A Multivariate Analysis of Federally Mandated School Wellness Policies on Adolescent Obesity

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ABSTRACT

Purpose: To evaluate the effects of school wellness policies mandated by the 2004 Child Nutrition and WIC Reauthorization Act on the prevalence of overweight and obesity among adolescents.

Methods: Multivariate logistic regressions, adjusted for clustering within school districts, were used to estimate the effects of district-level wellness policies on the odds of overweight and obesity among adolescents. The analyses were performed on a population-based sample obtained from the Utah Population Database, a compilation of vital characteristic, administrative, and genealogical records on all residents in Utah. Models controlled for individual, maternal, and familial characteristics, as well as characteristics of school district of residence. Self-reported body mass index was taken from drivers license data.

Results: Each additional component included in a district’s wellness policy was associated with as much as: 3.2% lower odds in the prevalence of adolescent overweight (OR = .968; 95% CI = .941–.997), 2.5% lower odds of obesity (OR = .975; CI = .952–.997), and 3.4% lower odds of severe obesity (OR = .966; CI = .938–.995). Wellness policy components related to diet were significantly associated with lower body mass indexes across all three thresholds, whereas those related to physical activity had significant associations for lower odds of severe obesity only.

Conclusion: Results suggest that school wellness policies can significantly reduce the risk of adolescent obesity. Further research should address specific policy components that are most effective in various populations, as well as the level of commitment that is required at both the school- and district-levels for sustained effect.

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tion requirements, on children’s body mass index (BMI) has been limited [4,6,10]. Among those studies which examined the effect of schools’ prevention practices on obesity rates [11–17], a few found evidence of policy impacts [11–15,17]. However, the associations were generally inconclusive because of the little variation in practices across schools [11,12] or because of the absence of critical covariates, such as parental BMI [11–16] and school-level socioeconomic status (SES) [15].

Few studies have been conducted on the effectiveness of district-level wellness policies, particularly those enacted under the Child Nutrition and WIC Reauthorization Act (CNRA) of 2004 [9], which mandated that all school districts receiving federal funding under the National School Lunch Program and Child Nutrition Act of 1966 establish nutritional guidelines for foods available on school campuses and a general wellness policy, with implementation plans, no later than the beginning of the 2006–2007 school year [9]. The CNRA gave considerable latitude to local school districts in adopting specific components to achieve, with community involvement, wellness “goals” in the three general areas of nutrition education, physical activity, and other school-based wellness activities [9]. As a result, there was considerable variation in the detailed composition of wellness policies implemented across local school districts.

The primary objective of this analysis was to use a population-based sample of adolescents to investigate the extent to which CNRA mandated wellness policies, at the school district-level, have been effective in curbing the risk of childhood overweight and obesity. This analysis was performed on a population-based sample of children in Utah and incorporated extensive measures of individual, household, and school district-level characteristics as covariates.

Methods

Data

The analysis used three data sources: first, data on individual children and families were extracted from the Utah Population Database (UPDB) [18]; second, school district data were taken from the Common Core of Data (CCD) [19]; and third, information about each Utah school district’s written wellness policy was based on evaluations reported in past research [20].

The UPDB is a genealogically linked clearinghouse of de-identified administrative records, including merged vital statistics and drivers license information, for all Utah residents. Demographic characteristics of the mother and child were obtained from the child’s birth certificate. Self-reported height and weight during adolescence (age 15–19 years) were taken from each child’s first state-issued drivers license. Residential addresses taken from the drivers license were converted to geographic coordinates which placed each child within one of the 40 Utah school district boundaries. Thus, the assignation of school district was made according to residence within a district and not according to individual-level enrollment data. Sociodemographic characteristics of the school district of residence were thereby linked to individuals.

The CCD is a yearly survey of school and school district officials conducted by the federal Department of Education. The variables from the 2006–2007 survey used for the current analysis included each district’s sociodemographic composition, specifically the percentage of students eligible for free and reduced price meals, a rural/nonrural designation, as well as the average median income of school district residents appended from the 2000 U.S. Census.

Between July and August of 2006 examinations were undertaken, and assessments made, of wellness policies that had been written and/or adopted by Utah school districts by July 1, 2006 in response to the CNRA legislation [20]. Each component of a policy was characterized as “mandated,” “suggested,” and “non-mandated” on the basis of policy language [20], as has now become customary [21]. Components were designated as adopted in this analysis only if they were “mandated.”

As of the assessment, 75% of Utah school districts had wellness policies (30 of 40 districts) [20], encompassing approximately 94% of Utah school children [19]. Thus, the percentage of Utah children exposed to CNRA wellness policies in 2006–2007 exceeded the national average of 81% [21]. Subsequent reexaminations of these 30 districts’ wellness policies revealed that only minimal and inconsequential modifications were made to these original policies through 2009.

Sample

The analytical sample was restricted to the cohorts first exposed to the CNRA wellness policies while in secondary school, that is, the 40,713 adolescents born in Utah between 1990 and 1992 residing within one of the 30 sample Utah school districts and receiving their drivers license after January 1, 2007, 4 months after those policies went into effect. This date was chosen on the basis of the findings in previous studies of lag between the implementation of health interventions and effect [22–24] of as little as 4 [22] to 8 weeks [23].

Subjects who moved from the state or had not yet applied for their drivers’ license by 2009 were excluded, as no BMI data were available on them. The sample represented 37.2% of all births that took place between 1990 and 1992.

Although Utah is not as racially diverse as the nation as a whole, the state’s ethnic and racial diversity has increased considerably in recent decades. About one-quarter of Utah’s population growth during the 1990s was of Hispanic origin and over one-third of net migrants were foreign-born [25]. These demographic changes are reflected in Utah school districts. For instance, Hispanic students comprise 37.4% of the population in the Salt Lake City School District. Further evidence of the demographic and socioeconomic diversity across Utah school districts is reflected in Table 1.

Measures

Self-reported height and weight were taken from the child’s first state-issued drivers license obtained between the ages 15 and 19 years. BMI was calculated (weight in kg divided by height in meters squared) and then converted to a percentile score using the 2000 Centers for Disease Control and Prevention (CDC) sex-and-age-specific growth curves for children [26,27]. In accordance with these guidelines, three dichotomous variables were created to indicate the child’s obesity risk: overweight (at or above the 85th percentile), obese (at or above the 95th percentile), and severely obese (at or above the 98th percentile) [26,27]. Although less reliable than clinically assessed measures, self-reported BMIs are highly correlated with clinical measures. The use of self-report measures, including data from drivers license [28], is established in epidemiologic research on obesity [29,30].
Each district’s wellness policy was assessed in terms of specific policy components associated with three broad policy domains: (1) physical activity and education, (2) competitive food, nutrition practices, and nutrition education, and (3) other wellness-related components. Table 2 provides a comprehensive list of the specific components within each of these three wellness policy domains. Domain subscales were generated by counting the number of separate components within each of the three wellness domains. Districts’ policies contained from zero to nine mandated components related to “physical activity and education,” with a mean of 2.3 mandated components per district (SD = 1.6). The range of mandated “competitive foods and nutrition practices and education” components was zero to seven, with a mean of 1.8 mandated components per district (SD = 1.62). The range of mandated “other wellness-related components” was zero to five, with a mean of 1.2 mandated components per district (SD = 1.02). Factor analysis was used to limit domain subscales to those components having high internal validity, as evidenced by Cronbach’s alpha values of a minimum of .61.

Several demographic and household-level socioeconomic characteristics of the child, as well as sociodemographic characteristics of each school district, were included to control for confounding between school policy and childhood BMI. District-level characteristics, which were taken from the CCD, included designation of rural (remote, distant, and fringe) or nonrural (all other geographic classifications) school districts [19], the percentage of students within each district eligible for free and reduced price school meals, and the median income of school district residents. Individual and household-level characteristics included the child’s precise age at the time of the drivers license, and race, sex, ethnicity, maternal marital status, education, and prepregnancy BMI from birth certificate information included on the UPDB. Sociodemographic and biometric information on parents subsequent to birth would have been desirable but was not available. A proxy for the community’s propensity for obesity was also generated by calculating the mean pre-pregnancy maternal BMI between 1990 and 1992 associated with each school district.

### Table 1

Selected characteristics of Utah school districts

<table>
<thead>
<tr>
<th></th>
<th>Mean or %</th>
<th>Median</th>
<th>Standard deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Rural (binary)a</td>
<td>40%</td>
<td>0</td>
<td>49.6</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>% of students who are non-white</td>
<td>16%</td>
<td>12.8%</td>
<td>13.1</td>
<td>1.8%</td>
<td>58.4%</td>
</tr>
<tr>
<td>% of students who are ESLb</td>
<td>6.6%</td>
<td>4.8%</td>
<td>6.5</td>
<td>0%</td>
<td>30.3%</td>
</tr>
<tr>
<td>% of students eligible for free/reduced price lunch</td>
<td>37%</td>
<td>38.9%</td>
<td>14.3</td>
<td>3.2%</td>
<td>72%</td>
</tr>
<tr>
<td>Median household income</td>
<td>$45,219</td>
<td>$41,641</td>
<td>10,516</td>
<td>$31,673</td>
<td>$88,029</td>
</tr>
<tr>
<td>% of students overweightc</td>
<td>17.9%</td>
<td>18.0%</td>
<td>5.1</td>
<td>8.5%</td>
<td>31.3%</td>
</tr>
<tr>
<td>% of students obese d</td>
<td>7.2%</td>
<td>7.2%</td>
<td>2.8</td>
<td>0%</td>
<td>13.3%</td>
</tr>
<tr>
<td>% of students severely obese</td>
<td>2.8%</td>
<td>2.8%</td>
<td>1.6</td>
<td>0%</td>
<td>6.3%</td>
</tr>
<tr>
<td>Mean maternal BMI (mean BMI of all mothers in district)</td>
<td>23.42</td>
<td>23.44</td>
<td>.57</td>
<td>21.42</td>
<td>24.98</td>
</tr>
</tbody>
</table>

Notes: *Factor analysis was used to confirm the strength of the three domains. Cronbach’s alphas, illustrating the internal validity of each scale, were .80 for the physical activity and education domain, .61 for competitive foods and nutrition practices and education, and .56 for other wellness related components domain. Source: Assessments based on evaluations of written wellness policies reported in previous publication [20].

### Table 2

Description of school district wellness policies by domain

<table>
<thead>
<tr>
<th>Did the district include language mandating the following components in their 2004</th>
<th>% of districts mandating policy (n = 30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Core PE curriculum in elementary schools</td>
<td>53%</td>
</tr>
<tr>
<td>Core PE curriculum in secondary schools</td>
<td>57%</td>
</tr>
<tr>
<td>150 min/wk aim for PE instruction and activity</td>
<td>17%</td>
</tr>
<tr>
<td>At least two recess or “active” periods each school day</td>
<td>7%</td>
</tr>
<tr>
<td>Prohibiting the use of recess as punishment</td>
<td>17%</td>
</tr>
<tr>
<td>Schedule recess before lunch</td>
<td>10%</td>
</tr>
<tr>
<td>Promote/establish safe walking and biking routes to/from school</td>
<td>13%</td>
</tr>
<tr>
<td>Lifelong fitness and activity instruction emphasis</td>
<td>33%</td>
</tr>
<tr>
<td>Intramural sports and activities promotion</td>
<td>23%</td>
</tr>
<tr>
<td>Competitive food and nutrition practices and education</td>
<td>47%</td>
</tr>
<tr>
<td>Nutrition education core curriculum</td>
<td>50%</td>
</tr>
<tr>
<td>Ban/restrictions on all competitive foods, grades K-6</td>
<td>50%</td>
</tr>
<tr>
<td>Ban/restrictions on vending in elementary schools</td>
<td>3%</td>
</tr>
<tr>
<td>Ban/restrictions on vending in secondary schools</td>
<td>7%</td>
</tr>
<tr>
<td>Fruits/vegetables for sale where competitive foods sold</td>
<td>10%</td>
</tr>
<tr>
<td>Nutrition standards for all snacks, sweets, and side dishes sold outside of school meal programs</td>
<td>17%</td>
</tr>
<tr>
<td>Portion size standards for all foods served</td>
<td>30%</td>
</tr>
<tr>
<td>Other wellness related components</td>
<td>13%</td>
</tr>
<tr>
<td>Participate in Gold Medal School Program (voluntary state wellness program)</td>
<td>20%</td>
</tr>
<tr>
<td>Food restriction on fundraising activities</td>
<td>20%</td>
</tr>
<tr>
<td>Wellness programs for staff</td>
<td>20%</td>
</tr>
<tr>
<td>Wellness programs for parents</td>
<td>33%</td>
</tr>
<tr>
<td>Yearly wellness program review/evaluation</td>
<td>33%</td>
</tr>
</tbody>
</table>

Notes: *ESL = English as a second language. **Overweight is BMI ≥85th percentile, obese is BMI ≥95th percentile, and severely obese is BMI ≥98th percentile, based on growth curves and thresholds recommended by the Centers for Disease Control and Prevention [26,27]. School data were taken from CCD [19], collected in 2006–2007. BMI was calculated from reported height and weight on Utah Population Database (UPDB) [18] for children born between 1990 and 1992 who obtained their first Utah state drivers license after January 1, 2007.
Results

Approximately 18% of the entire sample was overweight, with considerable variation across districts. For example, slightly more than 8.5% of adolescents were overweight within the Wayne County School District, whereas 31.3% of adolescents were overweight in the Tintic School District. Figure 1 provides a map summarizing variation in the sample prevalence of overweight across Utah school districts. The districts also varied in other dimensions as illustrated by those provided for the 12 selected districts in Figure 1. For instance, even among the highly urbanized school districts along the Wasatch front (north-central Utah), where 76% of Utah residents reside, there was substantial variation in SES and enrollment.

Odds ratios (ORs) highlighting the relationship between district wellness policies and overweight and obesity prevalence from the multivariate models are presented in Table 3. Model 1 included controls for socioeconomic and geographic differences across districts; model 2 included additional controls for individual (e.g., age, gender, race, ethnicity) and household environment characteristics (e.g., maternal education, marital status, and maternal prepregnancy BMI). Model 3 incorporated an additional control for the mean maternal BMI associated with each district.

In each of the models, stronger district-level policies, as measured by an additional mandated component within each domain, were associated with significantly lower odds of overweight, obesity, and severe obesity among children within each district (ORs ranged from .966 [CI = .938–.995] to .975 [CI = .955–.995]). Policy effects were dampened with the addition of controls, but the significant association between policy and lower odds of BMI remained in the completely adjusted specification (model 3). The significant effects associated with covariates describing the individual, household, school district, and community contexts (not shown) were all in the expected direction.

Additional models were estimated on cohorts born earlier and unexposed to the CNRA wellness provisions to test whether policy variables might be acting as proxies for unmeasured characteristics, such as a district’s historical commitment to wellness-related activities. The models reported in Table 3, with the absence of maternal BMI which was not available before 1990, were run on a sample of Utah children born between 1983 and 1990 who obtained a Utah drivers license before September 2006. Several of the policy domains were significantly associated with lower odds of obesity risk in these regressions. However, when district-level maternal BMI between 1990 and 1992 cohorts was incorporated as an instrument for maternal BMI in these regressions only one significant policy effect remained. Figure 2 presents a visual comparison of the salient ORs from the entire models on the exposed versus the unexposed cohorts. Tabular results for this analysis are available from the authors on request.

Discussion

Given the sharp increase in childhood obesity over the past several decades [1,2], policy makers have looked toward the school environment as a potential venue for bending the obesity curve [3,7,34]. The Centers for Disease Control and Prevention [34], the Institute of Medicine [3], as well as a recent White House report [7] have all called for school-based interventions to reduce and prevent adolescent overweight and obesity. To date, these recommendations have largely been anchored in inconclusive empirical evidence regarding whether the school environment can make a significant difference in reducing childhood obesity risk [4,6,10]. Findings from the current study support the conclusion that district-based wellness policies, as mandated by the nationwide CNRA legislation, are associated with lower odds of adolescent overweight and obesity, effects that persisted even after controls were integrated for characteristics of the individual, family, school, and community.

This study suggests that certain types of wellness policies seem to be more effective for some at-risk groups than others. For example, policy components related to “competitive foods and nutrition practices and education” seem to have particular significance among obese children (BMI ≥95th percentile), whereas components related to both “competitive foods and nutrition practices and education” as well as “other wellness related components” were associated with lower odds of overweight (BMI ≥85th percentile). All three domains were associated with lower odds of severe obesity (BMI ≥98th percentile). These findings suggest that policy could be tailored to risks faced by particular schools when schools or districts are constructing wellness policies.

While uncovering an independent effect of school policy, the analysis also corroborates the large body of research that several other factors are clearly important in the risk of childhood obesity. Although not shown, maternal education and marital status, as well as the child’s racial and ethnic identification, were all significantly associated with a child’s propensity to be overweight, obese, or severely obese. Similarly, children from school districts with relatively high SES had lower odds of overweight, obesity, and severe obesity. The odds of overweight, obesity, and severe obesity were strongly correlated with whether the child’s mother was obese as well, suggesting that there is a transmission of risk and lifestyle through a child’s exposure to obesity at home and in the community [35,36]. Additional research on the interaction of school district wellness policies with these covariates will permit greater understanding of how policies differentially affect populations at greatest risk for obesity, and may provide additional insights into crafting policies that affect risk indirectly through interacting with these other critical covariates.

The significant effects associated with the “other wellness-related domain” indicate that some of the components contained in that domain, such as multilayered support and involvement from peers, parents, schools, and community, may contribute independently to a reduction in childhood obesity risk. Most of the policies in that domain consisted of programs encouraging behavioral changes that extended to a child’s mentors, parents, and community members. Such “community” effects that extend beyond the local school level where parents are generally most invested were unexpected, but are intriguing and merit additional research.

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Granite School District, N: Overweight: 21.5%  
Median income: $49,660  
Free/reduced price meals: 30%  
Student population: 67,502

Salt Lake School Dist., N: Overweight: 20.1%  
Median income: $35,353  
Free/reduced price meals: 61%  
Student population: 24,314

Sevier School District, R: Overweight: 21.4%  
Median income: $40,110  
Free/reduced price meals: 45%  
Student population: 4,575

Wayne School District, R: Overweight: 8.5%  
Median income: $36,940  
Free/reduced price meals: 44%  
Student population: 561

Washington Sch. Dist., N: Overweight: 18.9%  
Median income: $41,845  
Free/reduced price meals: 33%  
Student population: 24,357

Kane School District, N: Overweight: 23.1%  
Median income: $40,030  
Free/reduced price meals: 38%  
Student population: 1,177

Garfield School District, R: Overweight: 12.8%  
Median income: $40,192  
Free/reduced price meals: 45%  
Student population: 977

Davis School District, N: Overweight: 16%  
Median income: $58,329  
Free/reduced price meals: 27%  
Student population: 62,193

Park City School Dist., N: Overweight: 12.1%  
Median income: $88,029  
Free/reduced price meals: 13%  
Student population: 4,339

Jordan School District, N: Overweight: 16.1%  
Median income: $64,982  
Free/reduced price meals: 21%  
Student population: 78,299

Provo School District, N: Overweight: 16.4%  
Median income: $36,393  
Free/reduced price meals: 49%  
Student population: 13,208

Grand School District, N: Overweight: 20.2%  
Median income: $39,095  
Free/reduced price meals: 46%  
Student population: 1,499

Legend
% of District students overweight
- 8.5—14.9%  
- 16—17.9%  
- 18.2—20.6%  
- 21.3—31.3%

*Non-responding district to written wellness policy examination, excluded from regression analyses.
† R, rural and N, non-rural district, based on classifications in the Common Core of Data (CCD).
Å Insufficient information

Notes: 1. Highlighted information on selected districts provide a geographic overview of statewide variation in district characteristics. Overweight is a BMI ≥85th percentile; free/reduced price meals indicates the percent of district students eligible for federally funded free and reduced priced meals; median income represents the median family income of the district (2000). Sources: UPDB [18], CCD [19], and wellness policy components based on evaluations of written wellness policies reported in a prior publication [20].

Figure 1. Percentage of sample overweight by school district and sociodemographic profiles of selected school districts in Utah. Notes: Highlighted information on selected districts provides a geographic overview of statewide variation in district characteristics. Overweight is a BMI ≥85th percentile; free or reduced price meals indicate the percent of district students eligible for federally funded free and reduced priced meals; median income represents the median family income of the district (2000). Sources: UPDB [18], CCD [19], and wellness policy components based on evaluations of written wellness policies reported in a past publication [20].
Table 3
The effect of selected district-level wellness policies on the overweight, obese, and severely obesity risk among children in Utah (odds ratios)

<table>
<thead>
<tr>
<th>District level wellness policy domains</th>
<th>Overweight</th>
<th>Obese</th>
<th>Severely obese</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Model 1b</td>
<td>Model 2c</td>
<td>Model 3d</td>
</tr>
<tr>
<td>Physical activity and education (95% confidence interval)/p</td>
<td>.983–1.04/.436</td>
<td>.995–1.02/.276</td>
<td>.993–1.01/.516</td>
</tr>
<tr>
<td>Competitive foods and nutrition practices and education (95% confidence interval)/p</td>
<td>.988–1.01/.126</td>
<td>.95–.994/.013</td>
<td>.955–.995/.016</td>
</tr>
<tr>
<td>Other wellness-related components (95% confidence interval)/p</td>
<td>.834–.987/.024</td>
<td>.922–.976/.000</td>
<td>.941–.997/.028</td>
</tr>
</tbody>
</table>

Odds ratios were based on transformed coefficients in multivariate logistic regressions with the Huber–White modified sandwich clustering connection.

a Overweight is BMI ≥85th percentile, obese is BMI ≥95th percentile, and severely obese is BMI ≥98th percentile, based on growth curves and thresholds recommended by the Centers for Disease Control and Prevention [26,27].

b Model 1 included additional controls for schools district-level median income, rural/nonrural designation, and total students eligible for free and reduced price lunch.

c In addition to model 1 characteristics, model 2 included additional controls for individual age, race, ethnicity, and sex, maternal education level, maternal prepregnancy body mass index, and maternal marital status.

d The completely adjusted, model 3 added mean mother's body mass index for each district to all controls included in model 2.

* p < .01.
** p < .001.
*** p < .0001.
research to analyze this more refined gradation of commitment on risk of obesity.

Additionally, policy adoption is dichotomous and does not convey evidence on rigor of enforcement, which is another reason why further data on enforcement and analysis of variation at the school level are of importance. Future research should not only evaluate a school’s or district’s de jure adoption of policies, but also de facto compliance and implementation of the policies.

Given the unparalleled richness of multilevel data, this analysis was limited to Utah, a state that, despite being one of the most urban states in the nation (76% of the population resides along the Northern Wasatch Front, Salt Lake City area) [38] is also more racially and ethnically homogenous and leaner than the country as a whole. However, the upward trajectory of obesity rates in Utah and the state’s profile across SES and the growing racial and ethnic minority populations in the state closely mirrors that of the nation. However, studies focusing on other states and regions ought to replicate, to the extent possible, analyses of the type contained here to test the generalizability of our results.

Conclusion

The 2004 CNRA federal legislation mandating that all school districts write and implement a local wellness policy was premised on an assumption that changing the school environment to encourage healthy lifestyles might provide a counterweight to the childhood obesity epidemic in America. The robust associations between the CNRA wellness policy mandates and lower odds of overweight and obesity among Utah adolescents exposed to those policies in this analysis demonstrate that school district wellness policies can indeed be vital to obesity prevention efforts. Therefore, policy makers should remain focused on school-based wellness programs, while providing latitude in the specific types of policy components districts enact to ensure that the school environment is tailored to the characteristics of their respective populations. Furthermore, given the associations among a child’s household and community environments and their BMI status, altering school environments should be only one part of an overall, comprehensive policy aimed at encouraging healthier behavior in a child’s household and community.

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References
