this differential association, disparities in mean intake between students with regular access to only unhealthy snacks versus students with regular access to only FV were smaller in California/Mississippi by a magnitude of 0.54 (95% CI=0.03, 1.06) and 0.56 (95% CI=0.18, 0.94) cups of FV per day, respectively. For example, students who had regular access to only unhealthy snacks at home consumed 0.70 fewer cups of vegetables per day than students with regular access to only FV if they lived in states that did not require FV in school meals (95% CI= -0.81, -0.58), but only 0.14 fewer (95% CI= -0.50, 0.23) if they lived in California or Mississippi.

Disparities in fruit intake were also reduced among students with regular access to neither FV nor unhealthy snacks, although disparities in vegetable intake were approximately equal. Consistently, associations between state laws and intake were strongest among students who obtained school lunches 4–5 days/week. To summarize the results of the model, FV intake tended to be lowest among blacks, Hispanics, boys, and students who consumed more fast food, particularly in the total sample.

Evidence of lower disparities generally extended to both Mississippi and California (Appendix A, available online at www.ajpmonline.org). Both states had higher mean FV intake than states with no FV laws among students who did not have regular access to FV at home and regularly obtained school lunches. It should be noted that unweighted difference estimates in this analysis were smaller and less precise for both states compared to results in Table 3. However, the interaction terms of interest were approximately equal in California and Mississippi, suggesting that the results in Table 3 were not attributable to one particular state.

Discussion

Systematic reviews have identified the home food environment as a consistent predictor of fruit and vegetable intake among children.^{22,23} The results of this study replicated this finding and found that state laws that require FV in school meals were associated with higher FV intake primarily among students with limited FV access within the home. Results were similar in California and Mississippi, two states that have aggressively targeted school nutrition reforms in similar ways despite being dissimilar in many political, demographic, and cultural respects.

Results in Mississippi are particularly encouraging because the state has one of the poorest health profiles of any state. In recent years, Mississippi had the highest prevalence of obesity among children aged 10–17 years (2007)³⁷ and, among adults, the highest prevalence of obesity, third-highest prevalence of diabetes, and second-lowest proportion of residents eating five or more FV per day.³⁸ Data from this study also suggest that Mississippi students had particularly unhealthy home food environments. Recently, however, Mississippi has been active in passing laws to target childhood obesity. In addition to requiring FV in school meals, Mississippi requires a nutrition education curriculum that teaches behavior-focused skills to high school students.³⁹ Both California^{40,41} and Mississippi^{42,43} also have laws regarding nutrition content for competitive foods in schools.

Such a multifaceted approach may be necessary to raise FV intake to recommended levels. Although several results in the current study were encouraging, the fact remains that mean intake was well below the amounts recommended by the *Dietary Guidelines for*

Americans.⁴⁴ Even among regular school lunch consumers in California/Mississippi, adjusted mean vegetable intake (1.4 cups/day) was approximately half the recommended amount. This may be due to numerous factors including non-adherence to state laws, students not eating FV that are served, and lack of healthy foods in the community. School-based nutrition laws may mitigate the disadvantages that some teenagers face at home, but they are unlikely to negate the complex physical, social, and economic deterrents to healthy eating without help from other public and private sectors.

The IOM has argued that obesity prevention efforts should adopt a systems perspective by implementing an array of educational and environmental initiatives in homes, schools, and other settings.²⁸ The results of the current study lend support to this idea, suggesting that a fruitful approach may be to include interactions between policies and the broader environment in which students live. School-based nutrition policy research is a growing discipline, but studies have generally focused on the school setting without considering how effects of in-school changes may be modified by factors outside of school. It is possible that barriers to healthy eating outside of school could negate positive changes to the school environment.^{28,45} Evidence from this study suggests the opposite, in this particular case, but this may not be true for other environmental measures (e.g., fast food–restaurant proximity) or other outcomes (e.g., sweetened-beverage consumption).⁴⁶

Limitations

These issues are appropriate to consider as schools implement updated USDA school meal standards, which will present future opportunities to assess whether stronger school meal nutrition standards improve dietary intake and reduce disparities in intake on a national scale. Future research could examine this question while addressing limitations of this study. This study relied on self-reported measures of home food access and dietary intake, which are likely vulnerable to measurement error. Measurement error could bias estimates away from the null if students in California and Mississippi over-reported their intake more than students in other states.

Dietary data also lacked information on where students obtained FV, making it impossible to ascertain whether school meals were the cause of any differences in intake. This inability to ascribe causality was heightened by the cross-sectional design; inability to control for SES (not measured in NYPANS); and the limited number of states in the intervention group. California and Mississippi's comprehensive efforts to reduce childhood obesity are commendable, but they also make it impossible to conclude whether any particular law is the cause of the associations observed in the current study. Finally, missing data were associated with several variables, although the unadjusted differences in FV intake between California/Mississippi and other states were greater among students who were excluded due to missing data. Future longitudinal studies could use more precise and valid measures of the home environment (e.g., barcode scanning technology⁴⁷) and dietary intake (e.g., 24-hour recall), and examine the association between school meal nutrition reforms and student weight gain. This study did not analyze weight status for two reasons: (1) the association between FV consumption and adiposity among children is unclear⁴⁸; and (2) Mississippi enacted strong nutrition laws due to its high obesity prevalence, which is likely to bias the cross-sectional association between laws and weight status. However, future studies could study more comprehensive school meal laws and employ a longitudinal design to examine whether improved nutrition standards reduce student weight gain.

Conclusion

One of the original motives of the NSLP was to address disadvantages that low-income children face by providing healthy school meals. Previous research suggests that NSLP

meals have fallen short of that objective, but results of this study suggest that improvements in school meal standards have the potential to reduce disparities in diet that are caused by disadvantages beyond school.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Descriptive statistics of study sample, overall and by state law regarding fruit/vegetable requirements, % unless otherwise noted

	Overall	State law	
		No	Yes
n	9574	8079	1495
Gender			
Female	49.8	49.6	51.9
Race/ethnicity			
Non-Hispanic white	58.0	61.1	30.0
Non-Hispanic black	14.5	15.0	10.4
Hispanic	18.8	15.5	48.6
Non-Hispanic other	8.7	8.5	11.0
Grade			
9	27.2	27.5	24.6
10	25.6	25.5	27.1
11	24.2	24.0	26.5
12	22.9	23.1	21.8
Census region			
Northeast	14.3	15.9	0.0
Midwest	26.0	28.9	0.0
South	37.4	38.5	28.2
West	22.3	16.9	71.8
Home access to fruits/vegetables			
Never	3.2	3.2	3.1
Rarely	7.7	7.8	6.2
Sometimes	20.3	19.9	23.5
Usually	32.4	32.5	31.8
Always	36.4	36.5	35.4
Home access to chips/cookies/cakes			
Never	2.6	2.5	3.0
Rarely	15.9	15.5	19.4
Sometimes	32.2	31.6	37.0

	State law	
	Overall	No Yes
Usually	27.8	28.3 23.9
Always	21.6	22.1 16.8
Dietary behaviors (M)		
Cups fruit per day	1.2	1.2 1.2
Cups vegetable per day	0.9	0.9 0.9
School meals per week	2.9	2.9 2.6
Fast-food servings per week	1.9	1.9 1.8
State-level variables, 2010 (M)		
<i>n</i>	27	25 2
% obese adults ^a	28.5	28.4 29.6
Median income ^b	48,969	49,189 46,221
Poverty rate ^b	15.6	15.3 19.1
% adults with Bachelor's degree ^b	27.5	27.7 24.8

^aObtained from Behavioral Risk Factor Surveillance Systems

^bObtained from U.S. Census Bureau

Table 2
Adjusted differences in mean fruit/vegetable intake associated with the home food environment

Home food environment	n	Fruit (cups/day)			Vegetables (cups/day)				
		M ^a	β ^{a,b}	95% CI [BSI]	p-value	M ^a	β ^{a,b}	95% CI	p-value
Fruit/vegetable access									
Always	3201	1.58		(ref)		1.25		(ref)	
Usually	3043	1.26	-0.32	-0.39, -0.25	<0.001	0.91	-0.34	-0.41, -0.28	<0.001
Sometimes	2143	0.89	-0.68	-0.77, -0.59	<0.001	0.64	-0.61	-0.69, -0.53	<0.001
Rarely	819	0.64	-0.94	-1.04, -0.84	<0.001	0.54	-0.71	-0.82, -0.60	<0.001
Never	368	0.57	-1.01	-1.18, -0.84	<0.001	0.41	-0.84	-0.98, -0.70	<0.001
Unhealthy snacks access									
Always	1931	1.15		(ref)		0.74		(ref)	
Usually	2604	1.23	0.08	-0.07, 0.23	0.30	0.91	0.17	0.08, 0.27	0.001
Sometimes	3202	1.22	0.06	-0.07, 0.20	0.36	0.97	0.23	0.15, 0.30	<0.001
Rarely	1571	1.31	0.15	0.03, 0.28	0.02	1.08	0.34	0.25, 0.43	<0.001
Never	266	1.50	0.35	0.04, 0.66	0.03	1.34	0.59	0.43, 0.76	<0.001
Regular access to fruits/vegetables or unhealthy snacks ^c									
Fruits and vegetables only	3079	1.46		(ref)		1.19		(ref)	
Both	3165	1.38	-0.08	-0.18, 0.01	0.09	0.98	-0.21	-0.26, -0.16	<0.001
Unhealthy snacks only	1370	0.84	-0.62	-0.71, -0.53	<0.001	0.59	-0.60	-0.68, -0.51	<0.001
Neither	1960	0.79	-0.67	-0.74, -0.60	<0.001	0.64	-0.54	-0.62, -0.47	<0.001

^aAdjusted for race/ethnicity, gender, grade, fast-food consumption, and number of school meals consumed per week

^bDifferences in mean intake between students who have varying frequency of food access at home relative to students who always have access (ref)

^c“Regular” defined as usually or always having access

Table 3

Reductions in disparities of FV consumption associated with state FV requirements

Outcome ^a	Sample	Home food access ^b	n	Adjusted mean intake by state law ^c		Adjusted difference ^{c,d}		Reduction in disparities ^{c,e}	
				Yes	No	Est. (SE)	β	95% CI [BS2]	p-value
Fruit	All students	FV only	3079	1.40	1.47	-0.08 (0.06)		(ref)	
		FV and unhealthy snacks	3165	1.22	1.39	-0.17 (0.06)	-0.09	-0.25, 0.03	0.26
		Unhealthy snacks only	1370	1.04	0.82	0.21 (0.08)	0.29	0.10, 0.48	0.004
		Neither	1960	0.91	0.77	0.14 (0.06)	0.21	0.03, 0.49	0.02
	Lunch consumers ^f	FV only	1406	1.40	1.49	-0.09 (0.10)		(ref)	
		FV and unhealthy snacks	1470	1.08	1.40	-0.32 (0.08)	-0.23	-0.48, 0.02	0.08
		Unhealthy snacks only	588	1.24	0.79	0.45 (0.20)	0.54	0.03, 1.06	0.04
		Neither	814	1.07	0.78	0.29 (0.07)	0.38	0.15, 0.61	0.002
Vegetable	All students	FV only	3079	1.18	1.19	-0.01 (0.06)		(ref)	
		FV and unhealthy snacks	3165	0.95	0.98	-0.03 (0.07)	-0.03	-0.21, 0.16	0.78
		Unhealthy snacks only	1370	0.94	0.55	0.39 (0.10)	0.39	0.12, 0.67	0.01
		Neither	1960	0.65	0.64	0.01 (0.07)	0.02	-0.14, 0.18	0.81
	Lunch consumers ^f	FV only	1406	1.25	1.20	0.05 (0.06)		(ref)	
		FV and unhealthy snacks	1470	0.93	0.96	-0.04 (0.06)	-0.09	-0.23, 0.06	0.24
		Unhealthy snacks only	588	1.11	0.50	0.61 (0.20)	0.56	0.18, 0.94	0.01
		Neither	814	0.73	0.65	0.08 (0.09)	0.03	-0.19, 0.25	0.76

^aCups of FV per day

^b“Usually” or “always” having access

^cAdjusted for race, gender, grade, and fast-food consumption; analysis of total sample also adjusted for number of school lunches consumed per week

^dDifference in mean cups per day among students in states with FV requirements versus students in states with no requirements (ref); represents linear combination of coefficients associated with state law and interaction between state law and home food access

^eRepresents interaction between state law and home food access; positive coefficient represents a smaller difference in FV intake between students with regular access to different foods at home relative to students with access FV only

^fStudents who obtain a school lunch at least 4 days per week
FV, fruits and vegetables