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School Obesity Prevention Policies and Practices in Minnesota and Student Outcomes:

Longitudinal Cohort Study

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Abstract

Introduction—The School Obesity-related Policy Evaluation (ScOPE) Study uses existing public surveillance data and applies a rigorous study design to evaluate effectiveness of school policies and practices impacting student behavioral and weight outcomes.

Methods—The ScOPE Study used a cohort of 50 combined junior–senior and high schools in Minnesota to evaluate the change in weight-related policy environments in 2006 and 2012 and test the effect of policy change on students attending those schools in 2007 and 2013. Exposure variables included school practices about foods and beverages available in school vending machines and school stores, physical education requirements, and intramural opportunities. Primary study outcomes were average school-level ninth grade student BMI percentile, obesity prevalence, daily servings of fruits/vegetables, and daily glasses of soda.

Results—Availability of fruits/vegetables in schools was associated with a significant increase in total daily intake among ninth grade students by 0.4 servings. Availability of soda in schools was associated with a significant increase in total daily intake among ninth grade boys by 0.5 servings. Less healthy snack and drink availability in schools were associated with a small, significant increase (1%) in student BMI percentile at the school level.

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Conclusions—Use of a school-level longitudinal cohort study design over a 6-year period uniquely adds to the methodologic rigor of school policy and practice evaluation studies. The ScOPE Study provides marginal evidence that school policies and practices, especially those that restrict vending and school store offerings, may have small effects on weight status among ninth grade students.

Introduction

Childhood obesity is a significant public health concern, with nearly 18% of youth aged 6–11 years and 20.5% of youth aged 12–19 years meeting criteria for obesity.[1] Further progress is required to meet *Healthy People 2020* goals and reduce the prevalence of obese children aged 6– 11 years to a target of 15.7% and adolescents aged 12–19 to a target of 16.1%.[2] A 2012 report from IOM suggests schools are the primary setting for reaching youth.[3] However, there are currently very few studies that have measured the impact of school food and beverage policies on student behaviors and weight.[4]

Using surveillance data to evaluate changes in school policies and practices and student behaviors over time can be challenging,[5] largely because of the frequent reliance on cross-sectional data, raising concerns of reverse causality. As part of the School Obesity-related Policy Evaluation Study (ScOPE), a 5-year NIH-funded research study, the authors have identified a subset of schools that were included in repeated cross-sectional surveys, allowing construction of a longitudinal cohort of schools in which to evaluate the impact of the school policy environment.[5] The aim of this study was to evaluate the effect of school weight-related policies and practices on diet and activity behaviors and weight outcomes of students attending those schools. This aim was addressed using data from a cohort of schools and aggregated outcomes among students attending those schools at two time points.

Methods

Data Sources

Two existing surveillance surveys were the source of the school policy/practice and student outcome variables. The School Health Profiles (Profiles)[6] survey is a national surveillance system that administers surveys to school principals and lead health education teachers to assess school weight-related policies and practices, the main exposure variables in this study. The Profiles survey is overseen by the Centers for Disease Control and Prevention (CDC) and administered every 2 years by states, large urban school districts, territories, and tribal government.[7] In this study, the Minnesota Profiles was used. In the 2006 Minnesota Profiles survey, 65.2% (270/414) of the randomly selected schools responded to the Profiles principal survey; in 2012, 66.5% (236/355) responded to the survey. This study identified 87 schools that completed the survey in both 2006 and 2012.

The main outcome measures were provided by the Minnesota Student Survey (MSS),[8] a state surveillance instrument conducted every 3 years. Student participation is voluntary and the data are self-reported. The MSS was administered to sixth, ninth, and 12th grade students in 2007 and to fifth, ninth, and 11th graders in 2013. The variation in grades represents a change in survey administration from 2007 to 2013. To increase comparability of the 2007 and 2013 MSS samples, analyses were limited to ninth grade students. The authors elected to use policy data from 2006 and 2012 and student data from 2007 and 2013 to ensure proper temporal ordering of the predictors and outcomes.

Of the 87 schools that were included in both the 2006 and 2012 Profiles samples, 52 of those schools had MSS data for ninth graders in both 2007 and 2013. Two schools changed grade configuration between 2006 and 2012 and were removed from the analysis. The remaining 50 schools represent the analytic sample. The voluntary participation rates among these 50 schools were high; 85% of students responded in 2007 and 86% responded in 2013. There were no significant differences in school location, school grade level, minority enrollment, or free and reduced-price lunch (FRPL) enrollment between the study sample schools and the other 2006 and 2012 Profiles schools with ninth graders. The University of Minnesota IRB approved this study (1007E85315).

Measures

Table 1 describes the Profiles survey questions used to identify variables characterizing the availability of healthy foods (one item: fruits or vegetables), less healthy foods (three items: salty snacks, candy, chocolate candy), and sugary drinks (two items: soda, sports drinks) for purchase in vending machines and school stores. Two policy scales were created to indicate “fruit or vegetable availability” and “sum of less healthy food and drink availability” for each school. Two items characterized the physical activity–related environment: whether physical education (PE) was required in ninth grade and whether intramural options or activity clubs were available. For each of these eight questionnaire items, the response options were *yes* and *no*. A total policy summary score was calculated by adding a point for fruit or vegetable availability, PE required in ninth grade, and intramural opportunities available, and adding a point for each less healthy food and drink that was not available. A higher score indicates a better policy environment, with a maximum obtainable score of 8.

Student data from the MSS survey were used to characterize the main outcomes in the study: school-level average student BMI percentile, school-level average prevalence of obesity, and school-level average of daily glasses of soda. BMI percentile was calculated as follows. First, student BMI was calculated from height and weight (kg/m^2). Next, the BMI number was plotted on the sex-specific CDC BMI-for-age growth charts to obtain a percentile ranking. The percentile indicates the relative position of the student's BMI number among students of the same sex and age.[3] Obesity was defined as BMI percentile ≥95th percentile on the sex-specific CDC BMI-for-age growth charts. Consumption of soda was assessed with one question: *How many glasses of pop or soda did you drink yesterday?* Response options included: *0, 1–2, 3–4, 5–6*, and *7 or more*. The National Center for Educational Statistics was the source of school-level FRPL and minority enrollments and is updated annually. Geographic locations of schools were defined using National Center for Educational Statistics location information and Rural Urban Commuting Area Codes, allowing identification of schools in rural locations. These definitions and data sources have been used in prior school policy evaluation research.[5,9,10]

Statistical Analysis

The preliminary analysis examined the distribution of polices in 2006 and 2012 and student BMI and average of daily glasses of soda in 2007 and 2013. Because policies are implemented at the school level, student-level responses were aggregated to the school level. This allowed assessment of the impact of school policies at the school level and retained the appropriate number of degrees of freedom for statistical tests. Descriptive statistics accounted for the "matched by school" design of the cohort and were conducted with either paired *t*-tests or McNemar's test. The association between each type of policy and outcome was estimated using separate regression models. Because of the small sample size and correlation of policy types, this study did not attempt to simultaneously model all policies. Fixed effects linear regression models were used to estimate the association between policy and outcome. Each school contributed 2 years of observation in the model. By including a term in the model for each school, fixed effects models controlled for all time-invariant potentially confounding factors at the school level. This study also included terms for year of data collection, percentage of FRPL students, and percentage of minority students. The authors examined whether policies had stronger effects by sex, FRPL enrollment, and minority status, separately for each factor. These analyses repeated the analytic strategy of aggregating student-level data to the school level. *P*-values were computed to help determine whether stratum-specific effects were similar to one another.[11] Heterogeneity tests provided little evidence interactions; however, results were stratified by sex for comparability with previous research. Final analyses were conducted in 2016.

Results

The average number of students from a school was 140; however, the range was wide (7–692). Student-level data were based on 7,237 students in 50 schools in 2007 and 6,791 students in 50 schools in 2013. Hereafter, this paper refers to all years according to the Profiles (exposure) years 2006 and 2012 to minimize confusion. Table 1 shows the distribution of school demographics, policies, and student daily glasses of soda intake in both exposure years 2006 and 2012. From 2006 to 2012, there was a significant increase in overall students enrolled and percentage of minority students. Additionally, there were significant improvements in the school food environments between 2006 and 2012, specifically there were fewer less healthy foods and drinks available in vending machines and school stores. There were no significant changes in BMI percentile or obesity among ninth grade students.

Table 2 describes the associations between school-level soda availability policy/practice and student daily glasses of soda intake, overall and stratified by sex. Greater school-reported soda availability was associated with an increase in intake of 0.3 daily servings of soda among ninth grade students relative to no soda availability. This association was more pronounced among ninth grade boys than among ninth grade girls, but the difference in the effect between girls and boys was not statistically significant (p=0.23).

Associations between school-level policies and student weight indicators, overall and stratified by sex, are described in Table 3. Among all ninth grade students, each additional less healthy food or drink that was available (of five possible items) was associated with a 1-

percentile increase in average school-level BMI percentile. There was no evidence of an interaction with sex. As each additional policy/practice was reported, average school-level obesity prevalence decreased non-significantly by 1% for all students. This association was significant among girls and not boys. However, the difference between boy and girl effects was not statistically significant and the overall effect was not significant. There was one counterintuitive finding among ninth grade boys: As more intramural opportunities or activity clubs were available, BMI percentile increased significantly by 4%. This magnitude of effect was not seen among girls, who had a significantly different effect than that seen in boys (p=0.04). Tests for interactions between school policies/practices and student weight outcome associations (Table 3) and school-level student race or student FRPL did not show any overall evidence of interactions.

Discussion

The school policy evaluation literature highlights the need for more-rigorous study designs and longer evaluation periods.[12] The ScOPE study uses previously collected state and national surveillance surveys representing school-level and student-level data to identify a cohort of schools and students within schools to assess the association between food and activity policy and student behavior and weight outcomes over time.

The modest increase in soda intake with corresponding school vending and store offerings was consistent with prior ScOPE work using a different cohort of 32 schools from 2002 to 2006. In that study, when soda was available, there was a statistically significant increase of 0.1 daily servings of soda among all students (compared with an increase of 0.5 among ninth grade boys in the current 2007–2013 analysis).[13] The response options for the question assessing student fruit and vegetable intake changed from “daily servings” in 2007 to “times per day” in 2013 and the implications of this instrument change supported by the literature are that comparisons are not acceptable.[14]

This study was unable to evaluate the more proximal outcome of PE requirements and intramural opportunities upon student physical activity levels because the physical activity questions in the MSS survey changed in 2013, making survey items non-comparable over time. Currently, the existing evaluation studies suggest that the school food environment is a more powerful determinant of youth obesity than the physical activity environment.[15] A meta-analysis examining the effect of nutrition and physical activity interventions in schools singularly and in combination identify the nutrition component as the major contributor to weight reduction in youth.[15] Another meta-analysis of school-based physical activity intervention studies concluded that these efforts are not likely to produce significant effects upon childhood obesity, but cite other significant health benefits (e.g., reducing blood pressure), which should not be discounted.[16]

For the current evaluation, obesity was characterized two ways. BMI percentiles were used to examine the overall distribution of weight in the entire population, whereas obesity was used to measure whether these policies had an impact on the most extreme of the BMI distribution. One finding is that the availability of less healthy foods and drinks was significantly associated with a slightly higher BMI percentile among all ninth graders. This finding is consistent with previous cross-sectional studies reporting a positive association between the availability of less healthy foods and drinks in schools and youth obesity.[17] Table 3 suggests that the relative decrease in obesity may be associated with the cumulative effect of several policies/practices rather than a single policy. For example, no individual food or drink within the less healthy food/drink score (e.g., salty snacks, candy, chocolate candy, soda, sports drinks), stood out as being substantially more influential than the others (data not shown). However, other studies suggest that policies reducing the availability of sugary drinks are particularly effective.[18,19] Masse et al.[20] reported data from 2007–2008 including 174 schools in British Columbia, Canada and >11,000 students where students had greater odds of being obese in schools where sugar-sweetened beverages were readily available. The previous 2002–2006 ScOPE study cohort evaluation study found no significant decreases in mean school-level student BMI percentile among students with each additional policy, suggesting that time and comprehensiveness of policy interventions matter.[13] A 2012 report identifies declines in childhood obesity in cities and states is a collective effect of taking cross-sector action to make healthy foods and beverages available in schools and communities and integrate physical activity into daily life over the past 10–20 years.[21]

In addition, a policy is effective to the extent that it is fully implemented.[22,23] Noncompliance with policy at the school level continues to be an issue and may provide additional explanation for the modest results seen in the ScOPE studies and elsewhere. An evaluation of California's regulation of nutrition standards and competitive foods in schools suggests that noncompliance by schools inhibited greater improvements in student dietary behaviors.[24] School policy implementation research is limited[22,25] but identifies that district wellness policies often lack sufficient plans for implementation and monitoring.[23] For policies to be most effective, schools need implementation support.[26] Factors that promote policy implementation in secondary schools include: prioritizing wellness, devoting time and resources to coordinate a policy team, and access to training and technical assistance.[23,27–29]

This study offered no compelling indication of differential policy effects by sex. Heterogeneity effects were only statistically significant for intramural policy effects on BMI percentile. Other studies report differential effects of school policy changes by sex. Some research suggests that boys respond to structural changes in schools whereas girls respond better to educational and socially focused interventions.[30] A study examining overweight and obesity trends following school competitive food and beverage policy changes in California reported significantly lower rates of increase in overweight status among fifth graders and seventh grade boys statewide, but not for girls.[31] Alternatively, Taber and colleagues[32] reported some evidence of lower BMI increase among girls in states with combined PE and competitive food laws, but not for boys.

Sex differences in response to obesity prevention policies are important to monitor, as obesity prevalence has remained stable among school-aged students since 2003 and remains highest among boys.[1] There was no compelling evidence of important or statistically significant differences in associations by student race/ethnicity or FRPL status among this cohort.

Limitations

Changes to state-sponsored surveillance instruments are important for responding to the evaluation needs of states and therefore, inevitable. Four changes were made to the MSS from 2007 to 2013 that constrained this study:

1. Administration methods changed from paper and pencil only in 2007 to an additional online option in 2013.
2. Grade restructured from sixth, ninth, and 12th grades in 2007 to fifth, ninth, and 11th grades in 2013.
3. Questions assessing physical activity changed from two questions assessing minutes spent in moderate and vigorous physical activity to one question assessing if activity totaled at least 60 minutes in 2013.
4. Response options for the question assessing student fruit and vegetable intake changed from "daily servings" in 2007 to "times per day" in 2013 and are not comparable.[14]

These changes to the MSS impacted this evaluation in the following ways. First, the authors were unable to determine associations between school food and activity environment and student fruit/vegetable consumption and physical activity behavior. Second, owing to survey administration restructuring, the evaluation of outcome variables was limited to ninth graders only. Third, it is unclear the extent to which changes in the MSS survey administration impacted student responses and therefore the study outcomes. Thirty-two percent of ninth grade participants chose the new web-based format in 2013. Comparisons of paper and pencil versus web administration of the Youth Risk Behavior Survey revealed similar prevalence estimates; however, perceptions of anonymity and privacy were reduced.[33,34] Further, the analytic approach using fixed effects regression corrects for time-constant confounding, but time varying confounding is a possibility in this study. Finally, power to detect interactions may have been small given the modest number of schools in the study.

Conclusions

A sense of urgency to address the obesity epidemic has contributed to demands for immediate policy action based upon the best available evidence.[35,36] Recent evidence shows school food-related monitoring and evaluation research has been highly influential in the enactment of legislation and policy.[37] Policy intervention particularly highlights the importance of evaluation. Despite limitations, study findings contribute to school policy evaluation research. To the authors' knowledge, this study provides the first longitudinal evidence using a cohort of schools that describes access to less healthy foods and drinks at school and potential associations with weight status among adolescents. This is particularly alarming given that more than half of high schools have school stores and 86% have vending machines.[17] The ScOPE study has produced two longitudinal cohort evaluations (2002–2006 and 2006–2012) that suggest that school-level obesity-related policies and practices may be associated with certain aggregate-level student outcomes. Findings from this study add to the body of cross-sectional school policy evaluation studies that modestly associate availability of less healthy food and drinks with student overweight status, providing further support for focusing attention on school competitive food environments.[38–40] Overall, evidence of any association between the school environment and student diet and obesity is remarkable considering the multiple other influences upon youth weight-related behaviors.[41] The time required to achieve measurable effects and resultant small effects identified by the ScOPE study suggests that there is more room for improvement in addressing childhood obesity both in and out of school settings.

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Table 1

School-Level Demographics, Policies (2006 and 2012), Student Soda Intake, and Weight (2007 and 2013)

	2006 (n=50)	**2012 (n=50)**
	Percent (N) or Mean (SE)	**Percent (N) or Mean (SE)**
School demographics		
Rural location	86.0% (43)	86.0% (43)
Minority enrollment	**9.7% (1.5)**	**14.4% (2.1)**
Free or reduced price lunch eligibility	**29.6% (2.0)**	**35.6% (2.1)**
School policy/practice		
Fruits or vegetables available in school stores or vending machines	53.9% (21)	48.7% (19)
Sum of less healthy foods and drinks available in school stores or vending machines[a]	**4.3 (0.2)**	**2.9 (0.3)**
PE required in ninth grade	85.7% (42)	93.9% (46)
Intramural options or activity clubs available	42.0% (21)	42.0% (21)
Policy/practice summary[b]	**2.6 (0.2)**	**3.7 (0.3)**
Ninth grade student soda intake and weight (averaged within schools)	**2007**	**2013**
Soda servings, daily	**1.4 (0.06)**	**1.2 (0.04)**
BMI percentile	0.61 (0.01)	0.61 (0.01)
Obese	9% (0.01)	10% (0.01)

[a]Sum of less healthy foods and drinks available: Salty snacks, Candy, Chocolate candy, Soda pop, Sports drinks (maximum obtainable value of 5).

[b]Policy summary score was calculated as follows: having fruits or vegetables available (1-item), PE required (1-item), intramural opportunities available (1-item) (yes=1); for each less healthy food or drink available (5-items) (no=1). Higher score is better (maximum obtainable value of 8).

Note: Boldface indicates statistical significance ($p<0.05$)

PE, physical education

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Table 2

Associations[a] Between Soda Availability and Student Self-Reported Daily Intake, Overall and Stratified by Sex

School policy/practice	Students' daily glasses of soda pop[b]
All ninth grade students	
Yes, soda available	0.31 (−0.01, 0.63)
Ninth grade boys	
Yes, soda available	**0.54 (0.04, 1.03)**
Ninth grade girls	
Yes, soda available	0.16 (−0.24, 0.56)

[a]Adjusted for year, school-level free and reduced lunch, minority enrollment and school.

[b]Coefficient with CIs from fixed effects linear regression.

Note: Boldface indicates statistical significance ($p<0.05$).

Table 3

Associations[a] Between School Policies and Practices and Student Weight Indicators, Stratified by Sex

School policy/practice	Difference in average school BMI percentile [d]	Difference in average school obesity [d]
All ninth grade students		
Fruits or vegetables available in school stores or vending machines	−0.01 (−0.03, 0.01)	−0.02 (−0.05, 0.00)
Sum of less healthy foods and drinks available [b]	**0.01 (0.00, 0.02)**	0.01 (−0.01, 0.02)
PE required	0.00 (−0.04, 0.04)	0.01 (−0.04, 0.07)
Intramural options or activity clubs available	0.01 (−0.01, 0.04)	0.01 (−0.03, 0.04)
Policy/practice summary score [c]	−0.01 (−0.02, 0.00)	−0.01 (−0.02, 0.00)
Ninth grade boys		
Fruits or vegetables available in school stores or vending machines	−0.01 (−0.04, 0.02)	−0.02 (−0.07, 0.02)
Sum of less healthy foods and drinks available [b]	**0.01 (0.00, 0.03)**	0.00 (−0.02, 0.02)
PE required	0.02 (−0.05, 0.09)	0.01 (−0.10, 0.11)
Intramural options or activity clubs available	**0.04 (0.00, 0.08)**	0.02 (−0.04, 0.08)
Policy/practice summary score [c]	−0.01 (−0.02, 0.00)	−0.01 (−0.03, 0.01)
Ninth grade girls		
Fruits or vegetables available in school stores or vending machines	0.00 (−0.04, 0.03)	−0.02 (−0.05, 0.01)
Sum of less healthy foods and drinks available [b]	0.00 (−0.01, 0.02)	**0.01 (0.00, 0.03)**
PE required	−0.01 (−0.08, 0.06)	0.02 (−0.04, 0.07)
Intramural options or activity clubs available	−0.02 (−0.06, 0.02)	0.01 (−0.02, 0.05)
Policy/practice summary score [c]	0.00 (−0.02, 0.01)	**−0.01 (−0.03, 0.00)**

[a] Adjusted for year, school-level free and reduced lunch, minority enrollment, and school.

[b] Sum of less healthy foods and drinks available: Salty snacks, Candy, Chocolate candy, Soda, Sports drinks (maximum obtainable value of 5).

[c] Policy summary score was calculated as follows: having fruits or vegetables available in school stores (1-item), PE required (1-item), intramural opportunities available (1-item) (yes=1); for each less healthy food or drink available (5-items) (no=1). Higher score is better score (maximum obtainable value of 8).

[d] Coefficient with confidence intervals from fixed effects linear regression.

Note: Boldface indicates statistical significance ($p<0.05$).

PE, physical education