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A comparison of the vending environment among three rural subtypes of secondary schools

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Abstract

The purpose of this study was to further explore the rural school food environment. This study assessed trends in prevalence of vending machines and vending items within and between Minnesota schools located in 3 rural subtypes: town/rural fringe, town/rural distant, and remote rural. Generalized estimating equation models were employed to analyze data from the 2006 through 2012 School Health Profiles Principal's Surveys (Profiles). All 3 rural subtypes had a statistically significant decrease in the prevalence of low nutrient energy dense (LNED) vending items between 2006 and 2012, with the exception of sports drinks. However, different vending practices were observed between rural subtypes, with town/rural fringe schools providing more LNED vending options and experiencing less positive change over time compared to town/rural distant and remote rural schools. Differences in vending machine practices emerge when rural schools are subtyped.

A substantial body of research indicates that children residing in rural areas in the United States are at higher risk of overweight and obesity compared to their metropolitan counterparts,^{1–9} with increased risk estimates as large as 25%.¹⁰ This evidence is concerning given that 33% of US schools are located in rural areas, accounting for over 9.5 million students.¹¹ Known individual-level risk factors including dietary and physical inactivity behaviors (e.g. soda intake, television watching, and computer use) only partially explain higher obesity rates among rural children,¹⁰ indicating that additional work is needed to understand this geographic disparity. Research exploring contextual differences, such as variations in policy environments, across geographic locations may provide further insight to explain geographic differences in childhood obesity rates.

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Conflicts of Interest

None of the authors have any conflicts of interest to disclose.

The built environment has been identified as a likely factor contributing to geographic differences in childhood overweight and obesity rates.¹⁰ In particular, the school environment may play an impactful role in determining childhood obesity rates, as youth spend approximately one-third of each weekday at school during which they consume up to two meals per day and are provided with a variety of opportunities for physical activity.¹² Accordingly, the school environment can have a significant impact on children's dietary and exercise behaviors. Recent cross-sectional and longitudinal data suggest that rural schools report weaker food policies than urban schools, resulting in a variety of low nutrient energy dense (LNED) food and drink items for students to purchase during the school day.¹³⁻¹⁶ These findings support the hypothesis that the school environment may play a role in the geographic disparity in childhood obesity rates. Consequently, policy interventions targeting the nutritional environment of rural schools present promising opportunities for addressing the high rates of childhood overweight and obesity in non-metropolitan settings.

A key limitation to previous work on geographic health disparities is the practice of homogenizing all non-urban locations into one classification of 'rural,' despite considerable evidence from rural sociologists that the concept of homogenous rural communities is a fallacy.¹⁷ Classifying all non-urban locations as a single geographic entity potentially overlooks substantial differences in the health environment of various rural communities, including differences in school settings. Therefore, an analytic approach that further stratifies rural communities into more geographically and contextually similar subtypes stands to generate a deeper understanding of the distribution of disease risk factors across the broader rural landscape, which may ultimately inform decision makers on where to target policy interventions within rural settings. This subtyping approach can be applied to the study of the nutritional environment of rural schools to determine if differential patterns of weight-related policies and practices emerge, thereby providing insight into where targeted intervention is needed to improve the school environment to address childhood obesity.

This study aims to further describe the nutritional environment of rural schools by examining policies and practices over time related to the availability of vending machines and vending items among a large sample of Minnesota secondary schools located in rural areas. Schools are stratified into three subtypes that include town/rural fringe, town/rural distant, and remote rural in order to identify possible differences in the vending environment among subtypes of rural schools. Therefore, this study not only has the potential to inform our understanding of the role of the school weight-related policy environment in rural settings, but may provide valuable insight to obesity researchers and decision makers, as this analysis attempts to identify nutrition policy trends within different rural subtypes thereby pinpointing areas within the broader rural context where policy interventions stand to have the most meaningful impact on reducing childhood obesity rates.

METHODS

This study was conducted as part of the School Obesity-related Policy Evaluation (ScOPE) study, which aims to assess school obesity prevention policies in Minnesota secondary schools using existing state and national surveillance data.¹⁸ We conducted a secondary data

analysis of survey data collected as part of the Minnesota School Health Profiles Principal's Survey (Profiles).¹⁹ The Centers for Disease Control and Prevention administers the Profiles survey in collaboration with state and local health agencies to monitor middle and high school health standards.²⁰ The survey is conducted biennially through self-administered questionnaires completed by principals.²⁰ Participation is confidential and voluntary.²⁰ The analysis was restricted to years 2006 to 2012 to ensure consistency in survey questions, resulting in a final sample of 526 rural secondary schools, some of which were sampled in multiple survey years. School response rates in Minnesota ranged from approximately 66% to 84% between survey years 2006 to 2012.

Three rural subtypes were constructed by the ScOPE team based on a combination of National Center for Education Statistics (NCES) and Rural-Urban Commuting Area (RUCA) classification schemes, which allowed for consideration of population density, distance from and daily commuting to an urbanized area in rural and urban classifications.^{21,22} NCES location codes are assigned using school address and proximity to urban area, while RUCA location codes are assigned using census tract (2000) population density, urbanization, and daily commuting data.^{21,22} Schools classified as 'metropolitan' or 'micropolitan or town' by RUCA and 'town or rural,' 'town fringe,' or 'rural fringe' by NCES were subtyped as town/rural fringe. Schools classified as 'micropolitan or town' by RUCA and 'town distant, town remote, rural distant, or rural remote' by NCES were subtyped as town/rural distant. Finally, schools classified as 'rural' in RUCA and 'rural distant or rural remote' in NCES were categorized as remote rural. More simply, the subtypes of town/rural fringe, town/rural distant, and remote rural represent areas of increasing distance from a metropolitan center (i.e. near metro to far metro, respectively). Figure 1 provides a visual overview of the categorization of rural subtypes. This classification of rural subtypes has been used in previous school policy evaluation research.^{18,23,24}

To measure school vending policies and practices over time, the following survey items were assessed: (1) Can students purchase snack foods or beverages from one or more vending machines at the school or at a school store, canteen, or snack bar? (yes/no); and if yes, (2) Can students purchase each of the following snack foods or beverages from vending machines or at the school store, canteen, or snack bar (hereafter collectively referred to as vending machines): (a) chocolate candy, (b) other kinds of candy, (c) salty snacks not low in fat, (d) soda pop or fruit drinks that are not 100% juice (coded as soft drinks), and (e) sports drinks? (yes/no).

School-level characteristics including percent minority enrollment (<10% and 10%) and percent free and reduced-price lunch eligibility (FRPL) (<30% and 30%), which is used as an objective proxy for low-income status, were obtained from NCES. Decisions on how to dichotomize these demographic characteristics were made based on the distribution of these variables in the dataset to ensure adequate sample size within each level. School grade level data were obtained from the Minnesota Department of Education. Schools with grades 5 through 8 or high grade < 10 and low grade 6 were categorized as 'middle schools'; schools with low grade < 9 and high grade 11 were categorized as 'junior/senior high schools'; schools with low grade 9 and high grade 11 were categorized as 'high schools'.

Chi-square tests were employed to compare demographic characteristics between schools in the three rural subtypes. For schools included in more than one survey sample between 2006 and 2012, the most recent demographic data were used for comparisons. Generalized estimating equation models specifying a binomial distribution with a logit link were used to estimate prevalence of vending machines and vending items over time, adjusting for school-level characteristics. An independent correlation structure corrected standard errors for sampling of some schools in multiple years. Models that included an interaction term between rural subtype and year were not significant at the $p < 0.05$ level, suggesting little evidence of differential rates of change over time between rural subtypes. Therefore, interaction terms were not included in final models. Analyses were conducted with Stata Statistical Software, version 12.1 (StataCorp, LP, College Station, TX).

RESULTS

Table 1 compares demographic characteristics of schools by rural subtype. There were significant differences in school grade level, percent minority enrollment, and percent FRPL eligibility across subtypes. Town/rural distant and remote rural schools were more racially diverse than town/rural fringe schools (40% and 33% versus 20%), and these two subtypes included more schools with 30% of students eligible for FRPL compared to town/rural fringe schools (67% and 81% versus 24%). Junior/senior high school was the most common grade level in town/rural distant areas (48%) and remote rural areas (69%), while high school was the most common grade level in town/rural fringe areas (44%).

Figure 2 compares the crude percentage for each vending policy and practice across the three rural subtypes over time. While the prevalence of vending machines remained fairly constant over time across the three subtypes, there was a marked reduction in chocolate candy, other kinds of candy, salty snacks and soft drinks over time, though to varying degrees across subtypes. Sports drinks remained prevalent over time in all rural subtypes. Overall, town/rural fringe schools experienced a smaller reduction in LNED vending items over time compared to town/rural distant and remote rural schools.

Table 2 presents adjusted trends in prevalence of vending machines and LNED vending items within and between rural subtypes, adjusted for school-level characteristics. In 2006, most rural schools had one or more vending machines available to students (range: 89.0% to 91.8%). Adjusted prevalence of vending machines remained high in 2012 (range: 87.1% to 90.4%), with no statistically significant change over time within or between rural subtypes. These findings are consistent with previous research indicating that vending machine availability, while declining, is still common in secondary schools.¹⁴ All three rural subtypes had a statistically significant decrease in the adjusted prevalence of LNED vending items between 2006 and 2012, with the exception of sports drinks. The largest decreases across time were found for soft drinks (range: -25.6% to -30.0%) and chocolate candy (range: -21.2% to -24.5%).

Different vending practices were observed across the three rural subtypes. Schools in town/rural fringe areas had a higher adjusted prevalence of chocolate candy ($p < 0.001$), other types of candy ($p = 0.002$), and soft drinks ($p = 0.035$) in vending machines compared to

schools in town/rural distant and remote rural areas, when averaged over time. Further, schools in town/rural fringe areas had a statistically significantly smaller decrease in the availability of chocolate candy (−21.2% versus −24.5%) and soft drinks (−25.6% versus −30.3% and −29.7%) over time compared to town/rural distant and remote rural schools.

Discussion

Study findings suggest significant improvements in the availability of some LNEED snacks and beverages for all rural subtypes of secondary schools in Minnesota from 2006 to 2012. These findings are encouraging and suggest that efforts are currently being made to improve the food environment of rural schools. However, some vending items including sports drinks remained widely available over the study period, which is concerning given the high sugar content of these types of beverages.²⁵ The continued high prevalence of sports drinks in comparison to the marked reduction in soft drinks may point to the need for education on the nutritional content of these beverages, presenting a promising opportunity for further improvement in the vending environment of rural schools through the removal of these items. Efforts should be made to identify and provide healthier beverage items, such as bottled water, as alternative options in school vending machines. If the observed reductions in LNEED vending options are merely the result of replacing unhealthy items with alternative LNEED options, such as sugary sports drinks, then further work is needed to improve vending options in schools.

Study findings also suggest that differences in the school environment emerge when rural schools are further subtyped. There were clear demographic differences between the three subtypes, with more diverse and low-income students attending schools further from metropolitan areas. These findings alone support the hypothesis of heterogeneity within the rural environment. Further, differences were identified across subtypes regarding vending machine policies and practices. Improvements in the vending environment over time were not consistent across rural subtypes, with town/rural fringe schools experiencing less positive change. In 2012, the proportion of schools offering chocolate candy, other types of candy, and soft drinks was substantially higher in the town/rural fringe subtype compared to town/rural distant and remote rural subtypes. Additionally, although town/rural distant and remote rural schools were more similar to each other in terms of their demographic characteristics and policy environment compared to town/rural fringe schools, observable differences were also identified between these two subtypes.

The observed variations across rural subtypes provide valuable insight for decision makers, as these results identify specific areas within the rural environment that are in most need of targeted policy intervention. It is important that policy makers at the state-level consider these geographic differences in the vending environment of rural schools, as state policy has been shown to be more effective than local school district policy in limiting competitive foods.²⁶ Based on study findings, efforts around improving the rural school food environment would likely be maximized by targeting schools located on the periphery of metropolitan areas, as students in remote areas appear to be more protected against access to less healthy food options. This finding that remote rural schools offer fewer LNEED vending options to students is supported by previous studies that have identified fewer overall food

choices in rural communities including schools.²⁷ Ultimately, these results indicate that additional information is gained when schools commonly designated as ‘rural’ are further stratified into more specific geographic subtypes. Future studies utilizing more precise rural categorizations may thus provide greater insight into in the food environment of non-metropolitan schools, which could result in more targeted policies and interventions addressing obesity rates among rural youth.

This analysis further adds to the literature by providing an assessment of vending policies and practices over time within and between rural school subtypes. However, there were limitations to this study. First, rural differences may not be fully identified in this analysis, as there may be additional variability among schools within the same rural subtype. Additional subtyping of rural locations may reveal further differences in school vending policies, which could be explored in future studies. Further, this analysis did not assess the efficacy of policy implementation among the rural subtypes, another promising area of exploration. The inclusion of rural schools located only in Minnesota is another limitation to this study, as results may not be generalizable to rural schools in other states, although previous work strengthens external validity.^{16,28} A further limitation of this study is that information was not available on hours during the day in which vending machines were turned on. Therefore, it is not identifiable from this analysis if frequency in vending availability, defined as allowable purchase times, varied by rural subtype. This is likely a key consideration when determining differences in vending practices between rural subtypes, pointing to the need for further research in this area. A final limitation of this analysis is the use of serial cross-sectional data over time, which prevents definitive conclusions regarding changes in vending machine practices within schools over time. Although, longitudinal cohort studies do suggest that vending availability matters, especially the presence of LNEF foods.^{29,30} Despite these limitations, this analysis provides valuable insight into the nutritional environment of schools within different rural subtypes, an area of research that has not been previously explored.

In summary, this study provides a critical analysis of the vending environment of rural schools in three geographic subtypes. This work has the potential to make a substantial public health impact, given the alarmingly high rates of childhood obesity in rural areas throughout the United States. To date, there has yet to be an in-depth descriptive analysis of the vending environment among rural schools, which is invaluable in understanding the role of school context in perpetuating the high rates of childhood obesity in non-urban areas. Further, by describing school vending policies within three specific rural subtypes, this study begins to shape the discussion regarding how best to target weight-related intervention efforts within the larger rural context.

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NCES Category	Town/Rural Fringe		Town/Rural Distant		Remote Rural	Total
	Metropolitan	Micropolitan	Town	Rural		
Town, Fringe	9	0	0	0		9
Town, Distant	9	6	6	0		21
Town, Remote	1	13	15	0		29
Rural, Fringe	23	4	13	0		40
Rural, Distant	14	8	4	19		45
Rural, Remote	1	4	4	53		62

Figure 1.

The School Obesity-related Policy Evaluation (ScOPE) rural subtype classification scheme for Minnesota secondary schools participating in the 2006–2010 Profiles Survey[†] based on National Center for Education Statistics (NCES) and Rural-Urban Commuting Areas (RUCA) location categories.

[†]School Health Profiles Principal's Survey

Note: Formal definitions available on the ScOPE website: <http://z.umn.edu/scope>

NCES location codes are assigned using school address and proximity to urban area.

RUCA location codes are assigned using census tract (2000) population density, urbanization, and daily commuting data.

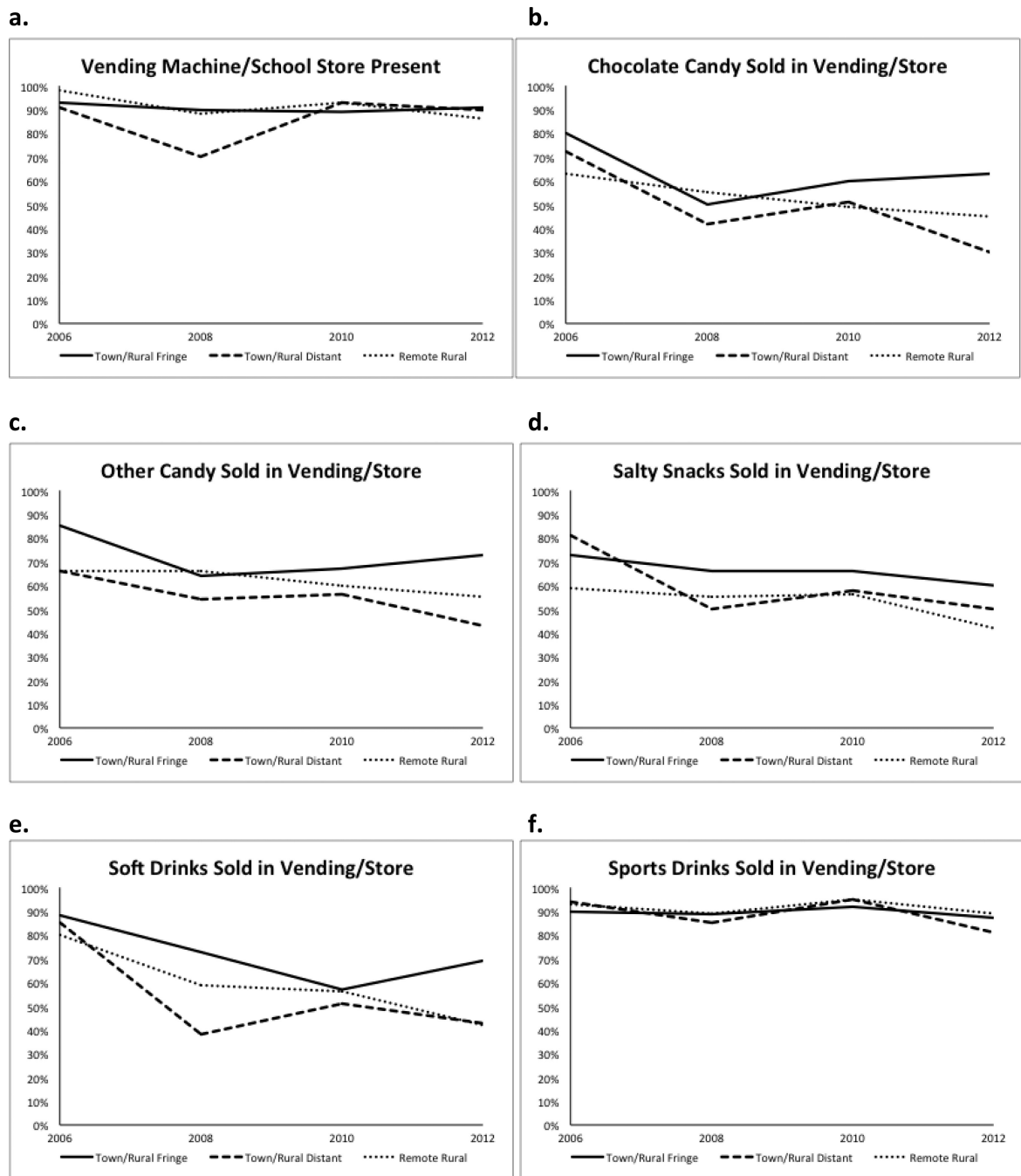


Figure 2. Crude percentages of vending policies and practices in Minnesota secondary schools by rural subtype. Profiles survey data. 2006–2012.

Table 1
Demographic Characteristics of Rural Minnesota Schools Participating in the Profiles Surveys* 2006–2012.

School Characteristics	Town/Rural Fringe N = 180	Town/Rural Distant N = 168	Remote Rural N = 178	p-value
School Grade Level[‡]				
Middle School	61 (34%)	46 (27%)	27 (15%)	< 0.001
High School	80 (44%)	42 (25%)	28 (16%)	
Jr/Sr High School	39 (22%)	80 (48%)	123 (69%)	
FRPL[‡] Eligibility				
< 30%	136 (76%)	56 (33%)	34 (19%)	< 0.001
30%	44 (24%)	112 (67%)	144 (81%)	
Minority Enrollment				
< 10%	144 (80%)	101 (60%)	119 (67%)	< 0.001
10%	36 (20%)	67 (40%)	59 (33%)	

Note: The rural subtypes of town/rural fringe, town/rural distant, and remote rural were constructed by the School Obesity-related Policy Evaluation (ScOPE) study team informed by National Center for Education Statistics (NCES) and Rural-Urban Commuting Areas (RUCA) location classifications. The subtypes represent increasing distances from a metropolitan center.

* School Health Profiles Principal's Survey

[‡] Middle school defined as grades 5 through 8 or high grade < 10 and low grade 6; jr/sr high school defined as low grade < 9 and high grade 11; high school defined as low grade 9 and high grade 11.

[‡] Free and reduced-price lunch

Table 2

Profiles Survey * 2006 – 2012: Prevalence differences of LINED vending items adjusted for school-level characteristics †

Policy	School Location ††	p-value for difference between locations averaged over time	Adjusted %, 2006	Adjusted %, 2012	p-value for change over time	Change in adjusted % within school type, 2006–2012 ‡
Vending Machine/School Store Present	Town/Rural Fringe ^a		91.8%	90.4%	0.569	-1.5% (-6.6%, 3.6%) ^a
	Town/Rural Distant ^a	0.613	89.0%	87.1%	0.567	-1.9% (-8.5%, 4.6%) ^a
	Remote Rural ^b		90.6%	88.9%	0.573	-1.7% (-7.5%, 4.1%) ^a
Chocolate Candy	Town/Rural Fringe ^a		78.5%	57.3%	< 0.001	-21.2% (-30.2%, -12.2%) ^a
	Town/Rural Distant ^b	< 0.001	61.9%	37.4%	< 0.001	-24.5% (-34.9%, -14.1%) ^b
	Remote Rural ^b		62.0%	37.5%	< 0.001	-24.5% (-34.9%, -14.1%) ^b
Other Candy	Town/Rural Fringe ^a		78.8%	68.0%	0.014	-10.8% (-19.4%, -2.2%) ^a
	Town/Rural Distant ^b	0.002	62.5%	48.8%	0.015	-13.7% (-24.7%, -2.6%) ^a
	Remote Rural ^b		66.9%	53.6%	0.015	-13.3% (-24.0%, -2.6%) ^a
Salty Snacks	Town/Rural Fringe ^a		73.2%	55.3%	< 0.001	-17.9% (-27.7%, -8.0%) ^a
	Town/Rural Distant ^a	0.228	70.6%	52.1%	< 0.001	-18.4% (-28.9%, -8.0%) ^a
	Remote Rural ^b		64.4%	45.2%	< 0.001	-19.3% (-30.2%, -8.4%) ^a
Soft Drinks	Town/Rural Fringe ^a		82.8%	57.2%	< 0.001	-25.6% (-34.0%, -17.2%) ^a
	Town/Rural Distant ^b	0.035	72.9%	42.9%	< 0.001	-30.0% (-40.1%, -20.0%) ^b
	Remote Rural ^b		74.2%	44.5%	< 0.001	-29.7% (-39.7%, -19.7%) ^{ab}
Sports Drinks	Town/Rural Fringe ^a		91.2%	87.3%	0.259	-3.8% (-10.5%, 2.8%) ^a
	Town/Rural Distant ^a	0.928	92.0%	88.4%	0.278	-3.6% (-10.0%, 2.9%) ^a
	Remote Rural ^b		92.4%	89.0%	0.269	-3.4% (-9.4%, 2.6%) ^a

Note: The rural subtypes of town/rural fringe, town/rural distant, and remote rural were constructed by the School Obesity-related Policy Evaluation (ScOPE) study team informed by National Center for Education Statistics (NCES) and Rural-Urban Commuting Areas (RUCA) location classifications. The subtypes represent increasing distances from a metropolitan center.

* School Health Profiles Principal's Survey

† Models are adjusted for % minority enrollment, % free-reduced price lunch eligibility and school grade level

†† Locations that do not share a common letter have significantly different prevalences averaged over time (p < 0.05).

‡ Locations that do not share a common letter have significantly different prevalence change between 2006 and 2012 (p < 0.05).