Area-Level Measures of Deprivation Predict Food Patterns Among 7th Grade Students in Washington State

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Abstract

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Introduction: Studies find that disparities exist between socioeconomic status and markers of diet quality among school-aged children. Only a few studies have examined food consumption at school and away from school for the specific purpose of uncovering the links between food patterns and the child's socioeconomic environment. The purpose of this cross-sectional study was to determine how socioeconomic environments contribute to the consumption of food items common used to assess diet quality in school-aged children. **Methods:** Area-level measures of deprivation were assigned to 64 middle schools (n=64) in Washington State using Singh Deprivation Index methodology. School level results from a Beverage and Snack Questionnaire completed by 9,319 7th grade students during the 2007-2008 school year were used to calculate

school average frequency of consumption for snacks, sugar sweetened beverages, fruit, vegetables, 1% or nonfat fluid milk and 2% or regular fluid milk at school and away from school. Linear regression was used to determine the association between area-level measures of depression and frequency of consumption for food and beverages items. **Results:** Area-level deprivation showed a significant positive association with school average frequency of consumption for 1% or nonfat fluid milk and 2% or regular fluid milk at school, but no other food or beverage items. Away from school, area-level deprivation showed a significant positive association with school average frequency of consumption for snacks and sugar sweetened beverages. A significant inverse association was observed for area-level deprivation in relation to school average frequency of consumption for fruit, vegetables and 1% or nonfat milk. **Conclusion:** At home, students attending schools serving areas of greater deprivation consume food and beverage items putting them at nutritional risk at a greater average frequency than students attending schools serving areas of lesser deprivation. At school however, neighborhood deprivation does not influence the average frequency of consumption for nutritionally problematic foods. School food environments actually promote consumption of nutritionally protective foods among students attending schools of greater deprivation relative to their lesser deprived counterparts. This supports the importance for the availability of milk, fruit and vegetables in school meals in promoting the nutritional health of low-income students. Area-level measures of deprivation can be used to identify schools within communities serving students at the greatest risk for consuming food and beverage items commonly associated with poor diet quality.

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Section One: Introduction

The Dietary Guidelines for Americans, 2010 provide the federal government's evidence-based nutrition guidance for Americans 2 years and older. These guidelines are intended to promote health, reduce the risk of chronic disease, and reduce the prevalence of overweight and obesity through changes in nutrition and other health-related behaviors. Nutrition recommendations include reducing the intake of calories from added sugars, increasing the intake of fat-free or low-fat milk products, and increasing the consumption of fruits and vegetables (1). Limited family resources may serve as a barrier in achieving nutrition recommendations for many children and adolescents of low-SES (2), and disparities exist between SES and markers of diet quality in children and adolescents.

Previous research indicates that higher consumption of energy-dense, low-nutrient foods (3) and added sugar (4) is associated with lower socioeconomic status (SES). Children and adolescents of low-SES consume a higher mean percentage of total energy from sugar sweetened beverages (SSB) compared to those of high-SES (5), and report low-fat fluid milk as the type of milk regularly consumed less frequently than those of higher-SES (6). Children and adolescents of lower-SES also consume fruits and vegetables less frequently than those of higher-SES (4,7,8).

School meal programs serve as a nutrition safety net for millions of lower-income students by providing nutritionally balanced, low-cost or free meals on a daily basis. These meals include low-fat milk, and fruits and vegetables. For many low-income students, meals provided as part of school meals programs may be the only nutritionally balanced meal encountered throughout the course of a day. Competitive foods within school food environments potentially undermine the

role of School Meals Programs by replacing foods of higher nutritional value with energy-dense foods of lower nutrient density. Availability of SSB is shown to predict consumption of these food items among middle school students while at school (9). Furthermore, when access to competitive foods within school food environments is restricted, students participating in the National School Lunch Program have been shown to increase consumption of fruits, vegetables and fluid milk (10).

Many studies have examined the association between SES and markers of diet quality among school-aged children. Only a few have examined food consumption at school and away from school for the specific purpose of uncovering the links between food patterns and the child's socioeconomic environment.

The aim of this study was to determine the association between area-level measures of deprivation and school average frequency of consumption for markers of diet quality including energy-dense, low-nutrient snacks, SSB, fruits, vegetables, and fluid milk among 7^{th} grade students in Washington State. It is hypothesized that schools located in areas of greater deprivation would have significantly higher school-average frequency of consumption for food items associated with lesser diet quality (snacks, SSB) and a lower frequency of consumption for foods associated with better diet quality (fruits, vegetables and low-fat fluid milk).

Section Two: Methods

This was a cross-sectional observational study. Food and beverage consumption data was obtained from previous studies that described the association between availability of snacks and SSB in middle schools and consumption of these food and beverage items among 7th grade students (9). The work of the research team was supported by an advisory group of diverse stakeholders who were interested in applying the results to policy decisions at the district, state, and national levels. The advisory group suggested that the study focus on seventh graders because they are old enough to make some independent decisions about food purchases, but still young enough to attend schools with closed campuses.

Recruitment

School recruitment was designed to ensure representation from middle schools that serve low-income and racial/ethnic minority students and geographically diverse parts of Washington State by using existing relationships to engage schools. The Washington State School Directors Association, Office of the Superintendent of Public Instruction and public health advocates announced the project at meetings, through newsletters, in letters mailed directly to school administrators and leaders and through personal contact. All public schools that enroll seventh-grade students and participate in USDA school meal programs were eligible to participate. A total of 65 schools from 29 districts returned a letter of cooperation agreeing to participate in all phases of data collection.

School characteristics

District and school level demographic data were obtained from the Washington State Office of Superintendent of Public Instruction (11). Data about the geographic locale (city, suburb, town, rural) of the schools were obtained from the National Center for Education Statistics in 2008 (12). Sample size limitations precluded stratifying across all four categories, so data were collapsed into city and non-city (suburb, town, rural).

Student consumption of Fruits, Vegetables,100% fruit juice, fluid milk, snacks and SSB

During the 2007–2008 school year, a research team worked with participating schools to administer the Beverage and Snack Questionnaire (BSQ) (13) to all seventh graders. To maintain student anonymity, the research team provided the schools with parent letters, student assent forms, a teacher script, and the survey tool. The schools provided the letters to families asking them to return signed forms if they did not want their student to participate. Student assent was obtained. Each school decided how they would administer the surveys to all 7^{th} grade students, either all at once (for example during first period) or during a specific class (for example, during homeroom). The schools returned the completed surveys to the research team. The BSQ was developed through a process of cognitive and psychometric testing and has been found to have adequate validity (r = .72–.85) and reliability (r = .69–.71) with seventh graders (13).

The BSQ included eight snack, five SSB beverage, two milk, one fruit and one vegetable category. Students were asked to provide categorical responses regarding the frequency of consumption over a period of one week for each food category. Students indicated the frequency of consumption at school and away from school for each food category. Snacks consisted of food

items often considered high in energy density and low in nutrient density as categorized by the Government Accountability Office (14) and Seattle Public Schools nutrition standards (15). Snack categories included low-fat chips, regular chips, other salty snacks, candy, breakfast pastries, cookies, non-fat frozen desserts, and regular ice cream.

SSB categories included fruit drinks (Snapple, Capri Sun), sport drinks (Gatorade, PowerAde), flavored water (Propel, vitamin water), regular soda or pop (all kinds) and energy drinks (Rockstar, Redbull, Monster, etc.). Milk was categorized as 1% or nonfat milk, and regular or 2% milk (whole and reduced fat), both of which included frequency of consumption for chocolate milk. One question each was asked regarding frequency of consumption for fruit and vegetables.

Categorical responses for frequency of consumption included “never or less than 1 per week”, “1 per week”, “2-4 per week”, “5-6 per week”, “1 per day”, “2-3 per day” and “4+ per day”. Categorical responses were transformed into numerical values for each food category. Frequency of consumption for students within schools was used to calculate school-average frequency of consumption over a period of one week for each food category. To calculate this, the frequency of consumption for each food category was summed and divided by the total number of students completing the questionnaire at their respective school. Snack and SSB categories were summed, yielding a single value (for each school) for average frequency of consumption for snacks and SSB. For questionnaires to be included in calculation of the school average frequency of consumption, students must have completed greater than 80% of total items on the questionnaire.

Area-level Deprivation (Singh Index)

Area-level data came from the 2000 U.S. Census. A composite measure of deprivation, the Singh index, was composed of 17 census variables representing material and social conditions and relative socioeconomic disadvantage (16,17). The 17 variables were selected through a factor analysis of an original list of 21. Factor score coefficients served to weight the individual variables in order to calculate the single index value. The largest coefficients were for poverty level, median income, and population with at least a high school diploma. The smallest coefficients were for households without complete plumbing, household crowding, and home ownership status. Singh index values are scaled around a mean of 100, so that values greater and less than 100 indicate above- and below-average deprivation, respectively (18).

A school-specific deprivation index was derived using ArcGIS 10 (Esri; Redlands, CA). Census tracts, as defined by U.S. Census Bureau from the year 2000, corresponding to middle school attendance boundaries were identified and included in the calculation of school-specific deprivation indexes using the following methodology. If greater than 50% of census tract total estimated land-area fell within middle school attendance boundaries, the census tract was included in calculation of the school-specific deprivation index. If less than 50% of estimated land-area fell within middle school attendance boundaries, census tracts were further analyzed to estimate the proportion of land-area designated for residential use. If estimated that greater than 50% of census tract land-area designated for residential use fell within school attendance boundaries, the census tract was included in school-specific deprivation index calculations. Census tracts corresponding to school attendance boundaries were weighted (based on total

population of individual census tracts) and aggregated to yield weighted-mean, school-specific deprivation indexes for each school in the sample set.

Statistical Analysis

The unit of analysis was the school. STATA v.12.0 (College Station, TX) was used to analyze descriptive data and perform linear regression analysis. Pearson's correlation coefficients were used to examine relationships between continuous variables. Linear regression was used to analyze relationships between independent (school-specific deprivation index) and dependent (school average frequency of consumption) variables. An alpha level of 0.05 established statistical significance.

Section Three: Results

Characteristics of schools

The schools included in this study are described in Table 1. The demographic characteristics of the students in the study schools were similar to those in the state as a whole. In Washington State, the mean proportion of students who were eligible for free and reduced-price school meals (i.e., free and reduced-price eligible) was 38%; in the study schools 38.9% were eligible for the programs. Overall, in Washington State the proportion of students in each racial/ethnic category was 8.7% Asian/Pacific Islander, 2.7% American Indian/Alaska Native, 5.7% black, 14.6% Hispanic, and 65.8% white. In the study sample the proportion of students in each racial/ethnic category was 5.8% Asian/Pacific Islander, 3.0% American Indian/Alaska Native, 4.3% black, 11.2% Hispanic, and 75.0% white.

Student Response Data

Complete data, representing 28 school districts, were collected in 64 of the 65 schools that volunteered to participate in the study. One school (and consequently one district) withdrew from the study because of widespread flooding and school closures. Questionnaires were collected from 10,618 students. The total seventh-grade enrolment in the 64 study schools was 13,889, for a total response rate of 76%. Surveys were excluded from analysis if missing 80% or more items from the entire questionnaire. Overall, 9,319 questionnaires were included in the final analysis. The number of questionnaires used to calculate the school average frequency of consumption for each food category depended on the number of students who responded to each food or beverage category at their respective school.

Table 1. Characteristics of schools studied (n=64)

School Characteristics	Total	Mean (SD)	Range
School enrollment		630 (233)	95-1074
Proportion of students free and reduced-price-eligible		38.9%	2.6-93.3%
Schools with > 30% FRPM	42		
Race/ethnicity			
Asian/Pacific Islander		5.8% (6.9)	0.1-37%
American Indian/ Alaskan Native		3.0% (4.1)	0.2-25%
Black		4.3% (6.5)	0.6-46%
Hispanic		11.2% (13.1)	1.5-82%
White		75.0% (18.4)	3.6-94%
Schools with >30% nonwhite	19		
Schools with >30% Hispanic	4		
Geographic Distribution			
City	24		
Noncity	40		

School Specific Deprivation Indexes

School-specific deprivation indexes had a mean of 0.085 and a standard deviation of 0.78. Deprivation indexes ranged from a low of -2.14 (below average deprivation) to a high of 2.79 (above average deprivation). Overall, 36 schools were classified as being geographically located in areas of above average deprivation (lower-SES) and 28 schools were consider below average deprivation (higher SES). Within the sample of schools included in this study, area-level

measures of deprivation were significantly correlated (r=0.77) with the percentage of students in schools price eligible for free-or-reduced school meals.

Deprivation and Food Consumption Patterns

Table 2 provides information for the association between area-level measures of deprivation and school average frequency of consumption for food and beverage categories examined. At school, deprivation was positively associated with school average frequency of consumption for 1% or non-fat milk and regular or 2% milk. Deprivation was not significantly associated with school average frequency of consumption for any other food or beverage categories while at school.

Away from school, deprivation was significantly associated with school average frequency of consumption for all food and beverage items examined, with the exception of regular or 2% milk. A positive association was observed for school average frequency of consumption for snacks and SSB (figure 1), while an inverse association was observed for the frequency of consumption for fruits, vegetables and 1% or non-fat milk.

Regardless of deprivation, school average frequencies of consumption for various markers of diet quality were similar for students while at school. Away from school, a strong social gradient was observed for markers of diet quality in relation to school deprivation measures. These findings indicate that school meals programs and school food environments address disparities in markers of diet quality for children of lower-SES by leveling the playing from a nutritional standpoint during the school day.

Table 2. Association between area-level deprivation and school average frequency of consumption for snacks, sugar-sweetened beverage, fruit, vegetable, 1% or nonfat milk and regular or 2% milk at school and away from school

Food/Beverage Items	Correlation Coefficient	P-value
Snacks		
At school	0.10	0.54
Away from school	0.33	0.009
Sugar-Sweetened Beverages		
At school	0.06	0.65
Away from school	0.39	0.001
Fruits		
At school	0.16	0.20
Away from school	-0.32	0.011
Vegetables		
At school	0.08	0.54
Away from school	-0.45	0.0002
1% or Nonfat Milk		
At school	0.45	0.0002
Away from school	-0.33	0.007
Regular or 2% Milk		
At school	0.39	0.002
Away from school	0.06	0.65

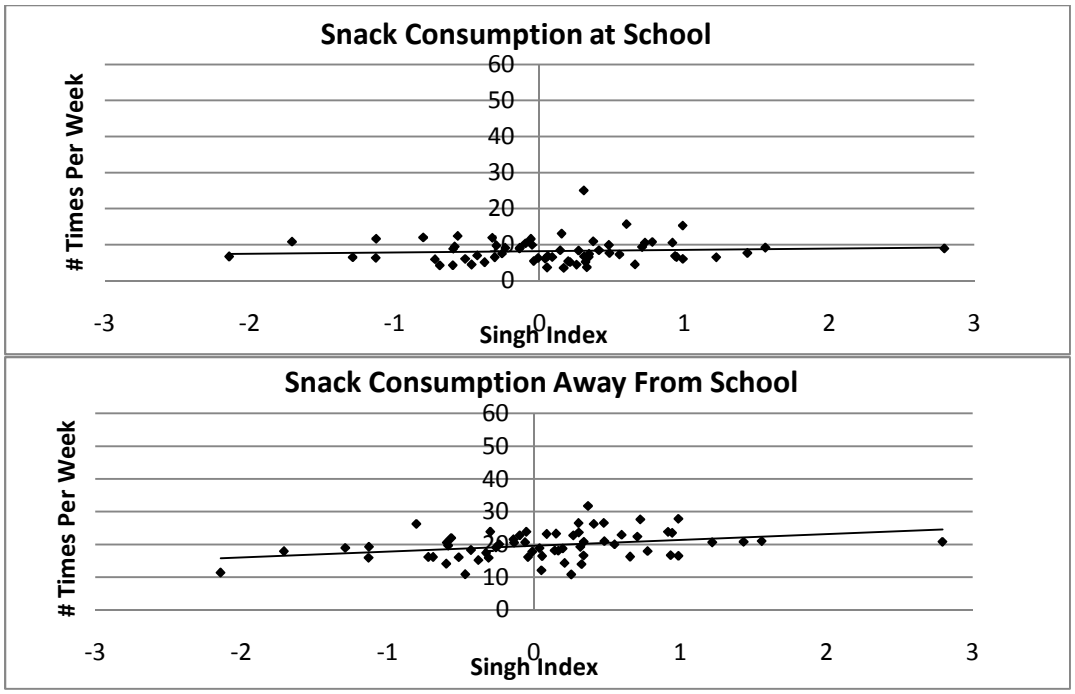

Figure 1. Area-level deprivation and school average frequency of snack consumption per week at school and away from school.

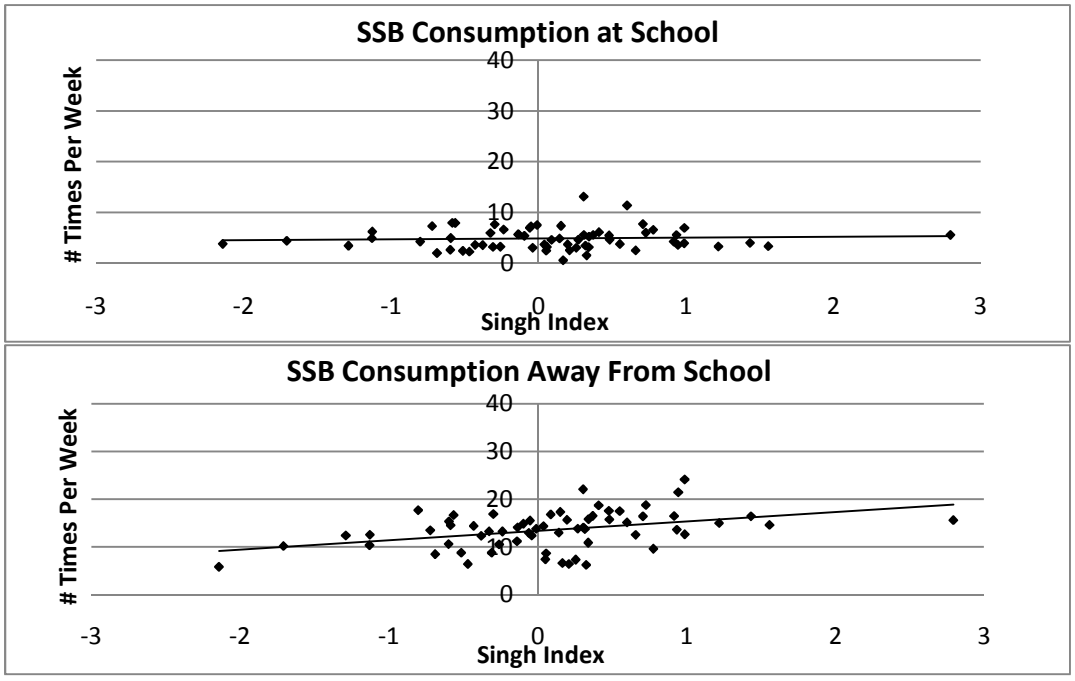

Figure 2. Area-level deprivation and school average frequency of sugar sweetened beverage consumption per week at school and away from school.

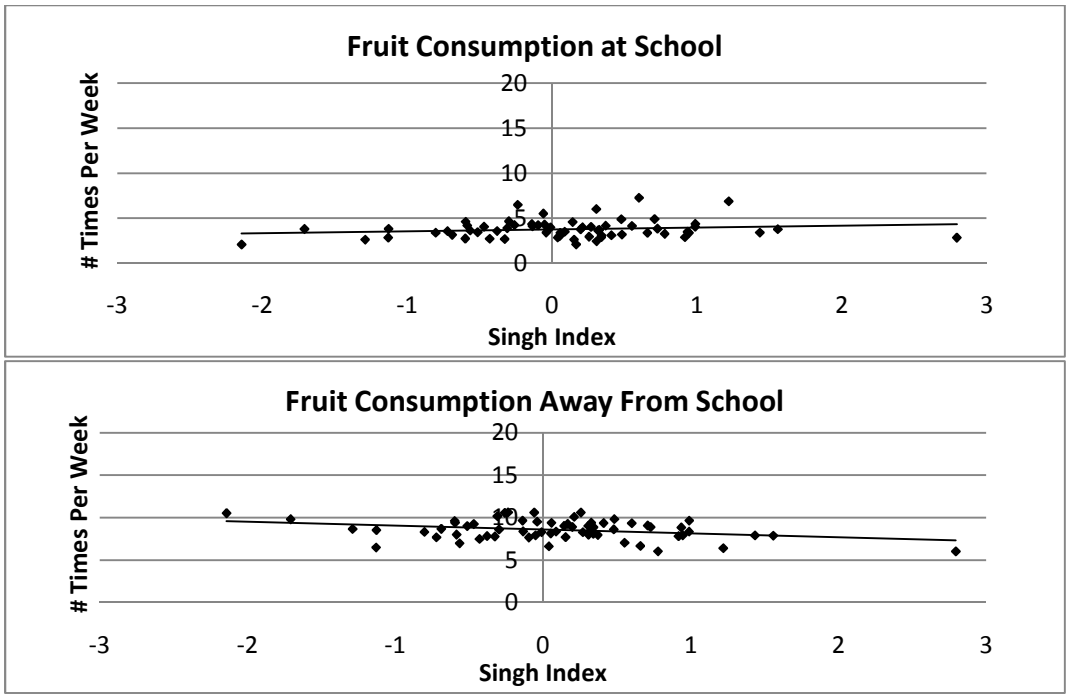

Figure 3. Area-level deprivation and school average frequency of fruit consumption per week at school and away from school.

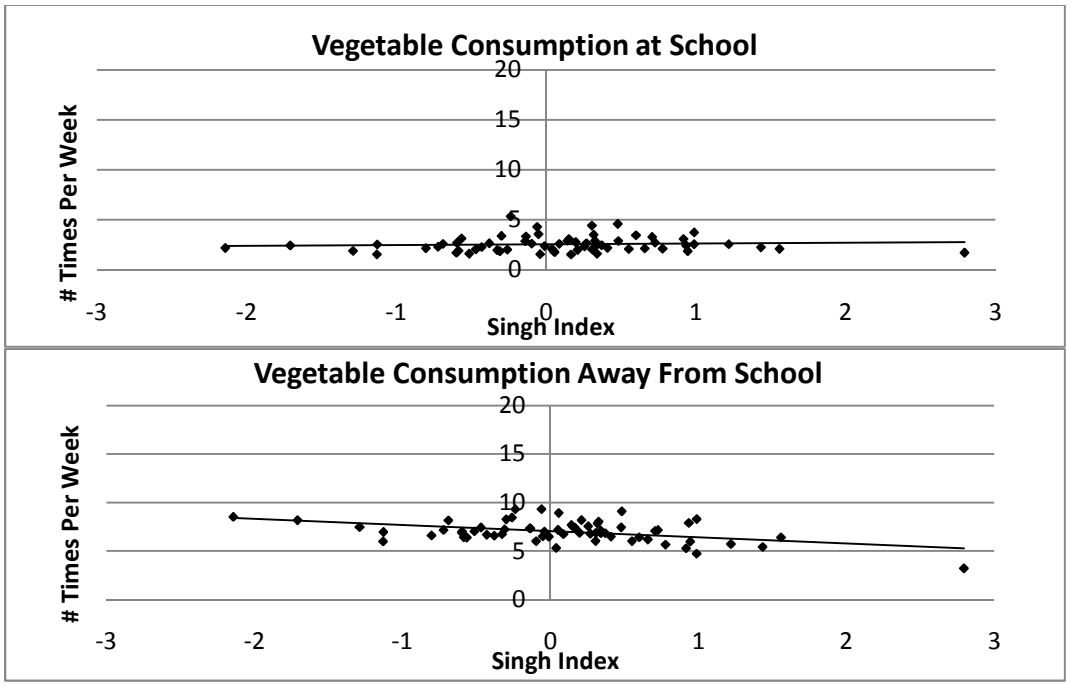

Figure 4. Area-level deprivation and school average frequency of vegetable consumption per week at school and away from school.

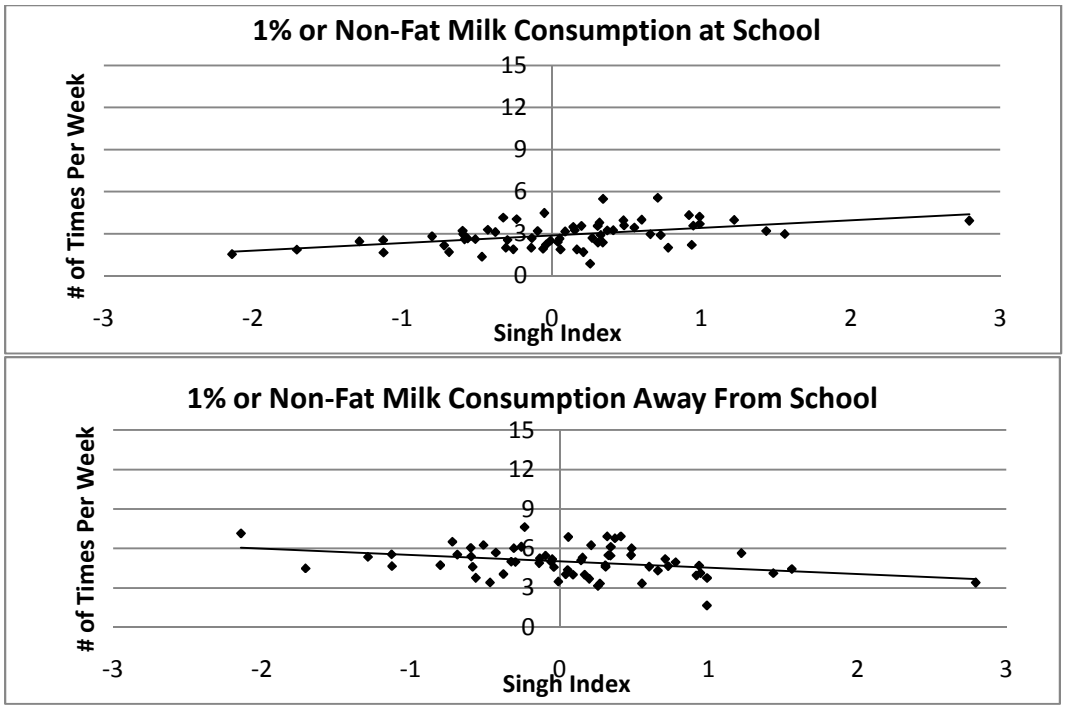

Figure 5. Area-level deprivation and school average frequency of 1% or non-fat milk consumption per week at school and away from school.

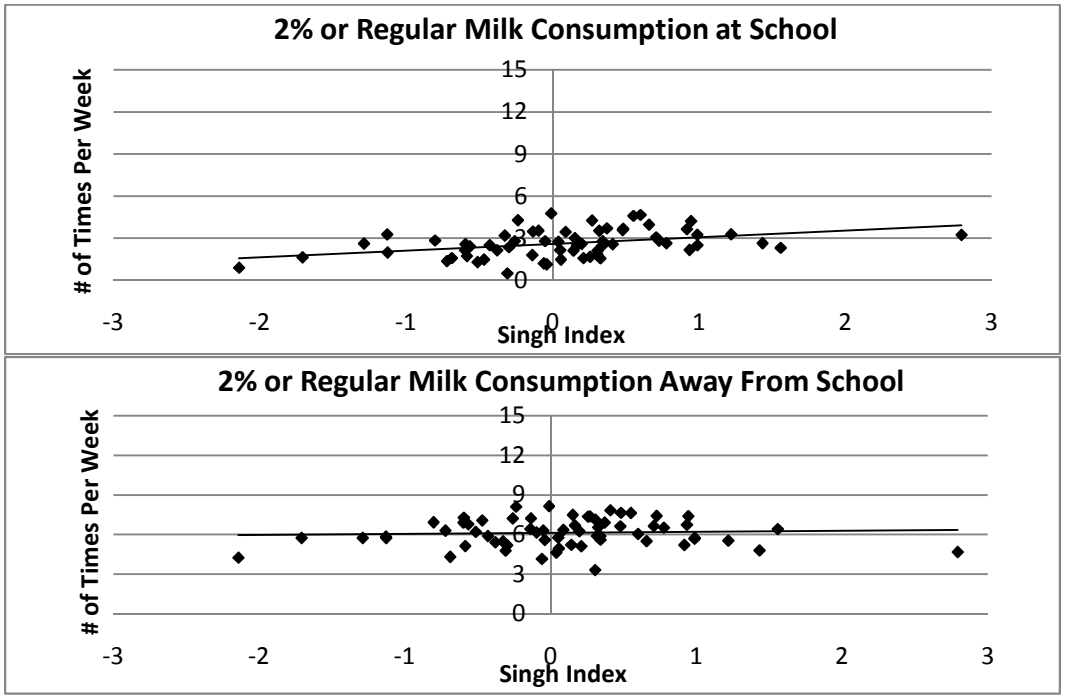

Figure 6. Area-level deprivation and school average frequency of 2% or regular milk consumption per week at school and away from school.

Section Four: Discussion

This study describes the association between area-level deprivation and school average frequency of consumption for food items commonly associated with diet quality. While numerous studies have assessed diet quality in relation to SES, few have attempted to compare markers of diet quality among students of various socioeconomic demographics while taking into account environment (at school compared to away from school). One study of interest concludes that participants of the National School Lunch Program (NSLP) consume less energy from SSB, but more energy from energy-dense, low-nutrient solid foods while at school. Away from school, NSLP participants did not consume greater energy from SSB or energy-dense, low-nutrient foods than nonparticipants (19).

These findings are inconsistent with the findings of this study, as our data suggests that school food environments are protective, while food environments away from schools promote consumption of low-nutrient, energy-dense foods and SSB among low-income children. We speculate that the use of area-level measures of deprivation helped this study to identify subtle changes in dietary intake that cannot be captured through the use of categorical variables, such as eligibility for free-or-reduced meals.

Limitations to this study include a cross-sectional study design, and inability to assign causation. Despite adequate validity and reliability of the survey tool used to assess student intake (13), accuracy of consumption data collected from students is a limiting factor to this study. The potential for misclassification bias, resulting from census aggregation, of deprivation scores

assigned to schools is noteworthy. However, through use of geographically defined spatial areas, such as school attendance boundaries, the potential for misclassification bias is minimized.

Strengths of this study include the use of area-level measures of deprivation to estimate SES for neighborhoods in which schools are located. In the United States, the most common approach to assess neighborhood effects involves using single census variables, such as percent poverty, to represent the spectrum of deprivation for an area (20). Studies taking this approach likely underestimate the constellation of factors that contribute to deprivation in neighborhoods. By using school attendance boundaries to estimate area-level deprivation, this study has taken a novel approach for estimating the material and social conditions and relative socioeconomic disadvantage in neighborhoods surrounding schools.

Section Five: Conclusions

This study underlines the importance of school nutrition programs in protecting the health of low-income and vulnerable children and adolescents throughout the U.S. The National School Lunch Program (NSLP) currently operates in over 101,000 public and non-profit private schools and residential child care institutions, providing nutritionally balanced low-cost or free lunches to more than 31 million children on school days (21). The School Breakfast Program (SBP) provided 9.7 million low-cost or free meals to students in 2010 (22).

Due to the high reported fat and saturated fat content of school meals (23,24,25), some research has implicated school meals in contributing to childhood obesity (26,27). Our findings indicate that school meals likely improve the nutritional status and health of low-SES students participating in school nutrition programs. Foods served as part of school nutrition programs may attenuate observed disparities in markers of diet quality and improve health outcomes associated with poor dietary intake among school-aged children. Rigid nutrition standards for all food and beverage items available within schools, including competitive foods, may help to further improve markers of diet quality and health outcomes among students, particularly those of low-SES.

The important of nutrition standards becomes magnified in areas of greater deprivation, as students attending these schools are more likely to be dependent on foods served within schools to maintain an adequate nutritional status. While the ability to impact the social status of children and adolescents is limited through broad public health interventions, the potential to implement policies that improve school food environments is reasonably achieved. Improvements to school

food environments through rigid nutrition standards for competitive foods, in addition to continued and increased funding of School Meals Programs, may help to move all school-aged students closer to reaching the nutrition goals outlined in the Dietary Guidelines for American, 2010. Students of low-SES would reap the greatest benefit from continuous improvement to nutrition standards in schools, as these students appear to suffer disproportionately from the effects of SES on markers of diet quality.

This study also demonstrates the utility of area-level measures of deprivation in identifying schools serving students of low-SES who may suffer disproportionately form the effects of SES on dietary intake. The strong correlation between area-level deprivation and eligibility for free-or-reduced school meals is evidence of this. Through utilization of deprivation indexes, schools of higher deprivation can be identified and qualified for universal access to School Meal Programs based on material and social conditions and relative socioeconomic disadvantage in the areas in which they are located, as opposed to measures of income alone. In addition, community interventions can be targeted to reach children and adolescents living in underserved neighborhoods of greater social disadvantage. Implementing policies and distributing resources intended to improve child and adolescent health based on risk (determined by area-level measures of deprivation) is a potential methodology for achieving the greatest social return on investment.

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