Food Environment around School and Students' Weight Status:

A Study of Four New Jersey Low-Income Communities

by

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ABSTRACT

Childhood obesity has been on the rise for the past decade, and it has been hypothesized that students' food choices may be influenced by easy access to food outlets near their schools that provide unhealthful options. But the results of recent studies on the relationship between the food environment around schools and student weight status are mixed and often contradictory. Most studies have used measures of weight and height that were self-reported by students, or have relied on data from a relatively small sample of students. I examine the association between weight status among school students and the food environment surrounding their schools using professionally-measured, student-level data across the full school-age spectrum. De-identified data were obtained for over 30,000 K-12 students in 79 public schools located in four New Jersey cities. Locations of alternative food-outlets (specifically, supermarkets, convenience stores, small grocery stores, and limited-service restaurants) were obtained from commercial sources and geocoded to develop proximity measures. A simplified social-ecological framework was used to conceptualize the multi-level the association between students' BMI and school proximity to food outlets and multivariate analyses were used to estimate this relationship controlling for student- and school-level factors. Over twenty percent of the students were obese, compared to the national average at 17% (Ogden, Carroll, Kit, & Flegal, 2012). On average, students had 2.6 convenience stores, 2.9 limited-service restaurants, and 0.1 supermarkets within a quarter mile of their school. This study suggests that easy access to small grocery stores (which this study uniquely examines as a separate food outlet category) that offer healthy choices including five types of fresh vegetable, five types of fresh fruits, low-fat dairy, and lean meats is associated with lower BMI z score

and lower probability of being obese for middle and high school students. This suggests that improving access to such small food outlets may be a promising area for future investigation in obesity mitigation research. Also, this study separates students of pre-schools, kindergartens and elementary schools (neighborhood schools) from that of the middle and high schools (non-neighborhood) schools because the two groups of schools have different neighborhood characteristics, as well as open-school and bussing policies that result in different levels of exposure that students have to the food outlets around the schools. The result of this study suggests that the relationship between students' weight outcomes and food environment around schools is different in the two groups of schools.

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Chapter 1

INTRODUCTION

During the past thirty years, obesity rates have been on the rise in America, especially among children (Ogden, Caroll, & Flegal, 2008). According to the National Health and Nutrition Examination Survey 2009 – 2010, 17% of U.S. children and adolescents are obese (Ogden et al., 2012). This observation is of concern because childhood obesity is associated with health problems, such as Type II diabetes, headaches, depression, anxiety, musculoskeletal pain, and obstruction sleep-apnea symptoms (Bell et al., 2007; Dietz, 1998; Park, Falconer, Viner, & Kinra, 2012). Such a drastic increase in obesity rates among children and adolescents calls for serious efforts to mitigate childhood obesity.

To contribute to a more accurate understanding of how food environments around schools influence student obesity rates, I analyze data on over 30,000 K-12 students in 79 public schools located in four New Jersey cities. Student height and weight were professionally measured by school nurses. I examine several variables at the student and school levels in order to tease out the relationship between student obesity and school proximity to four different kinds of food outlets: supermarkets, convenience stores, limited-service restaurants, and small grocery stores.

Theoretical Background

I use a simplified social-ecological framework to explore the relationship between childhood obesity and food environments around schools. This is a multi-tiered framework that depicts childhood obesity from six nested perspectives of the society. It takes on childhood obesity from cultural, social, political, communal, and individual lens,

rather than the public health perspective alone. The framework was first used by the Institute of Medicine to describe the possible etiology of the childhood obesity epidemic, and also to lay the groundwork for future studies (Koplan, Liverman, & Kraak, 2005). It places childhood obesity in the context of multiple layers of influence, starting at the individual level and moving outward to factors such as the social and cultural norms and public policies that shape eating habits and other obesogenic behaviors (Figure 1).

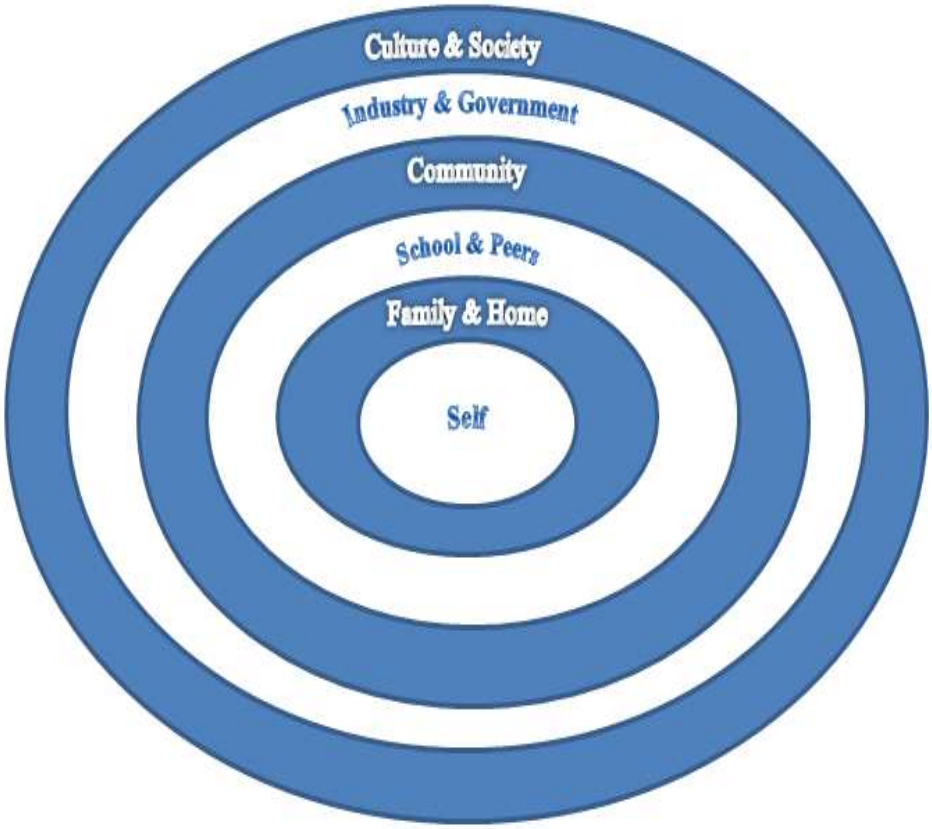

Figure 1. Simplified social ecological framework (Koplan et al., 2005)

The outermost layer of influence is the socio-cultural environment in which American children live. National Health and Examination Survey (NHANES) data indicate that roughly a third of American children between the ages of 6 and 18 are overweight, and half of those are obese (Ogden et al., 2006). The causes of the trend

towards increasing obesity are deeply imbedded in the current American culture and environment (Freeman-Fobbs, 2003).

The second tier of the framework represents industry and government as influences that can increase or reduce childhood obesity (Nestle, 2006). For example, in Australia, food advertisements aimed at children younger than 14 years old are illegal, and in the Netherlands, there is a legal ban on advertisements for sweets aimed at children younger than 12 (Nestle, 2006). Both policies are examples of how a government can regulate industry practices in order to deter obesity among children. The framework's first and second tiers place childhood obesity in the macro contexts of society, government, and industry, in order to help researchers and policy-makers identify policy interventions that might reduce or deter obesity.

The third tier of the social-ecological framework represents factors in the community food and recreational environments, and relevant food and exercise policies that are associated with childhood obesity. For community food environment, researchers have studied two kinds of community food environments, those around homes and those around schools. Although several scholars have studied the food environment around homes and its relationship to childhood obesity, findings have been mixed, and thus inconclusive. Many studies have concluded that neighborhood food environments influence children's weight status, with convenience stores, especially, contributing to childhood obesity (Forsyth, Wall, Larson, Story, & Neumark-Sztainer, 2012; Galvez et al., 2009; Laska, Hearst, Forsyth, K.E., & Lytle, 2010). However, Shier, An, and Sturm (2012) found no significant association between presence and number of various types of

food outlets and students' BMI percentile.[1] Similarly, Lee's (2012) study of family access to different food outlets found no association between the food environment around homes and childhood obesity.

The food environment around schools is the other part of the community tier of the social-ecological framework and the one that I examined in this study. Zenk and Powell (2007) were among the first to suggest that food environments around schools could play a pivotal role in curbing childhood obesity. Several recent studies have concluded that the food environment around schools can impact childhood obesity rates because students have easy access to food outlets located near their schools (Borradaile et al., 2009; Crawford, Gosliner, & Kayman, 2011; Howard, Fitzpatrick, & Fulfrost, 2011; Sturm, 2008). However, others found no association between food environment around schools and students' weight status (An & Sturm, 2011; Sanchez, Sanchez-Vaznaugh, Uscilka, Baek, & Zhang, 2012). Reasons for these inconclusive findings might include the use of self-reported and possibly inaccurate height and weight data (An & Sturm, 2011; Davis & Carpenter, 2009; Harris et al., 2011; Heroux, Iannotti, Currie, Pickett, & Janssen, 2012; Seliske, Pickett, Boyce, & Janssen, 2008), the use of unsuitable sample sizes (An & Sturm, 2011; Davis & Carpenter, 2009; Ellaway et al., 2012; Harris et al., 2011; Howard et al., 2011), and the lack of statistical inference beyond descriptive statistics to draw conclusions about the data (Day & Pearce, 2011; Gebaure & Laska, 2011)

The food environment around homes and schools is important in childhood obesity studies because people primarily select their foods from the choices easily

[1] BMI percentile is the percentile calculated from the CDC Growth Charts.

available to them, and the availability of healthy or unhealthy food at the community level consistently correlates with individual weight status. Studies using the bivariate K function have found clustering of food outlets around schools (Austin et al., 2005; "Common Core of Data (CCD) Public School Data 2006-2007 School Year," 2007; Ellaway et al., 2012), and this study hypothesizes that there is a relationship between the food environment around schools and the school-level characteristics.

The fourth tier of the social-ecological framework represents school and peer influences. It includes the in-school food environment, which affects student weight status because children spend half of their waking time at school (Crawford et al., 2011), and therefore have great access to the food in the schools. Research studies have found that higher BMI z-score[2] is linked to the availability of low-nutrient food, such as desserts and fried food, in school meals and vending machines (Fox, Dodd, Wilson, & Gleason, 2009). The in-home environment is the fifth tier of the social-ecological framework. In addition to the role of parental and siblings, household characteristics such as family socio-economic status have been shown to be associated with children's weight outcomes (Ellaway et al., 2012; Gebaure & Laska, 2011; Howard et al., 2011; Langellier, 2012), often finding that obesity is most prevalent in populations of low socioeconomic status (Schmeiser, 2009).

The innermost tier of the social-ecological framework represents influences that occur at the individual level. Research has identified many factors associated with childhood obesity rates at the individual level, and demographic and genetic factors are among the most common. Most studies of childhood obesity have considered only two or

[2] BMI z score is a number of standard deviations between observed BMI and the CDC Growth Charts' average BMI, where the standard deviation is measured from the CDC Growth Chart as well.

three factors. Some studies have found that children from racial and ethnic minorities are at highest risk for childhood obesity (Ogden et al., 2012). Others have analyzed childhood obesity in relation to children's genes, diet, or exercise, and proposed interventions to change children's diets or physical-activity levels (Poskitt, 2005).

I focus on the food environment around schools, which is part of the third (community) level of the SEM framework. While many studies have looked at food environment in students' home neighborhood (Lee, 2012) or children's own characteristics that relate to obesity (Poskitt, 2005), only recently have researchers begun to consider how the food environment *around* schools might influence obesity rates among children. Moreover, the results of studies of the food environment around schools have thus far been inconclusive, so more work is required.

To contribute to our understanding of how the food environments around schools affect children's weight status, this study targets four low-income cities in New Jersey – Camden, Newark, New Brunswick, and Trenton, and thus controls for many neighborhood-level socioeconomic characteristics. The study examines the relationship between obesity among public-school students and the food environments surrounding their schools. In these four cities, a majority of students walk to school (DeWeese, Yedidia, Tulloch, & Ohri-Vachaspati, forthcoming) and have plentiful access to food outlets around their schools. The study used nurse-measured data for students' heights and weights (instead of self-reported data which are known to be biased), and a large data set of almost 30,000 observations. Econometric methods were used to control for student-, school- and neighborhood-level characteristics.

Research Questions and Hypotheses

Because the simplified socio-ecological framework (Koplan et al., 2005) suggests that childhood obesity is associated with community-level, school-level and individual-level characteristics with findings from past studies indicating that being Black or Hispanic minorities are associated with more obese students (Langellier, 2012), and convenience stores and fast-food restaurants tend to cluster around schools (Ellaway et al., 2012), this study poses the following research questions and corresponding hypotheses to investigate the relationship between school-level characteristics and the food outlets around schools and the relationship between the food outlets around schools and students' weight outcomes.

Research Questions

1. *At the school level, how does student body's grade level, socioeconomic status and race or ethnicity correlate with the types of food outlets located near a school?*

    Hypotheses

    i. Limited-service restaurants and convenience stores are more likely to be located near schools where more than 50% of students are members of racial or ethnic minorities than near those with a lower proportion of racial or ethnic minorities.

    ii. Limited-service restaurants and convenience stores are more likely to be located near middle and high schools than elementary schools.

    iii. Limited-service restaurants and convenience stores are more likely to be located near schools where more than 75% of students are

eligible for free or reduced meals than near schools with a lower proportion of such students.

2. *How does students' weight status correlate with the proximity of their school to alternative food outlets (when controlling for student-, school- and neighborhood-level demographics)?*

    Hypotheses

    i. Student's weight status is positively associated with the proximity of limited-service restaurants and convenience stores to the schools the student attends and negatively associated with the proximity of supermarkets and small grocery stores to their schools.

CHAPTER 2

REVIEW OF RELEVANT LITERATURE

Demographics

The literature examining the relationship between childhood obesity and demographic characteristics belong to the innermost layer of the simplified social ecological framework (Koplan et al., 2005). In the "Self" layer of the framework, most of the previous studies have used data about middle and high school students, and controlled for age, gender, and race/ethnicity at the student-level (Davis & Carpenter, 2009; Harris et al., 2011; Heroux et al., 2012; Howard et al., 2011). Researchers often collected demographic information from states' departments of education (Davis & Carpenter, 2009; Howard et al., 2011; Langellier, 2012; Sanchez et al., 2012), or from publicly administered surveys (Harris et al., 2011) such as the Health Behavior in School Aged Children Survey (Heroux et al., 2012). Researchers have found that the proportions of overweight and obese students are higher among Hispanic and Black populations than among other ethnic or racial groups (Langellier, 2012). Therefore, students' race/ethnicity is an important factor to include in the analysis of the study.

Socioeconomic Status

Previous research investigating the association between childhood obesity and socioeconomic status of the children's homes and their schools belong in the "School & Peers" and "Family & Home" layers of the simplified social ecological framework (Koplan et al., 2005). Researchers studying student obesity have typically used receipt of free or reduced-price lunch as a proxy for socioeconomic status for school based studies (Ellaway et al., 2012; Gebaure & Laska, 2011; Howard et al., 2011; Langellier, 2012).

Other proxies have included family car-ownership, computer ownership, whether or not the family takes a vacation (Heroux et al., 2012; Seliske et al., 2008), and parents' education level (Sanchez et al., 2012). Most studies in the U.S. have obtained school-level data on the proportion of students receiving free or reduced-price lunches from state departments of education, while studies outside the U.S. have acquired socioeconomic-status proxies from public surveys (Ellaway et al., 2012; Heroux et al., 2012; Seliske et al., 2008). Results of previous studies suggest that fast food outlets tend to cluster around populations with low socioeconomic status as indicated by proxies (Ellaway et al., 2012).

Food Environment around Schools

Food environments around schools are at the "Community" level of the simplified social ecological framework (Koplan et al., 2005), and they are pivotal in curbing childhood obesity because students spend half of their waking time at school (Crawford et al., 2011; Zenk & Powell, 2007). Prior to 2007, research on obesity among schoolchildren focused on the food environments *inside* of schools and neglected food environments *around* schools, to which students also have access (Zenk & Powell, 2007). Since 2007, a number of childhood obesity studies have examined the food environments surrounding schools.

Most of these studies have used one of two approaches. One approach considers the presence and density of convenience stores or fast-food outlets near schools (Davis & Carpenter, 2009; Day & Pearce, 2011; Ellaway et al., 2012; Gebaure & Laska, 2011; Heroux et al., 2012). The other uses a more comprehensive selection of stores—not only convenience stores and limited-service restaurants, but also grocery stores and full-service restaurants (An & Sturm, 2011; Howard et al., 2011). Most of these studies have

examined food outlets that are within one-quarter to one-half mile of the school by roadway distance, but Harris et al.'s study (2011) extended the zone of accessibility to two kilometers around schools, and Ellaway et al.'s study (2012) used Euclidian distance. Studies that use roadway distance assume that one-half mile equals a ten-minute walking distance and is therefore a reasonable accessibility range, but Ellaway et al. argued that the route which students take to food outlets cannot be controlled, and therefore using Euclidian distance is also valid. Most U.S. studies have obtained data on food-outlet locations from infoUSA or Dun and Bradstreet (Howard et al., 2011; Langellier, 2012; Sanchez et al., 2012). Studies outside the U.S. have used data from Yellow Pages websites (Heroux et al., 2012; Seliske et al., 2008).

To analyze data, previous studies have used the bivariate K function and found spatial clustering in the location of food outlets around schools (Austin et al., 2005; Ellaway et al., 2012). They have also used descriptive statistics (Day & Pearce, 2011; Gebaure & Laska, 2011; Howard et al., 2011), logistic regression (Davis & Carpenter, 2009; Harris et al., 2011; Heroux et al., 2012; Seliske et al., 2008), and ordinary least squares to find the relationship between racial/ethnic minorities and overweight/obesity (Davis & Carpenter, 2009; Howard et al., 2011; Langellier, 2012; Seliske et al., 2008). While some studies found no association between childhood obesity rates and food environments around schools (An & Sturm, 2011; Harris et al., 2011; Heroux et al., 2012), others concluded that more convenience stores and fast-food outlets are located near schools than full-service restaurants and supermarkets (Austin et al., 2005; Ellaway et al., 2012), and that the rate of student obesity is higher in schools located within one-

half mile of fast-food outlets than in those located beyond that distance (Davis & Carpenter, 2009).

Research studies have focused on many aspects of the relationship between environment and childhood obesity, from various perspectives. Some have examined obesity in contexts as large as the social or cultural environment of America (Freeman-Fobbs, 2003), while others have concentrated on individual children's demographic characteristics. Numerous studies have assessed the relationship between childhood obesity and food environments in and around homes (Forsyth et al., 2012; Galvez et al., 2009; Laska et al., 2010), or in school (Crawford et al., 2011; Fox et al., 2009). Only recently have researchers begun to focus on how the food environment *around* schools influences student obesity and overweight (Zenk & Powell, 2007). Currently, there is no consensus in the field about the relationship between food environment around schools and childhood obesity. Limitations, such as self-reported data, richness of the dataset and statistical methods that inadequately control for confounding influences at different levels of the social-ecological system all relate to the lack of the consensus. This study contributes to understanding that influence by identifying correlations between childhood obesity and the kind, number, and proximity of food outlets to public schools, while accounting for the clustering that may exist in the food outlets and the relationship between weight status and demographic and socioeconomic factors.

CHAPTER 3

METHODS

Data Sets

I use five data sets to explore the relationship between school obesity rates and the food environments surrounding 79 urban New Jersey public schools in the Camden, Newark, New Brunswick and Trenton school districts. One student-level, two neighborhood-level, and two school-level datasets were used, with food environment being measured by the distance, presence, and counts of four kinds of food outlets around schools.

Student-level dataset: New Jersey Childhood Obesity Study (NJCOB)

The student-level data set includes students' height, weight, age, grade, race, and gender, as measured and recorded by school nurses. This data are available because New Jersey's State Board of Education (*Administrative Code Chapter 16 Programs to Support Student Development*, 2007) requires schools to measure students' height and weight in grades K through 12. The NJCOB research team obtained de-identified data on student height, weight, gender, race, date of birth, and date of measurement from public schools in each of the four study cities. School nurses weigh and measure children once during the school year. Most of the students from the public schools in Camden, New Brunswick and Trenton were measured, except for the ones that were absent at the time of measurement. There are close to 100 public schools in Newark – many more than any of the other three cities. Therefore, to minimize the burden on Newark Public School District, data are collected from a random sample of 25 schools. Using these data, the following variables are constructed and used in the present analysis:

Table 1. Variables from Student-level Data

Variables	Variable Definition
bmiz	a continuous variable indicating each student's BMI z score
Obese	a dichotomous variable indicating whether a student is obese or not; = 1 if obese
Female	a dichotomous variable indicating the gender of a student; = 1 if female
Age	a continuous variable indicating student's age
StudentRace	A categorical variable indicating student's race; = 1 if African American, = 2 if Hispanic, =3 if Other, and = 4 if Caucasian.

Body Mass Index (BMI) is a measure of body composition derived from a person's height and weight, and it is calculated as the quotient of a person's weight (in kilograms) over the square of their height (in centimeters). A healthy adult's BMI should range between 18.5 and 25; a score of 30 or over indicates that the adult is obese. However, because the amount of body fat on a child differs by age and gender, strict BMI cutoffs cannot be used to evaluate children's weight status. Thus, BMI percentile and BMI z score are often used as weight indicators for children. BMI percentile is the percentile in the population corresponding to a particular BMI level. BMI z score is the number of standard deviations away from the U.S. national average BMI, where the standard deviation comes from the reference U.S. population, not the sample. The BMI z scores used in this study were the z scores from the 2000 Center for Diseases Control and Prevention (CDC) Growth Charts, not from the sample population of the students in 82 New Jersey schools. To produce the 2000 CDC Growth Charts, the National Center for Health Statistics (NCHS) used a reference group of students from five cross-sectional health examination surveys and many supplementary surveys that were nationally representative to revise the 1977 CDC Growth Charts. The 2000 CDC Growth Charts account for children's gender- and age-specific weight, height, and stature growth, and therefore their BMI z scores. The BMI z scores from the 2000 CDC growth charts are also transformed using the Box-Cox transformation, and thus the BMI z scores in the

2000 CDC Growth Charts have a standard normal distribution (Kuczmarski et al., 2002). The age- and gender-controlled height and weight data in this study are compared to the normally distributed CDC BMI z scores.

To test the validity of BMI z scores as a measure of weight status in children, a clinical study used BMI z score, weight, and weight z-score as measures of weight status for 92 obese children (Hunt, Ford, Sabin, Crowne, & Shield, 2007). The study concluded that BMI z scores have the best linear relationship with fat percentage when compared to BMI and BMI percentile (Hunt et al., 2007).

The "obese" variable uses BMI percentile to indicate whether a student's weight status is obese or not. The CDC uses the 85^{th} percentile, conditional on age and gender, as the threshold at which a student is deemed to be overweight, and the 95^{th} as the one at which a student is deemed obese. This means that a student is considered overweight if his or her BMI is higher than 85% of students with the same age and gender in the population, and is considered obese if the BMI is higher than 95% of students of the same age and gender in the population. This study uses both BMI Z score and the obese weight status as dependent variables to find correlation between student weight status and the food environment around schools. Students' gender, age, and race/ethnicity are also recorded by school nurses, except in Newark, where race/ethnicity information is unavailable at the student-level.

School-level dataset: New Jersey Department of Education

The first school-level data come from the New Jersey Department of Education. The Department of Education collects annual student-enrollment data from schools. The data are available from the National Center for Education Statistics' web site ("Common

Core of Data (CCD) Public School Data 2006-2007 School Year," 2007), and include information on school name, ID, address, district, school type, grade level, and enrollment by demographic characteristics. This study uses school-level data on grade levels, school sizes, proportions of students receiving free or reduced meals, and numbers of students of a particular gender, race or ethnicity for 2008-2009. Table 2 shows the initial variables from this data set.

Table 2. Variables from School-level Data from the NJ Department of Education

Variables	Variable Definition
SchoolSize	The number of students in a school.
FreeReduced	The number of students receiving free or reduced meals in a school.
Asian	The number of Asian students in a school.
Black	The number of African American students in a school.
Hispanic	The number of Hispanic students in a school.
White	The number of Caucasian students in a school.
Grade	The grade levels included in the school.

From these initial variables, several categorical variations are constructed to account for a possible threshold effect in the initial variables. Table 3 shows the constructed variables.

Table 3. Constructed Variables Used in Regression

Variables	Variable Definition
PreKK	a dichotomous variable; = 1 if a school is a pre-school or kindergarten
Elementary	a dichotomous variable; = 1 if a school is an elementary school
Middle	a dichotomous variable; = 1 if a school is a middle school
High	a dichotomous variable; = 1 if a school is a high school
FreeReduced	The percentage of students receiving free or reduced meals in a school.
AsianP	The percentage of Asian students in a school.
BlackP	The percentage of African American students in a school.
HispanicsP	The percentage of Hispanic students in a school.
WhiteP	The percentage of Caucasian students in a school
Black Predominance	a dichotomous variable; = 1 if over 50% of students in a school are black
Hispanic Predominance	a dichotomous variable; = 1 if over 50% of students in a school are Hispanic
SchooSize Tercile	Terciles of the percentages of school size defined by the number of students in a school.
FreeReduced Tercile	Terciles of the percentages of students receiving free or reduced meals in a school.

The dichotomous variables indicating school category are generated based on the education levels offered in each school. Schools offering the majority of grade levels from 1 through 5 or 6 were classified as elementary schools. Schools offering mainly 9th through 12th grades are classified as high schools. Schools that offer grade levels between elementary school and high school are categorized as middle schools, and schools with grade levels kindergarten and below are categorized as pre-school and kindergarten.

The variables Black Predominance and Hispanic Predominance were constructed to indicate the predominance of a racial or ethnic group in a school. The categorical tercile variables (i.e., small, medium, large) are used to assess whether a threshold effect is present in the number of students in a school and the number of students receiving free or reduced meals.

Students from low-income families are eligible for a government program that provides free or reduced-price meals in schools. The proportion of students who participate in this program is often used as a negatively-correlated proxy for school-level socioeconomic status.

School-level dataset: GIS

Also, provided by the NJCOB research team, the second school-level data set used in this study is a purchased, commercial GIS dataset that included the locations of supermarkets, convenience stores, small grocery stores, and limited- and full-service restaurants within one-quarter, one-half, and one-mile radii of each school. Supermarkets are the grocery stores that make annual sales more than $2 million dollars. They are chain stores with 4 or more checkouts and offer many healthy and unhealthy food options. Small grocery stores are stores that make annual sales volume of $1 to 2 million dollars

that offer fewer options than supermarkets but have healthy options including five fresh fruits, five fresh vegetables, five low-fat dairy foods, and five lean meats. Limited-service restaurants require customers pay for their food before they dine (e.g., “fast food” outlets), while full-service restaurants provide the bill after customers finish their meals. The NJCOB research team (P. Ohri-Vachaspati et al., 2010) purchased data on the latitudes and longitudes of food outlets in Camden, Newark, New Brunswick, and Trenton, as well as within a one-mile zone around the city boundaries, from InfoUSA and Trade Dimensions. The Study research team used North American Industry Classification System codes and purchased data on supermarkets, grocery stores, convenience stores, specialty food stores, full-service restaurants, limited-service restaurants, and snack bars. The team then categorized food outlets as supermarkets, small grocery stores and specialty stores, convenience stores, or limited-service restaurants, using the data cleaning and classification methodology developed by Ohri-Vachaspati et al. (2011). They computed distance, presence, and number of food outlets from the geo-coded data (see Table 4). Presence is a binary variable indicating presence or absence of a type of food outlet, and distance and counts were continuous variables representing the number of feet from a school to the closest food outlet and the number of a given type of food outlet near schools, respectively. The presence of food outlets was measured in roadway distance and the count in Euclidian distance. The cutoffs of the presence and count variables are present at a quarter mile, a half mile, and a mile from schools. The cutoffs are constructed based on walkability, with the quarter mile cutoff being the most walkable for students and the mile cutoff being the least walkable.

Table 4. School-level Food Environment around School Data from InfoUSA

Variable	Variable Definition
dist_sup	The distance in feet from school's roadway entrance to its nearest supermarket.
dist_small grocery stores	The distance in feet from school's roadway entrance to its nearest healthy food outlet.
dist_lsr	The distance in feet from school's roadway entrance to its nearest limited service restaurant.
dist_convst	The distance in feet from school's roadway entrance to its nearest convenience store.
dist_parklg	The distance in feet from school's roadway entrance to its nearest large park.
nqtm_sup	The number of supermarkets within a quarter mile radius of schools.
nqtm_small grocery stores	The number of small grocery stores within a quarter mile radius of schools.
nqtm_lsr	The number of limited service restaurants within a quarter mile radius of schools.
nqtm_convst	The number of convenience stores within a quarter mile radius of schools.
nhfm_sup	The number of supermarkets within a half mile radius of schools.
nhfm_small grocery stores	The number of small grocery stores within a half mile radius of schools.
nhfm_lsr	The number of limited service restaurants within a half mile radius of schools.
nhfm_convst	The number of convenience stores within a half mile radius of schools.
nm_sup	The number of supermarkets within a mile radius of schools.
nm_small grocery stores	The number of small grocery stores within a mile radius of schools.
nm_lsr	The number of limited service restaurants within a mile radius of schools.
nm_convst	The number of convenience stores within a mile radius of schools.
presq_sup	The presence of supermarkets within a quarter mile radius of schools; = 1 if present
presq_small grocery stores	The presence of small grocery stores within a quarter mile radius of schools; = 1 if present
presq_lsr	The presence of limited service restaurants within a quarter mile radius of schools; = 1 if present
presq_convst	The presence of convenience stores within a quarter mile radius of schools; = 1 if present
presq_parklg	The presence of large parks within a quarter mile radius of schools; = 1 if present
presh_sup	The presence of supermarkets within a half mile radius of schools; = 1 if present
presh_small grocery stores	The presence of small grocery stores within a half mile radius of schools; = 1 if present
presh_lsr	The presence of limited service restaurants within a half mile radius of schools; = 1 if present
presh_convst	The presence of convenience stores within a half mile radius of schools; = 1 if present
presh_parklg	The presence of large parks within a half mile radius of schools; = 1 if present
presm_sup	The presence of supermarkets within a mile radius of schools; = 1 if present
presm_small grocery stores	The presence of small grocery stores within a mile radius of schools; = 1 if present
presm_lsr	The presence of limited service restaurants within a mile radius of schools; = 1 if present
presm_convst	The presence of convenience stores within a mile radius of schools; = 1 if present
presm_parklg	The presence of large parks within a mile radius of schools; = 1 if present

Neighborhood-level dataset: Census Tract

The neighborhood-level data come from the U.S. Census Bureau (Table 5). It was included in this study because, according to Koplan et al.'s Social Ecological Framework (Koplan et al., 2005), the demographic characteristics, socioeconomic factors and food environments around schools and homes affect health outcomes. Due to the lack of data on food environments around students' homes, this study used Census data to control for the omitted variable bias that could arise from the lack of information about the demographic and socioeconomic characteristics in the neighborhood where the students live, as well as the food environments around homes. The Census Bureau records information from every census tract in the counties of Camden (for Camden city), Essex (for Newark), Middlesex (for New Brunswick), and Mercer (for Trenton), and these data include census tract-level population, racial composition, median household income, educational attainment, and poverty status. This study used tract-level data because there is no consistently reliable information on the size of schools' attendance zones, and the population in census block-groups indicates that the block-group resolution may be too spatially fine to capture schools' attendance zones.

Table 5. U.S. Census Bureau Tract-level Data

Variable	Variable Definition
Pop	Total population in a tract
TotalHH	Total number of household in a tract
medincome	Median household income in a tract
hisp	Percentage of Hispanics in a tract
nhblack	Percentage of non-Hispanic blacks in a tract
nhwhite	Percentage of non-Hispanic whites in a tract
nhother	Percentage of non-Hispanic others in a tract
belowpov	Percentage of population below poverty in a tract
belowHS	Percentage of population with less than a high school education or equivalent in a tract
HS	Percentage of population with a high school education or equivalent in a tract
someColl	Percentage of population with some college education or equivalent in a tract
BachAdv	Percentage of population with a college education or above in a tract

Neighborhood-level dataset: AGS Crime Data

The final data set used in the study is a census block-group-level crime index data set purchased from Applied Geographic Solutions (AGS). Researchers at Arizona State University used the FBI's Uniform Crime Report data from 1998 to 2006, which included about 16,000 law enforcement jurisdictions and over 65 Census socioeconomic characteristics, to impute block-group-level personal and property crime indices (Table 6). It is possible that students are less likely to walk on the streets in higher crime areas, thereby obtaining less physical exercise while potentially having less access to food outlets around their schools. However, because the AGS crime data is imputed and includes over 65 Census characteristics, it is primarily used here to account for the unobserved aspects of school neighborhoods that are not directly accounted for with the tract level Census data.

Table 6. Applied Geographic Solutions Data at Census Block-group Level

Variable	Variable Definition
crimeTotal	Total crime index in a block group
crimePers	Personal crime index in a block group
crimeProp	Property crime index in a block group

Variables Used for Analysis

This study uses student BMI z scores and a dichotomous variable indicating obese weight status (BMI 95th percentile and above) as dependent variables. Student BMI z scores are based on CDC BMI z scores, which are stratified based on student age and gender.

The dichotomous obese variable is created by matching students' BMI from nurse-measured heights and weights with the 95th percentile (or above) of the CDC's age-

and gender-specific BMI percentile chart. By using this variable as the dependent variable in a linear regression, we examine the probability of a student being obese based on the incremental change in the independent or control variables.

The primary independent variables are the food outlet proximity measures: 1) presence within a quarter mile of the school, 2) counts within a quarter mile of the school, and 3) distance (in 1000 feet) from the school to the nearest food outlet. The presence variable accounts for the availability of food outlets within a quarter mile of schools because a quarter mile is considered walkable for the students. It identifies whether students have access to food outlets close to their schools. The counts variable measures the degree to which students have access to the food outlets that are located within a quarter mile of their schools. The presence, counts and distance variables together form the proximity measures the 79 New Jersey school sin the study to limited-service restaurants, convenience stores, small grocery stores, and supermarkets.

There are five levels of control variables in the study: student, school, census block, census tract, and city. Student-level control variables included the age and gender for all students, and race/ethnicity for non-Newark students. Age and gender were included in the analysis because they allow for the BMI z scores and percentiles to vary with them systematically. Some age and gender groups in the sample may be systematically heavier/lighter than others relative to their respective comparison group in the population. Race/ethnicity variables were important because past studies have shown that racial and ethnic minorities tend to have higher rates of overweight or obese cases among their student populations than do non-minorities (Howard et al., 2011).

School-level control variables include the number of students in a school by terciles as dummy variables and the proportions of students receiving free or reduced-price meals. The number of students in a school was controlled for by tercile dummy variables because this allows for a non-constant effect of school size on students' BMI z score or obese weight status. By using terciles of school size, schools can be classified into large, medium and small schools, which may help interpret the results of the relative effect of school size. The proportion of students receiving free or reduced-price meals was used as the proxy for school-level affluence. However, it may not fit well with the definition of a proxy, since a valid proxy should not play a direct role in the results of the regression other than through the variable that it proxies for (Wooldridge, 2002). In this study, the proportion of students receiving free or reduced-price meals not only serves as a proxy variable for socioeconomic status, but it also indicates a level of nutrition that students should have received from at least one of their daily meals. Therefore, the single proxy indicates dual conditions; while a high proportion of students receiving free or reduced-price meals is likely to positive correlate with high BMI z scores, the same proportion may also indicate that many students are securing a more nutritious diet than they would if they were not in the meal program, potentially indicating a negative correlation of BMI z score and the proportion of free or reduced-price meals. Therefore, the proportion of students receiving free or reduced-price meals must be interpreted in light of this variable's dual role as a proxy for socioeconomic status and as a policy variable targeted at childhood nutrition.

Block-group- and tract-level control variables are the census block-group-level imputed total crime index and the census tract-level demographics variables. Although

imputed, the crime index consisted of over 65 block-group-level socioeconomic characteristics; thus, it was included to help account for the any unobservable effects that other control variables failed to adjust for, such as the food environment around students' homes. It may also control for the effects of crime on the tendency of students to engage in physical exercise outside. The census tract-level variables include the total population and households of the tract where the school is located; the proportions of Hispanics, non-Hispanic blacks, and non-Hispanic others; and the proportions of population with educational attainment from less than high school to some college education. Census tract-level controls were used instead of block-group-level controls because a block-group is likely too small to capture the attendance zones of schools. Without reliable data on the size of the schools' attendance zones, this study assumed that census-tract data would capture neighborhood effects better than census block-group data when examining the relationship between school-level food environment and student-level BMI z scores and weight status.

The fifth-level control variable was a dummy variable for the city in which the school was located: Camden, Newark, New Brunswick, or Trenton. The city control variable was used to explain any additively separable effect that unobserved difference in the cities might have on students' BMI z scores and weight statuses.

CHAPTER 4

RESULTS

Descriptive Statistics

In the student-level data set, there were 28,022 students, with 4,379 in pre-schools or kindergartens, 12,360 in elementary schools, 6,017 in middle schools, and 5,266 in high schools. Table 7 shows the student distribution by school level, city, gender, and race.

Table 7. Percentage of Students in each City, Gender, and Racial Group*

	Pre-school & Kindergarten	Elementary School	Middle School	High School	Total
Camden	35.37	33.75	35.55	27.14	33.14
Newark	20.35	27.9	32.47	42.92	30.58
New Brunswick	25.12	9.17	4.32	16.29	11.96
Trenton	19.17	29.17	27.65	13.65	24.33
Sum	**100**	**100**	**100**	**100**	**100**
	Pre-school & Kindergarten	Elementary School	Middle School	High School	Total
Female	51.31	50.49	50.29	46.7	50.15
Male	48.69	49.51	49.71	53.3	49.85
Sum	**100**	**100**	**100**	**100**	**100**
	Pre-school & Kindergarten	Elementary School	Middle School	High School	Total
Black	40	48.55	50.31	53.89	48.21
Hispanic	57	48.43	45.62	43.58	48.63
White	1.11	1.39	1.69	0.68	1.86
Other	1.86	1.62	2.38	1.86	1.29
Sum	**100**	**100**	**100**	**100**	**100**

*Race of Newark students not included in calculation

The majority of students in the study are from Camden and Newark. Because student-level race data are not available for Newark students, the student-level race percentages displayed in Table 7 are for non-Newark students only. The gender composition is roughly even for all school levels.

As shown in Table 8, the mean of students' BMI z scores was about 0.7-0.8, which is much larger relative to the baseline z-score in the population of 0. This observation indicates that the students in this study are heavier than typical students in the population. The median of the students' BMI z scores was about 0.8 for all school levels, which confirms the observation from the mean that the majority of the students were overweight.

Table 8. Summary Statistics of Student BMI z scores by School Levels

School level	Mean	S. D.	25th %-tile	Median	75th %-tile
Pre-school & Kindergarten	0.730	1.154	0.036	0.784	1.559
Elementary School	0.775	1.120	0.034	0.823	1.654
Middle School	0.859	1.046	0.151	0.924	1.692
High School	0.762	1.040	0.065	0.766	1.551
All School-Levels	0.784	1.096	0.063	0.829	1.634

Table 9 shows that about 22 to 27% of the total student body at all school levels in all cities was obese. This finding agrees with the findings from analysis of BMI z scores. Compared to the national statistics of children from 2 through 19 years old in 2009 to 2010 which contained roughly 16% of obese students, this study has more obese students than the national study (Ogden et al., 2012).

Table 9. Percentage of Obese Students by School Level and City

	Pre-school & Kindergarten	Elementary School	Middle School	High School
Obese	22.76	25.26	26.56	22.48
	Camden	Newark	New Brunswick	Trenton
Obese	22.48	24.39	26.43	26.94

Further confirmation that students in this study were heavier than average is provided by comparing the histogram of the BMI z scores found in this study with the standard normal curve (Figure 3). Figure 3 demonstrates that not only are the BMI z

scores of students in this study is higher than the national study, it also shows that the distribution of BMI z scores in this study is skewed right.

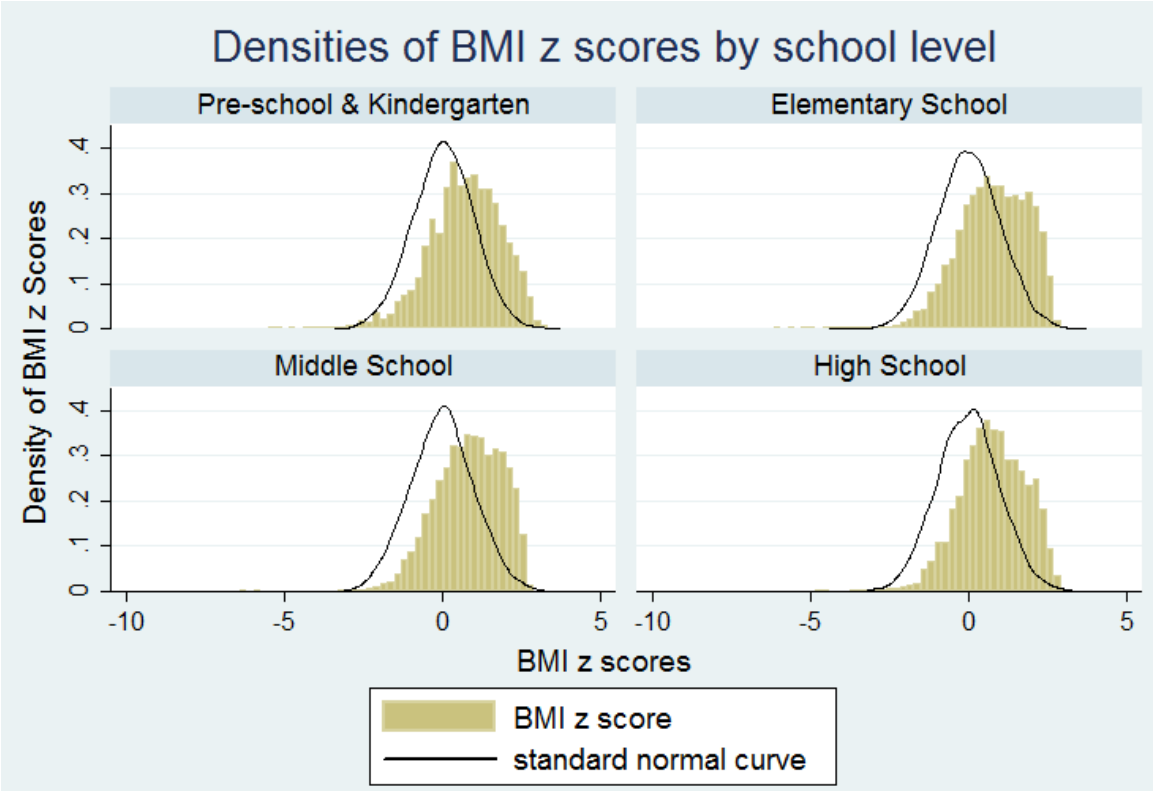

Figure 2. Distribution of BMI z scores by school level.

Among the 79 schools in the study, 27 were in Camden, 23 in Newark, 9 in New Brunswick, and 20 in Trenton. Just over half the schools (51%) have predominantly African American student populations, and 41% have predominantly Hispanic student populations with predominance defined as more than half of a school's population.

Figures 3-6 display the distances to food outlets from schools, and the number of food outlets within given distances. Supermarkets, not surprisingly, are the most distant from schools, and convenience stores are the nearest; given the relative number of these establishments we would expect this to be the case. Within a quarter mile from schools, limited-service restaurants are most abundant and supermarkets are the least abundant.

The same holds true for the abundance of outlets that are a half mile or a full mile from schools.

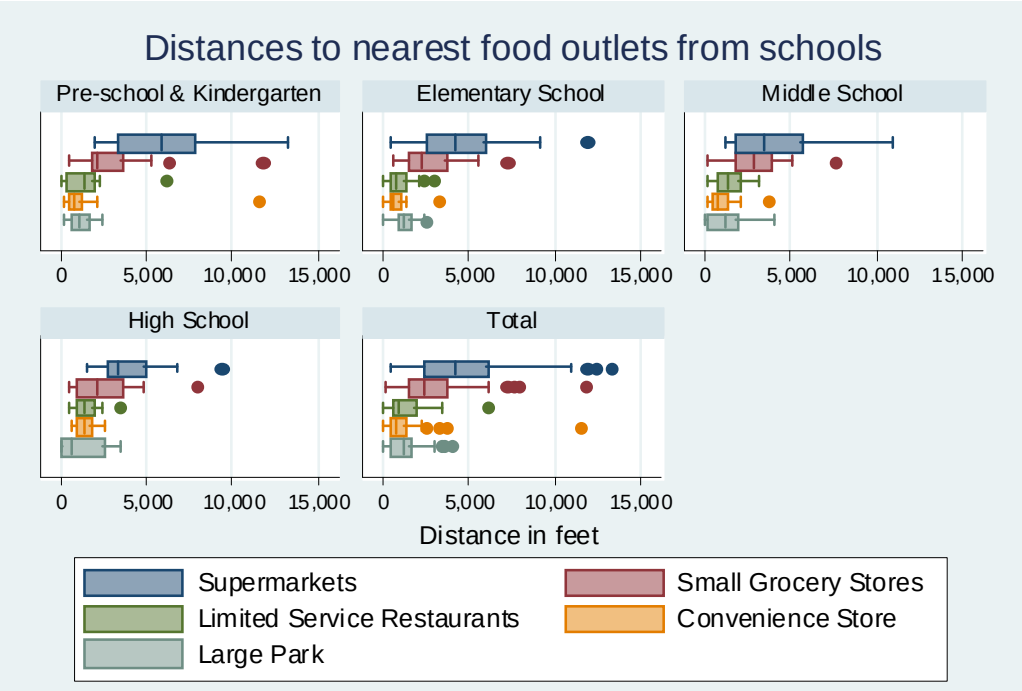

Figure 3. Distance to nearest food outlets from schools.

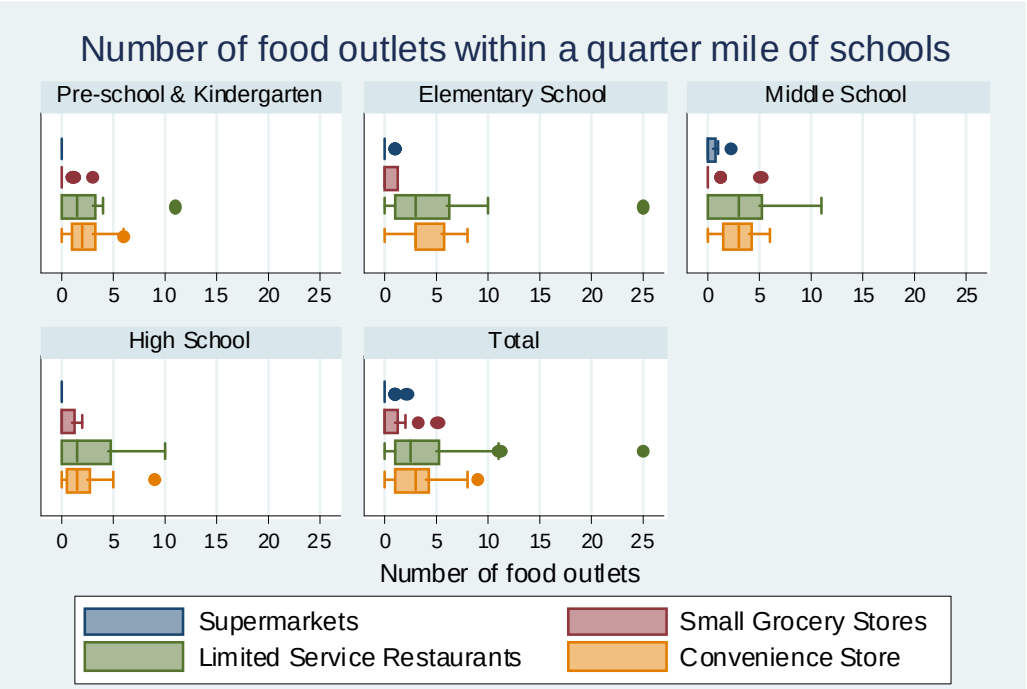

Figure 4. Number of food outlets within a quarter mile of schools.

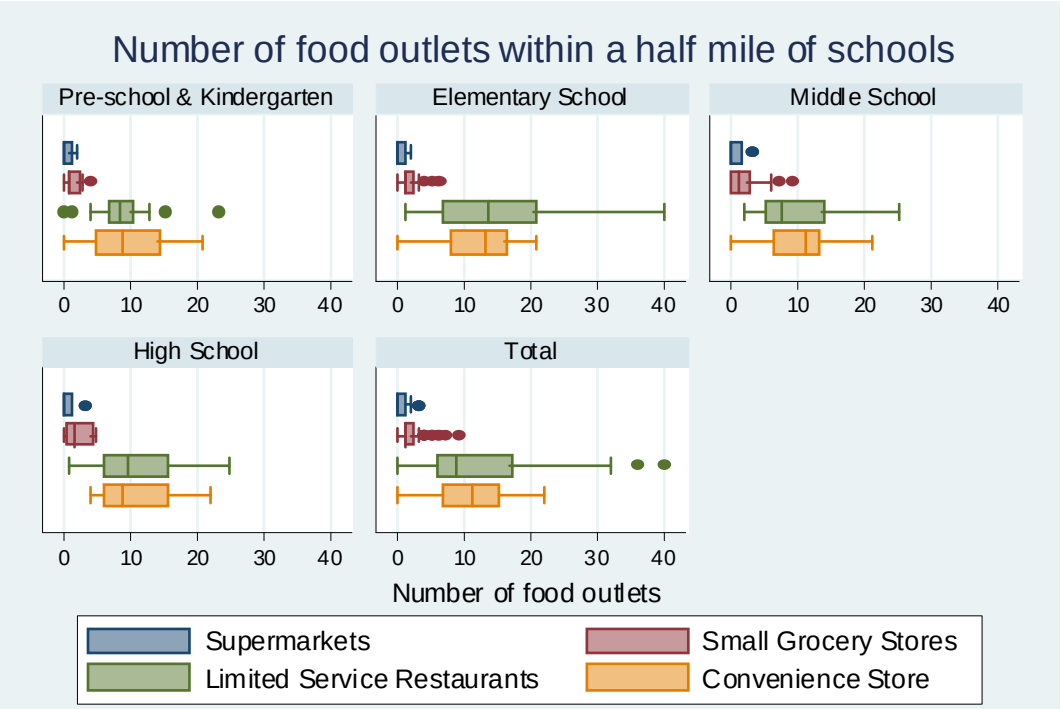

Figure 5. Number of food outlets within a half mile of schools.

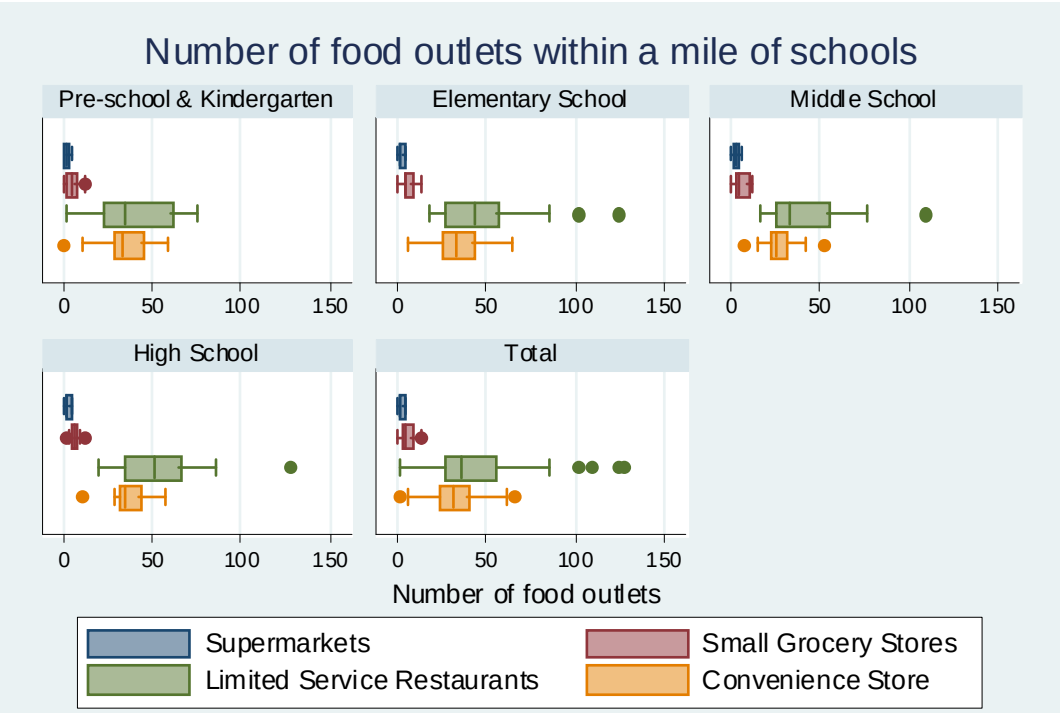

Figure 6. Number of food outlets within a mile of schools.

Below, Table 10 contains the amount of schools' exposure to the four types of food outlets. The "Presence" category displays the percentage of schools with at least one outlet within a quarter mile for the particular type of food outlet. The "Counts" category displays the average number of a particular type food outlet within a quarter mile of the schools, and the "Distance" shows the average distance (in feet) of the schools to their nearest food outlets.

Table 10. Schools' Average Exposure to Food Outlets

	Pre-K, K & Elementary School				Middle & High School			
	LSR	Convenience Store	Small Grocery Store	Supermarket	LSR	Convenience Store	Small Grocery Store	Supermarket
Presence	65.7	88.4	18.5	5.4	67.8	69.4	21.9	7.5
Counts	3.4	3.5	0.5	0.2	3.5	2.7	0.5	0.1
Distance (in ft.)	1139.6	947.1	2823.1	4809.3	1172.8	1146.9	2782.9	3803.3

	Overall			
	LSR	Convenience Store	Small Grocery Store	Supermarket
Presence	66.6	80.6	19.9	6.3
Counts	3.5	3.1	1.0	0.4
Distance (in ft.)	1153.1	1028.6	2806.7	4398.8

In the 79 census tracts containing the schools in this study, population ranged between 948 and 8,021. Most of the tracts are highly segregated tracts with high Hispanic and black populations, and high proportions of the population with incomes below the poverty line (see Figure 7).

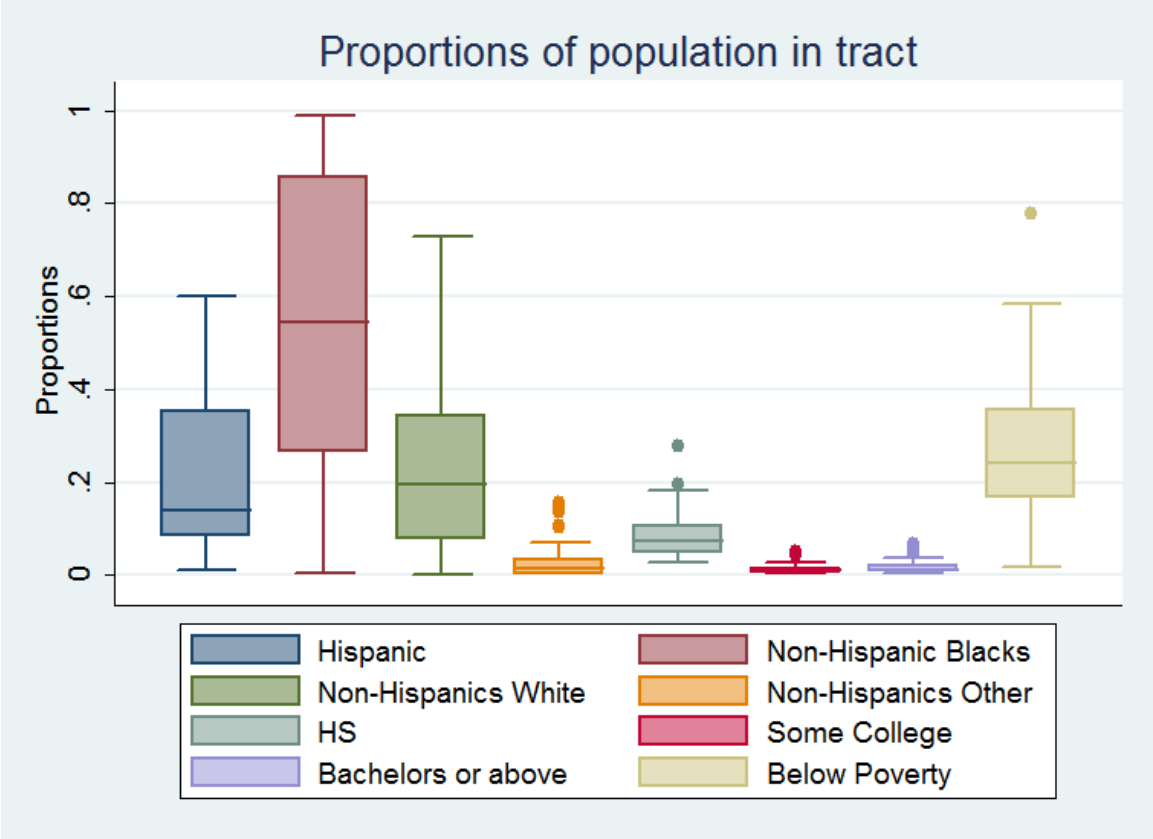

Figure 7. Census-tract population characteristics.

Analysis of Research Question 1

To examine the hypotheses of the first research question which looks at the relationship between the proximity of food outlets to the schools and schools' demographic and socioeconomic factors, this study uses linear regressions with robust standard errors to control for heteroskedasticity (Wooldridge, 2002). The linear regressions use one of the proximity measures of a chosen type of food outlet as the dependent variable and schools' demographic and socioeconomic information as independent variables. The regressions also control for school size and neighborhood-level demographics because food outlets may be less likely to be located near small schools and thus confound the relationship between proximity of food outlets with schools' demographic and socioeconomic characteristics. Neighborhood-level

demographics are controlled because neighborhood characteristics may influence the location of food outlets. Furthermore, because lower grade-level schools and higher grade-level schools have different exposure to the surrounding food environment due to the incidence of walking, bussing, freedom to eat off campus, this study conducts the analysis for the two age-groups separately. Based on evidence from research (discussed in Chapter 2), we expected the limited-service restaurants and convenience stores to be in closer proximity with schools that have predominantly Hispanic or Black student populations (Langellier, 2012; Sanchez et al., 2012).

Tables 11-13 present the results of the linear regressions examining the relationship between the proximity of food outlets to the schools and schools' demographic and socioeconomic factors. They only provide the essential results, and the complete tables are in the Appendices. Table 11 presents the results of the relationship between the presence of food outlets within a quarter mile of schools and schools' demographic and socioeconomic characteristics. For pre-schools, kindergartens and elementary schools, proportions Black and Hispanic population in the census tracts positively correlate with the probability of having a small grocery store near the schools. For middle and high schools, having a predominantly Hispanic school negatively correlates with the probability of having a small grocery store near those schools, and the proportions of students receiving free or reduced meals positively correlates with the probability of having a supermarket near those schools.

Table 11. Association between Presence of Food Outlets within A Quarter Mile of Schools and Schools' Demographic and Socioeconomic Characteristics

Presence of food outlets within a quarter mile of schools								
Independent Variable	Pre-K, K & Elementary School				Middle & High School			
	LSR	Convenience Store	Small Grocery Store	Supermarket	LSR	Convenience Store	Small Grocery Store	Supermarket
Black Predominance	-0.333	0.042	-0.400	-0.386	-0.132	0.745	-1.397	-0.755
	(0.25)	(0.21)	(0.35)	(0.32)	(1.03)	(1.11)	(0.78)	(0.46)
Hispanic Predominance	-0.233	-0.005	-0.327	-0.391	-0.294	0.575	-1.0964*	-0.613
	(0.23)	(0.15)	(0.35)	(0.32)	(0.60)	(0.69)	(0.45)	(0.30)
Free and Reduced Meals	-0.350	0.594	-0.749	0.749	-1.825	1.159	-0.134	1.8672*
	(1.17)	(0.54)	(0.74)	(0.53)	(2.13)	(1.27)	(1.63)	(0.80)
BG Crime	0.000	0.000	0.001	0.000	0.000	0.001	0.000	0.000
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tract Black	0.961	0.145	1.9509***	0.110	-1.053	-1.837	1.912	0.895
	(0.66)	(0.32)	(0.53)	(0.37)	(2.16)	(2.21)	(1.67)	(0.96)
Tract Hispanic	1.307	0.176	3.8013***	0.179	-0.706	-0.891	3.042	1.277
	(0.95)	(0.49)	(0.70)	(0.42)	(2.64)	(2.51)	(1.64)	(1.09)
R-Square	0.210	0.565	0.580	0.368	0.551	0.573	0.647	0.710
Sample Size	49	49	49	49	30	30	30	30
Standard errors in parentheses				*p<0.05, **p<0.01,***p<0.001				

When looking at the relationship between the counts of food outlets within a quarter mile of schools and schools' demographic and socioeconomic characteristics, the relationship differs between the two categories of school levels in Table 12. There are no statistically significant results for pre-schools, kindergartens and elementary schools. For middle and high schools, having a predominantly Hispanic school negatively correlates with the probability of having a limited service restaurant near those schools, and the proportions of students receiving free or reduced meals positively correlates with the probability of having a supermarket near those schools.

Table 12. Association between Counts of Food Outlets within A Quarter Mile of Schools and Schools' Demographic and Socioeconomic Characteristics

Counts of food outlets within a quarter mile of schools								
Independent Variable	Pre-K, K & Elementary School				Middle & High School			
	LSR	Convenience Store	Small Grocery Store	Supermarket	LSR	Convenience Store	Small Grocery Store	Supermarket
Black Predominance	2.815	-0.512	-0.080	-0.340	-10.009	-2.123	-3.544	-0.160
	(2.87)	(1.21)	(0.30)	(0.30)	(6.73)	(4.07)	(2.02)	(1.09)
Hispanic Predominance	3.250	1.478	0.027	-0.414	-10.303*	-0.316	-3.165	-0.683
	(2.43)	(1.24)	(0.32)	(0.28)	(4.40)	(2.32)	(1.63)	(0.76)
Free and Reduced Meals	-11.116	-5.043	0.038	1.394	1.280	3.477	4.392	4.0091*
	(8.69)	(4.90)	(1.21)	(0.69)	(12.32)	(6.37)	(3.18)	(1.63)
BG Crime	-0.005	0.001	0.000	0.000	-0.002	0.001	0.001	0.001
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tract Black	-7.732	3.257	1.254	0.286	8.869	-0.159	3.352	-1.497
	(8.14)	(3.50)	(0.93)	(0.43)	(12.57)	(8.15)	(3.53)	(2.08)
Tract Hispanic	-7.972	4.306	2.554	0.399	18.129	-2.176	6.062	-0.225
	(11.74)	(5.23)	(1.40)	(0.58)	(15.92)	(9.63)	(4.11)	(1.92)
R-Square	0.457	0.370	0.374	0.335	0.609	0.613	0.639	0.708
Sample Size	49	49	49	49	30	30	30	30
Standard errors in parentheses				*p<0. 05, **p<0.01,***p<0.001				

As seen below in Table 13, when using the distance (in feet) to the nearest of food outlets of the schools as the dependent variable, the percentages of Black & Hispanic population in census tracts negatively correlates with the distance to the nearest small grocery store and supermarkets for both categories of education levels. For the middle and high schools, all statistically significant results are in the small grocery stores, and predominantly Black or Hispanic school positively correlates with the distance to the nearest small grocery store, and yet the tract-level racial/ethnic minorities negatively correlate with the nearest small grocery store.

Table 13. Association between Distance (in feet) to the Nearest Food Outlet to the Schools and Schools' Demographic and Socioeconomic Characteristics

Distance (in feet) to the nearest food outlet from the schools								
Independent Variable	Pre-K, K & Elementary School				Middle & High School			
	LSR	Convenience Store	Small Grocery Store	Supermarket	LSR	Convenience Store	Small Grocery Store	Supermarket
Black Predominance	-307.7	-815.3	-617.2	1074.9	477.3	2232	14617.4**	-4497.3
	(867.0)	(1,523.0)	(1,596.0)	(1,989.0)	(1,955.0)	(1,817.0)	(4,158.0)	(6,172.0)
Hispanic Predominance	-240	-1524.4	-1020.3	1946.3	341.7	1487.5	9822.5**	-272
	(859.0)	(1,540.0)	(1,480.0)	(1,991.0)	(1,187.0)	(1,070.0)	(2,536.0)	(4,083.0)
Free and Reduced Meals	312.8	885.1	867.9	-8050.8	1398.2	1166.1	2721.3	-8821.6
	(1,902.0)	(2,140.0)	(3,148.0)	(4,873.0)	(3,774.0)	(2,600.0)	(4,476.0)	(7,963.0)
BG Crime	0.1	0.854	-0.0112	6.304**	-0.0718	-0.268	2.485	-0.982
	(0.8)	(0.9)	(1.7)	(1.9)	(1.6)	(1.2)	(2.0)	(2.2)
Tract Black	-2694	-5160.8	-7630.6*	-10645.1*	853	-2623	-22160.1*	15935.9
	(1,801.0)	(3,454.0)	(3,653.0)	(4,209.0)	(3,889.0)	(3,482.0)	(7,652.0)	(10,445.0)
Tract Hispanic	-4214	-6313.6	-14001.6**	-18179.3**	-419.2	-4102.7	-22492.1**	10377.1
	(2,460.0)	(4,566.0)	(4,882.0)	(5,999.0)	(4,495.0)	(3,910.0)	(6,818.0)	(13,048.0)
R-Square	0.365	0.562	0.451	0.605	0.421	0.579	0.794	0.719
Sample Size	49	49	49	49	30	30	30	30
Standard errors in parentheses				*p<0.05, **p<0.01,***p<0.001				

Overall, the relationship between the proximity of food outlets and schools' demographic and socioeconomic characteristics differs between the two categories of school levels, and most of the significant results occur in the linear regressions using proximity measure of small food outlets as the dependent variable. Overall, when using linear regressions to examine the hypotheses corresponding to the first research question, most of the statistically significant results occur when using the proximity measures of small grocery stores to the schools as dependent variables, and the results are different in the neighborhood schools and non-neighborhood schools.

Analysis of Research Question 2

To examine the hypothesis of the second research question which looks at the relationship between the proximity of food outlets to the schools and students' weight

outcomes, this study uses random effects models with heteroskedasticity-robust standard errors. Random effects is a type of econometric model that accounts for unobserved heterogeneity in a sample when the errors are assumed to have an additive component that is shared in common between clusters and another additive component that is independent across observations (Wooldridge, 2002).

Due to the lack of student-level race data from Newark, the random effect model is not only applied separately for the younger students (kindergarten, pre- and elementary school students) and the older students (middle and high school students) with no student-level race, but also conducted separately for non-Newark schools with and without student-level race as controls. The purpose is to consider whether the exclusion of student-level race information alters the models' results on the relationship between childhood obesity and food outlets around schools. The random effect models suggest that although student-level race variables are almost always statistically significant when they are included in the model, the models' results do not change. Therefore, adding the student-level race variables adds explanatory power to the models without altering the results.

When conducting the random effect models, the dependent variable is either students' BMI z score, or a dichotomous variable indicating whether a student is obese or not. The independent variables are the proximity measures of the food outlets for all four types: the presence of food outlets within a quarter mile of schools, the counts of food outlets within a quarter mile of schools, and the distance (in 1000 feet) to the nearest food outlet from schools. Each random effect model includes only one type of proximity measure. The control variables are the student-, school-, and neighborhood-level

demographics and socioeconomic characteristics. The results of the analysis are reported in Tables 14-17 by types of food outlets.

The results of the relationship between the proximity of convenience stores and students' weight outcomes are presented below in Table 14. There is no statistically significant information from the presence of convenience stores within a quarter mile of schools, but there are statistically significant results from the counts of convenience stores within a quarter mile of schools. For non-Newark kindergarten, pre- and elementary school students, one additional convenience store within a quarter mile of their schools would significantly increase the students' BMI z score by about 0.03. It would also increase the probability of being obese by 0.622 for the non-Newark kindergarten, pre- and elementary school students when students' race variables are not included in the model. However, the results of the relationship between students' weight outcomes and counts of convenience stores within a quarter mile of middle and high schools are the opposite of the results for the younger students. For middle and high school students, having one additional convenience store within a quarter mile of middle or high schools in non-Newark cities would decrease students' probability of being obese by 0.9 without including student-level race variables and by 1 when they are included.

As for the using the closest distance from school to a convenience store as the proximity measure, it is negatively statistically significant in its relation with BMI z scores for all middle and high school students with or without Newark students, and obese weight status with kindergarten, pre- and elementary school students when Newark students are included. Generally, the statistically significant coefficients of the distance measure are very small. Overall, the count of convenience stores within a quarter mile of

schools is the best of the three proximity measures in its ability to explain the relationship between students' weight outcomes and proximity to food outlets around schools.

Table 14. Model Results of Proximity of Convenience Stores with BMI Z Score and Dichotomous Obese Weight Status

Convenience Stores Results Comparison: Race VS No-Race for All & Non-Newark Students							
Independent Variable	Dependent Variable	Pre-K, K & Elementary School			Middle and High School		
		All	Non-Newark		All	Non-Newark	
			No Race	With Race		No Race	With Race
Presence	BMI Z Score	-0.0821	-0.0254	-0.0459	-0.0143	0.0272	0.0101
		(0.0689)	(0.0709)	(0.0629)	(0.0550)	(0.0476)	(0.0521)
	Obese	-0.00494	0.00593	-0.00533	-0.0154	-0.0139	-0.0212
		(0.0164)	(0.0158)	(0.0123)	(0.0161)	(0.0180)	(0.0171)
Counts	BMI Z Score	0.025	0.0343**	0.0261**	-0.0108	-0.00736	-0.0134
		(0.0139)	(0.0114)	(0.0101)	(0.0099)	(0.0106)	(0.0109)
	Obese	0.00314	0.00622**	0.00257	-0.00234	-0.0089**	-0.010**
		(0.0025)	(0.0023)	(0.0021)	(0.0027)	(0.0033)	(0.0032)
Distance (in 1000 feet)	BMI Z Score	-0.0512	-0.00584	0.0194	-0.0001***	-0.0001**	-0.0001*
		(0.0263)	(0.0290)	(0.0282)	(0.0204)	(0.0332)	(0.0362)
	Obese	-0.00002**	-0.00922	0.000727	-0.0115	-0.0175	-0.0229
		(0.0054)	(0.0061)	(0.0059)	(0.0075)	(0.0155)	(0.0192)

The results of the relationship between students' weight outcomes and the proximity of limited service restaurants around their schools are displayed in Table 15 below. Again, there are no statistically significant results from the presence measure of proximity, and little significance from the distance measure of proximity. For the counts of limited service restaurants within a quarter mile of schools, having one additional limited service restaurant increases the probability of being obese by 0.4 for non-Newark middle and high schools. In contrast, one additional limited service restaurants within a quarter mile of kindergarten, pre- and elementary schools for non-Newark students decreases their BMI z score by 0.017 and probability of being obese by 0.44 when student-level race variables are considered. Overall, the number of limited service

restaurants within a quarter mile of schools is the best of the three proximity measures in terms of statistical significance.

Table 15. Model Results of Proximity of Limited Service Restaurants with BMI Z Score and Dichotomous Obese Weight Status

Limited Service Restaurants Results Comparison: Race VS No-Race for All & Non-Newark Students							
Independent Variable	Dependent Variable	Pre-K, K & Elementary School			Middle and High School		
		All	Non-Newark		All	Non-Newark	
			No Race	With Race		No Race	With Race
Presence	BMI Z Score	-0.0433	0.0807	0.0814	-0.0649	0.0251	0.0234
		(0.0590)	(0.0697)	(0.0611)	(0.0474)	(0.0541)	(0.0553)
	Obese	-0.0112	0.00806	0.00973	-0.00397	0.0133	0.0126
		(0.0123)	(0.0118)	(0.0079)	(0.0138)	(0.0187)	(0.0200)
Counts	BMI Z Score	-0.0022	-0.0151	-0.0165*	-0.00334	0.00823	0.0096
		(0.0096)	(0.0081)	(0.0073)	(0.0057)	(0.0050)	(0.0058)
	Obese	-0.0022	-0.00376	-0.00441*	-0.000709	0.00357*	0.00439*
		(0.0018)	(0.0020)	(0.0018)	(0.0017)	(0.0018)	(0.0019)
Distance (in 1000 feet)	BMI Z Score	0.0528	-0.0436	-0.0583	0.0966**	0.0838*	0.0895*
		(0.0323)	(0.0492)	(0.0465)	(0.0333)	(0.0373)	(0.0388)
	Obese	0.00704	-0.00631	-0.0133	0.0136	0.0161	0.0257
		(0.0072)	(0.0103)	(0.0093)	(0.0111)	(0.0174)	(0.0195)

For supermarkets (see Table 16), the presence variable is dropped for non-Newark cases because there are no supermarkets within a quarter mile of non-Newark schools based on roadway distance. For middle and high school students, the students of schools with a supermarket within a quarter mile have a lower BMI z score by 0.114. Furthermore, the presence of a supermarket within a quarter mile of school has a negative relationship with both of the dependent variables with all student age groups.

Using Euclidian distance, there are at most 2 supermarkets within a quarter mile of school. For all kindergarten, pre- and elementary school students, having one additional supermarket within a quarter mile of their schools negatively correlates with the probability of them being obese. For middle and high school students, the number of supermarkets within a quarter mile of their schools negatively correlates with the students' BMI z scores and their probability of being obese. There are no statistically

significant results from the distance proximity measure. Due to the lack of presence of supermarkets within a quarter mile of non-Newark schools and the lack of statistical significance of the distance measure, the number of supermarkets within a quarter mile of schools is likely the most reliable of the three proximity measures.

Table 16. Model Results of Proximity of Supermarkets with BMI Z Score and Dichotomous Obese Weight Status

Supermarkets Results Comparison: Race VS No-Race for All & Non-Newark Students							
Independent Variable	Dependent Variable	Pre-K, K & Elementary School			Middle and High School		
		All	Non-Newark		All	Non-Newark	
			No Race	With Race		No Race	With Race
Presence	BMI Z Score	-0.0999			-0.114*		
		(0.0944)			(0.0564)		
	Obese	-0.013			-0.00088		
		(0.0251)			(0.0213)		
Counts	BMI Z Score	-0.0952	-0.0784	-0.0392	0.0405	-0.29***	-0.312***
		(0.0620)	(0.0848)	(0.0767)	(0.0918)	(0.0332)	(0.0371)
	Obese	-0.0457***	-0.041*	-0.0269	0.00883	-0.11***	-0.106***
		(0.0116)	(0.0201)	(0.0179)	(0.0238)	(0.0166)	(0.0161)
Distance (in 1000 feet)	BMI Z Score	0.00156	0.0106	0.00707	0.00345	0.0173	0.0196
		(0.0145)	(0.0149)	(0.0143)	(0.0100)	(0.0108)	(0.0118)
	Obese	0.00266	0.00416	0.00273	0.0011	0.00379	0.00612
		(0.0028)	(0.0025)	(0.0024)	(0.0037)	(0.0049)	(0.0062)

Table 17 shows arguably the most significant findings of the study, relating to the proximity measures of the small grocery stores, particularly for middle and high school students. For the presence of a small grocery store within a quarter mile of kindergarten, pre- and elementary schools, none of the model result is statistically significant for either student BMI z score or obese weight status. For middle and high school students, having a small grocery store within a quarter mile of their schools decreases their BMI z score by roughly 0.2, and decreases their probability of being obese by 0.04 to 0.06 depending on whether the student-level race information is included in the model.

For the counts of small grocery stores within a quarter mile of kindergarten, pre- and elementary schools, although it has a positive association with students' BMI z score

and weight status, it is only statistically significant for the model with non-Newark schools and student-level race control variables. For middle and high school students in Camden, Newark, New Brunswick and Trenton, having one additional small grocery store decreases students' BMI z score by 0.08 and students' probability of being obese by 0.02. For non-Newark middle and high schools with or without student-level race control variables, having one additional small grocery store decreases students' BMI z scores by about 0.15 and reduces their probability of being obese by roughly 0.03. This finding is encouraging because the number of small grocery stores within a quarter mile of schools traces a negative relationship with students' BMI z score and weight status.

Finally, using distance to the nearest small grocery store as the proximity measure, middle and high school students' BMI z score and weight status indicate that as the distance between school and the small grocery store increases, students BMI z score and probability of being obese also increases. The results indicate students' BMI z score and probability of being obese increase when the small grocery stores are located farther away from schools. Although the presence and counts of small grocery stores within a quarter mile of schools and the distance between the nearest small grocery store to the schools have an unclear relationship with kindergarten, pre- and elementary school students' BMI z score and probability of being obese, the three proximity measures of small grocery stores indicate that having small grocery stores near schools may exert a significant effect on childhood obesity at the middle and high school level.

Table 17. Model Results of Proximity of Small Grocery Stores with BMI Z Score and Dichotomous Obese Weight Status

Small Grocery Stores Results Comparison: Race VS No-Race for All & Non-Newark Students							
Independent Variable	Dependent Variable	Pre-K, K & Elementary School			Middle and High School		
		All	Non-Newark		All	Non-Newark	
			No Race	With Race		No Race	With Race
Presence	BMI Z Score	0.0206	0.0015	0.00765	-0.159***	-0.226***	-0.216***
		(0.0851)	(0.1060)	(0.0986)	(0.0341)	(0.0452)	(0.0490)
	Obese	-0.0142	-0.0223	-0.0196	-0.0460***	-0.0559**	-0.0629***
		(0.0153)	(0.0204)	(0.0166)	(0.0124)	(0.0182)	(0.0178)
Counts	BMI Z Score	0.0122	0.164*	0.188**	-0.0822**	-0.157***	-0.140***
		(0.0356)	(0.0680)	(0.0579)	(0.0309)	(0.0325)	(0.0375)
	Obese	0.00667	0.0201	0.0313**	-0.0168*	-0.0319*	-0.0344*
		(0.0060)	(0.0136)	(0.0104)	(0.0078)	(0.0136)	(0.0139)
Distance (in 1000 feet)	BMI Z Score	0.0165	-0.0192	-0.0217	0.0357***	0.0379***	0.0363**
		(0.0179)	(0.0237)	(0.0224)	(0.0064)	(0.0113)	(0.0118)
	Obese	0.0038	-0.0012	-0.00141	0.00648*	0.00887	0.0097
		(0.0038)	(0.0054)	(0.0049)	(0.0028)	(0.0050)	(0.0056)

CHAPTER 5

DISCUSSION

It was hypothesized from the first research question that limited service restaurants and convenience stores would be located in closer proximity with predominantly Hispanic and Black schools, middle and high schools, and schools with more than 75% students receiving free or reduced meals. The hypotheses were examined using linear regressions with heteroskedasticity-robust standard errors, and the results are different across the two categories of school-levels, often with statistically significant results in one group and not the other and the signs of regression coefficients are sometimes different for the same variable across the two categories. Also, most of the statistically significant results occur when using the proximity measures of small grocery stores as the dependent variable. This finding is different from previous research because past studies treat small grocery stores as part of convenience stores, instead of a separate category of food outlets. Although previous studies have separated middle and high school students from the younger students (Davis & Carpenter, 2009; Ellaway et al., 2012; Harris et al., 2011), they do not consider small grocery stores as an explicit food outlet category by itself. The results of this study is relevant for low-income communities because the data used in the study are from primarily poor neighborhoods, and the results suggest that future studies and policy interventions need to consider neighborhood and non-neighborhood schools separately, and the proximity of small grocery stores to schools could be the focus of future studies and policies.

For the second research question, it was hypothesized that students' weight status would be positively correlated with the proximity of limited service restaurants and

conveniences stores to their schools and negatively correlated with proximity of small grocery stores and supermarkets. This hypothesis is proven for the negative correlation between students' weight outcomes and the proximity of small grocery stores to their schools. The models relating the BMI z scores and weight status of the students with the presence of limited service restaurants or convenience stores within a quarter mile of the schools and nearest distance to schools do not have statistically significant results, and the results from models with counts of food outlets within a quarter mile of schools as independent variables yield opposite results for neighborhood and non-neighborhood schools. For supermarkets, one additional supermarket within a quarter mile of schools would decrease students' probability of being obese by 0.04 to 0.3 depending on students' education level. The number of food outlets within a quarter mile of schools appear to be the proximity measure with most of the significant results because the counts variables not only measures the existence of exposure that students have to the food outlets but also the degree of the exposure. The presence variables only indicate the existence of exposure, and the distance variables simply state the distance between schools and their nearest food outlet.

The most noteworthy result of this study is the relationship between middle and high school students' BMI z score/obese weight status and the proximity to small grocery stores around the schools. The statistically significant negative association between the students' BMI z score/obese weight status and the presence/counts of small grocery stores within a quarter mile of the schools is an important new finding. This is because in past studies, small grocery stores have been pooled with convenience stores and thus their unique effect has not been teased out (Day & Pearce, 2011; Ellaway et al., 2012; Harris

et al., 2011; Heroux et al., 2012; Howard et al., 2011; Sanchez et al., 2012). Thus, this finding suggests that future studies should consider small grocery stores as a distinct form of food outlets in their analysis. It is difficult to assess the effect of the availability and abundance of the small grocery stores around the schools on middle and high school students' BMI z score or probability of being obese decreases, because this study does not answer the question of whether students' BMI z scores or probability of being obese decreases because of the small grocery stores, or that the small grocery stores are located where the students are less heavy. Thus, longitudinal studies that assess the causal effect of proximity of the small grocery stores to the schools on middle and high school students' weight outcomes are needed. Also, if future studies confirm the negative correlation and large magnitude of the relationship between students' BMI z score and probability of obesity and schools' proximity to small grocery stores, policies that intend to lower childhood obesity in poor urban areas could be established if the cost of policy intervention is lower than the existing interventions that would achieve at least the current level of obesity reduction. Possible interventions include incentivizing the existing convenience stores to carry fresh produce or incentivizing the establishment of new small grocery stores.

In this study, omitted variable bias is a recurring problem due to the lack of more comprehensive data at the student-level and the information on students' in-home food environment and neighborhood food environment around their homes. The lack of information is evident in the three types of R^2 in the Random Effect models. In the Random Effect models, the Within R^2 which presents models' explanatory power at the student-level, and the Between R^2 which depicts the models' explanatory power at the

school-level. The Overall R^2 represents the model's explanatory power at both the student- and the school-level. In this study, the Within R^2 is much lower than the Between R^2. For example, using all middle and high school students' BMI z scores as the dependent variable and counts of food outlets as the independent variable, the Within R^2 for the regression is 0.004 and the Between R^2 is 0.4577, but the Overall R^2 is 0.0141 (see Appendix B). Because the computation of Overall R^2 includes both the Within R^2 and the Between R^2, the extremely low Within R^2 causes the low Overall R^2 in the models (Wooldridge, 2002). To avoid omitted variable bias, future cross-sectional studies should control for students' in-home food environment and neighborhood food environment around their homes. In the absence of such detailed student-level controls, longitudinal data with student-level fixed effect models could lessen the effect of omitted variable bias by allowing for the use of statistical techniques to control for unobserved but time-invariant aspects of student heterogeneity that contribute to weight outcomes. The food environment around schools and in-school food environment should be controlled at the student-level, in case students transfer to different schools. Also, accurate information on schools' attendance zones would be valuable to establish the geographical level of controls that are needed.

This thesis makes a number of contributions to the literature on the relationship between childhood obesity and the food environment around students' schools. First, the data used in the study was unique. Instead of using data on state- or city-wide samples (An & Sturm, 2011; Davis & Carpenter, 2009; Ellaway et al., 2012; Harris et al., 2011; Howard et al., 2011; Sanchez et al., 2012; Seliske et al., 2008), the study used data on tens of thousands of students in four low-income New Jersey cities. The choice of low-

income cities and the large size of the data set mean that study findings are likely to be generalizable to schools in other low-income urban areas (but should not be generalized to more affluent urban areas). The four low-income cities included in this study have a much higher proportion (around 22%) of the population with childhood obesity relative to the national average (around16%) (Ogden et al., 2012), thus these represent hot spots of obesity prevalence that need to be examined in depth. Using data from the four low-income cities also makes the study's results more reliable because they all have fairly consistent socioeconomic and geographic characteristics with each other, and thus the small inconsistencies can be absorbed into the intercept term of the regressions, instead of left unexplained in the error terms. Secondly, the study used five data sets that provided information on students, schools, the food environment around the schools, the demographics of the census tracts in which the schools were located, and other neighborhood variations that were not captured by the census tract data. Most previous research on the relationship of childhood obesity to the food environment around schools has not considered neighborhood factors at the census-tract or block-group levels (An & Sturm, 2011; Davis & Carpenter, 2009; Ellaway et al., 2012; Harris et al., 2011; Heroux et al., 2012; Howard et al., 2011; Langellier, 2012; Sanchez et al., 2012; Seliske et al., 2008). The tract- and block-group-level characteristics are important because neighborhood-level analysis is able to identify policy intervention points as it is related to the physical accessibility of the food environment. Thirdly, the study used nurse-measured student height and weight data, rather than self-reported survey data. Although nurse-measured data has missing observations due to random or systematic absence of students at the point of measurement, nurse-measured data are more accurate and help

address the issue of biases that occur due to people will over- or under-reporting their height and weight (Davis & Carpenter, 2009; Harris et al., 2011; Heroux et al., 2012; Seliske et al., 2008). The study's use of accurate and comprehensive data has contributed to the reliability of findings that promote the scholarly understanding of how food environments around schools affect childhood obesity rates among students in low-income urban areas.

Also, the study demonstrated that linear regressions and random effect models can be used to capture the relationship between students' BMI z scores or their obese weight-status and the food environments around their schools. Although linear regression has been a common approach used in obesity-related studies, random effect models have not. Random effect models were suitable for this study because they addressed the clustering around the schools that was present in the merged data.

Finally, it has been consistently observed in the results of this study that the relationship between students' weight outcomes and the food environment around the schools have distinct patterns in the neighborhood schools (pre-schools, kindergartens and elementary schools) and the non-neighborhood schools (middle and high schools). This result urges future studies to conduct separate analysis for the two school-level categories because students of different ages interact with the physical environment around their schools and homes differently, and the middle and high school students may be less a part of the food environment around their homes.

This study did not fully control for omitted variable bias in food environments in schools and around students' homes. Future research should conduct longitudinal studies that could better explain the causal effect between proximity of food outlets around

schools and students' weight outcomes, and could enhance understanding by controlling for the effects of in-school, in-home and neighborhood food environments when evaluating the effects of childhood obesity of food environment around schools. Also, accurate information on schools' open-school and bussing policies would be valuable to those studying around-school food environments in the future, because it would allow them to establish more accurate controls. At the geographical–level, collecting accurate schools' attendance zone data and separating the neighborhood schools from the non-neighborhood schools are critical in future data analysis because these measures helps to ensure accurate exposure of students from the food outlets around their schools.

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APPENDIX A

CORRELATION BETWEEN SCHOOL- AND NEIGHBORHOOD- LEVEL CHARACTERSITICS AND THE PROXIMITY MEASRUES OF FOOD OUTLETS

Distance (in feet) of food outlets								
Variables	Pre-School, Kindergarten & Elementary School				Middle & High School			
	LSR	Convenience Store	Small Grocery Store	Supermarket	LSR	Convenience Store	Small Grocery Store	Supermarket
Black Predominance	-307.7	-815.3	-617.2	1074.9	477.3	2232	14617.4**	-4497.3
	(867)	(1,523)	(1,596)	(1,989)	(1,955)	(1,817)	(4,158)	(6,172)
Hispanic Predominance	-240	-1524.4	-1020.3	1946.3	341.7	1487.5	9822.5**	-272
	(859)	(1,540)	(1,480)	(1,991)	(1,187)	(1,070)	(2,536)	(4,083)
High School					320.5	411.5	129.2	-635.2
					(499)	(328)	(638)	(1,047)
Free/Reduced Meals	312.8	885.1	867.9	-8050.8	1398.2	1166.1	2721.3	-8821.6
	(1,902)	(2,140)	(3,148)	(4,873)	(3,774)	(2,600)	(4,476)	(7,963)
SchoolSize 2nd Tercile	89.8	246.1	-314.7	-381.3	66.69	-768.9	-2416.7	-1121.6
	(419)	(478)	(760)	(851)	(786)	(537)	(1,360)	(1,762)
SchoolSize 3rd Tercile	-2.383	209.7	-15.54	270	-646.1	-541.8	-1205.2	-2405.6
	(370)	(436)	(824)	(759)	(643)	(422)	(708)	(1,417)
BG Crime	0.1	0.854	-0.0112	6.304**	-0.0718	-0.268	2.485	-0.982
	(0.83)	(0.91)	(1.71)	(1.91)	(1.61)	(1.22)	(2.01)	(2.23)
Tract Pop	-0.204	-0.444	-0.522	-1.880**	-0.269	-0.287	0.158	-1.404
	(0.27)	(0.37)	(0.55)	(0.54)	(0.54)	(0.46)	(0.82)	(1.23)
Tract HH	0.127	0.0924	1.593	1.429	0.714	0.115	-1.971	0.795
	(0.84)	(1.17)	(1.68)	(1.96)	(1.65)	(1.24)	(2.72)	(3.95)
Tract Hispanic	-4214.4	-6313.6	-14001.6**	-18179.3**	-419.2	-4102.7	-22492.1**	10377.1
	(2,460)	(4,566)	(4,882)	(5,999)	(4,495)	(3,910)	(6,818)	(13,048)
Tract Black	-2694	-5160.8	-7630.6*	-10645.1*	853	-2623	-22160.1*	15935.9
	(1,801)	(3,454)	(3,653)	(4,209)	(3,889)	(3,482)	(7,652)	(10,445)
Tract Other	-6561.7	-6707.9	-24252.9	-36246.9	-1456.6	-6608.5	-20967.4	47624.3
	(5,528)	(10,765)	(15,659)	(20,339)	(9,245)	(7,657)	(14,488)	(25,595)
Tract MedIncome	0.0138	0.0414*	0.0315	-0.000707	0.0246	0.0217	-0.0142	0.123*
	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)	(0.05)
Tract BelowHS	-9816.9	-14161	30772.2	-53291.7	33270.1	-6467.9	15606.6	213151.2*
	(23,673)	(27,994)	(42,790)	(62,288)	(22,963)	(24,181)	(47,464)	(71,462)
Tract HS	10841.6	11906.7	11644.3	-18893.1	-13074.5	-7438.1	-9267.4	-80932.9*
	(9,383)	(10,089)	(14,853)	(15,383)	(15,870)	(11,862)	(22,276)	(30,995)
Tract SomeCollege	-47081.6	-71632.7*	-66799.9	-42220	27602.8	-25031.2	-132320.2	210529.4
	(25,732)	(30,223)	(43,424)	(62,873)	(49,849)	(32,782)	(80,364)	(106,505)
Constant	3540.9	5536.8	9136.2	26828.1***	-544.9	2595.1	11249.3*	3955.5
	(2,444)	(3,603)	(4,815)	(4,497)	(3,848)	(2,902)	(4,840)	(7,271)
Sample Size	49	49	49	49	30	30	30	30
R^2	0.365	0.562	0.451	0.605	0.421	0.579	0.794	0.719
Standard errors in parentheses				*p<0.05, **p<0.01,***p<0.001				

Presence of food outlets in a quarter mile of schools								
Variables	Pre-School, Kindergarten & Elementary School				Middle & High School			
	LSR	Convenience Store	Small Grocery Store	Supermarket	LSR	Convenience Store	Small Grocery Store	Supermarket
Black Predominance	-0.3327	0.0423	-0.4003	-0.3855	-0.132	0.7446	-1.3973	-0.7554
	(0.25)	(0.21)	(0.35)	(0.32)	(1.03)	(1.11)	(0.78)	(0.46)
Hispanic Predominance	-0.233	-0.0049	-0.3266	-0.3912	-0.2938	0.5747	-1.0964*	-0.6131
	(0.23)	(0.15)	(0.35)	(0.32)	(0.60)	(0.69)	(0.45)	(0.30)
High School					-0.1797	-0.1557	0.2587	0.0029
					(0.27)	(0.23)	(0.20)	(0.10)
Free/Reduced Meals	-0.3497	0.5944	-0.7492	0.7488	-1.8247	1.1585	-0.1343	1.8672*
	(1.17)	(0.54)	(0.74)	(0.53)	(2.13)	(1.27)	(1.63)	(0.80)
SchoolSize 2nd Tercile	0.0842	0.2197*	-0.1169	-0.0153	-0.422	0.1013	0.1639	-0.1558
	(0.25)	(0.10)	(0.15)	(0.07)	(0.39)	(0.39)	(0.28)	(0.11)
SchoolSize 3rd Tercile	-0.036	0.1104	-0.2315	-0.0432	0.1414	0.0211	-0.0655	0.1726
	(0.22)	(0.13)	(0.12)	(0.07)	(0.36)	(0.26)	(0.28)	(0.11)
BG Crime	0.0001	-0.0002	0.0005	-0.0001	-0.0002	0.0006	-0.0001	0.0003
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Tract Pop	0.0001	0.0001*	0.0001	0	0.0005	0.0004	0.0003	0.0003
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Tract HH	0	0	-0.0004	0.0002	-0.0018	-0.0004	-0.0009	-0.0005
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Tract Hispanic	1.3073	0.1762	3.8013***	0.1787	-0.7061	-0.8913	3.042	1.2769
	(0.95)	(0.49)	(0.70)	(0.42)	(2.64)	(2.51)	(1.64)	(1.09)
Tract Black	0.9614	0.145	1.9509***	0.1095	-1.0531	-1.8371	1.9124	0.895
	(0.66)	(0.32)	(0.53)	(0.37)	(2.16)	(2.21)	(1.67)	(0.96)
Tract Other	3.329	-0.381	6.8401*	2.34	-0.7842	-0.7928	1.2115	-2.4204
	(3.34)	(1.69)	(2.75)	(1.97)	(5.39)	(5.18)	(4.54)	(2.56)
Tract MedIncome	0	-0.0000***	0	0	0	0	0	0
	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tract BelowHS	10.8414	-3.1511	-10.1454	12.8465	-16.883	-8.9192	-10.861	2.8685
	(16.51)	(5.17)	(8.11)	(7.21)	(14.64)	(16.76)	(5.58)	(6.25)
Tract HS	-2.5138	-0.6633	-4.3758*	-0.9989	1.4953	12.7802	4.974	2.6811
	(4.22)	(3.26)	(2.04)	(1.76)	(9.38)	(7.08)	(8.38)	(3.13)
Tract SomeCollege	24.3961	18.9630*	15.3718	8.3123	-19.585	-2.5382	7.1118	4.5954
	(15.92)	(9.09)	(9.27)	(10.07)	(26.89)	(23.88)	(19.02)	(8.47)
Constant	-0.4649	0.0456	-0.417	-0.7084	4.5551	-1.2419	-1.0017	-2.2846*
	(1.13)	(0.53)	(0.67)	(0.50)	(2.12)	(1.90)	(1.82)	(0.93)
Sample Size	49	49	49	49	30	30	30	30
R^2	0.2101	0.5651	0.5798	0.3681	0.5505	0.5732	0.6466	0.7095
Standard errors in parentheses				*p<0.05, **p<0.01,***p<0.001				

Counts of food outlets in a quarter mile of schools								
Variables	Pre-School, Kindergarten & Elementary School				Middle & High School			
	LSR	Convenience Store	Small Grocery Store	Supermarket	LSR	Convenience Store	Small Grocery Store	Supermarket
Black Predominance	2.8146	-0.5119	-0.0796	-0.3397	-10.0085	-2.1232	-3.5443	-0.1601
	(2.87)	(1.21)	(0.30)	(0.30)	(6.73)	(4.07)	(2.02)	(1.09)
Hispanic Predominance	3.2498	1.4775	0.0273	-0.4141	-10.303*	-0.3164	-3.1654	-0.6826
	(2.43)	(1.24)	(0.32)	(0.28)	(4.40)	(2.32)	(1.63)	(0.76)
High School					0.8241	0.3687	0.38	0.0903
					(1.90)	(0.86)	(0.39)	(0.16)
Free/Reduced Meals	-11.1159	-5.0425	0.038	1.3943	1.2796	3.4765	4.3923	4.0091*
	(8.69)	(4.90)	(1.21)	(0.69)	(12.32)	(6.37)	(3.18)	(1.63)
SchoolSize 2nd Tercile	0.6154	0.0057	0.2317	0.1355	-1.1587	-0.1008	0.0769	-0.0268
	(1.36)	(0.98)	(0.21)	(0.13)	(1.93)	(1.09)	(0.58)	(0.25)
SchoolSize 3rd Tercile	1.5162	-0.6978	-0.0537	0.1063	-0.2147	0.9479	0.5574	0.2455
	(1.47)	(0.84)	(0.25)	(0.13)	(1.73)	(0.91)	(0.53)	(0.18)
BG Crime	-0.0047	0.0007	-0.0003	-0.0002	-0.0015	0.0006	0.0014	0.0013
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Tract Pop	0.0011	0.0002	0.0001	0.0001	0.001	0.0019	0.0011	0.0003
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Tract HH	-0.0033	0.0012	-0.0006	0	-0.0085	-0.0057	-0.0015	-0.0002
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)
Tract Hispanic	-7.9723	4.3059	2.5538	0.3991	18.1285	-2.1759	6.0623	-0.2252
	(11.74)	(5.23)	(1.40)	(0.58)	(15.92)	(9.63)	(4.11)	(1.92)
Tract Black	-7.7321	3.2565	1.2537	0.2859	8.8693	-0.1589	3.352	-1.4972
	(8.14)	(3.50)	(0.93)	(0.43)	(12.57)	(8.15)	(3.53)	(2.08)
Tract Other	-14.1736	15.46	3.4314	1.2448	48.5806	21.0044	-4.048	-2.5098
	(23.41)	(14.91)	(3.69)	(2.19)	(24.82)	(20.81)	(9.21)	(5.01)
Tract MedIncome	0	0	0	0	-0.0001	-0.0001	0	0
	(0.00)	0.00	0.00	0.00	(0.00)	(0.00)	0.00	0.00
Tract BelowHS	19.1886	44.7152	1.1574	9.307	-151.271	38.826	-7.767	-9.807
	(102.29)	(56.05)	(17.09)	(8.60)	(113.24)	(73.89)	(20.21)	(10.22)
Tract HS	-68.7701*	-4.0816	-8.879	-1.2582	-4.9926	12.9466	26.1529	12.1097
	(30.08)	(17.55)	(6.11)	(2.51)	(50.35)	(24.04)	(16.46)	(8.78)
Tract SomeCollege	367.4285**	53.3431	30.1952	10.619	-213.551	-34.919	-16.690	-24.867
	(128.05)	(51.68)	(21.28)	(11.51)	(156.95)	(72.78)	(37.06)	(19.97)
Constant	18.1189	1.1054	-0.305	-1.4814	16.3111	1.4606	-7.8513	-3.2232
	(11.49)	(4.67)	(1.09)	(0.76)	(10.83)	(8.04)	(4.66)	(1.95)
Sample Size	49	49	49	49	30	30	30	30
R^2	0.4565	0.3704	0.3736	0.3353	0.6087	0.6134	0.6386	0.7083
Standard errors in parentheses				*p<0.05, **p<0.01,***p<0.001				

Appendix A

The relationship between school- and neighborhood-level characteristics and the proximity from schools to their surrounding food outlets are displayed above. The first table presents the correlation between school- and neighborhood-level characteristics with schools' nearest food outlets. The second table presents the correlation between the characteristics with the presence of food outlets within a quarter mile of the schools, and the third presents the correlation between school- and neighborhood-level characteristics and the counts of food outlets within a quarter mile of the schools.

The analysis is conducted using Ordinary Least Square with heteroskedasticity-robust standard errors, and the regression values for limited service restaurants, convenience stores, small grocery stores and supermarkets are displayed in separate columns. The analysis is also conducted by separating middle and high schools from elementary schools, kindergartens and pre-schools.

APPENDIX B

RELATIONSHIP BETWEEN STUDENTS' BMI Z SCORE OR WEIGHT STATUS, AND PROXIMITY TO FOOD OUTLETS AROUND THE SCHOOL WITH CENSUS TRACT DATA

Model Comparison: BMI Z Score with Presence of Outlets, including Race VS No-Race for All & Non-Newark Students

Variable	Pre-K, K & Elementary School			Middle and High School		
	All	Non-Newark		All	Non-Newark	
		No Race	With Race		No Race	With Race
LSR	-0.043300	0.080700	0.081400	-0.064900	0.025100	0.023400
	(0.0590)	(0.0697)	(0.0611)	(0.0474)	(0.0541)	(0.0553)
Supermarket	-0.099900			-0.114*		
	(0.0944)			(0.0564)		
SMALL GROCERY STORE	0.020600	0.001500	0.007650	-0.159***	-0.226***	-0.216***
	(0.0851)	(0.1060)	(0.0986)	(0.0341)	(0.0452)	(0.0490)
Convenience Store	-0.082100	-0.025400	-0.045900	-0.014300	0.027200	0.010100
	(0.0689)	(0.0709)	(0.0629)	(0.0550)	(0.0476)	(0.0521)
Large Park	-0.080900	-0.014600	-0.027200	-0.029600	-0.024500	-0.015800
	(0.0777)	(0.0894)	(0.0793)	(0.0432)	(0.0450)	(0.0459)
Female	-0.0576**	-0.0478*	-0.0481*	0.037800	0.021900	0.021400
	(0.0183)	(0.0216)	(0.0210)	(0.0275)	(0.0303)	(0.0310)
Age	0.00222***	0.00262***	0.00261***	-0.00433***	-0.00347***	-0.00339***
	(0.0006)	(0.0007)	(0.0007)	(0.0007)	(0.0008)	(0.0008)
SchoolSize 2nd Tercile	0.168*	0.106000	0.106000	-0.265***	-0.295***	-0.283***
	(0.0757)	(0.0603)	(0.0559)	(0.0453)	(0.0571)	(0.0546)
SchoolSize 3rd Tercile	0.159*	0.030100	0.012400	-0.114**	-0.193***	-0.179***
	(0.0668)	(0.0582)	(0.0507)	(0.0417)	(0.0403)	(0.0373)
FreeReduced	0.000654	-0.001890	-0.003750	-0.004870	-0.005820	-0.005100
	(0.0021)	(0.0025)	(0.0022)	(0.0027)	(0.0033)	(0.0034)
Student Black			0.200*			0.198000
			(0.0885)			(0.1200)
Student Hispanic			0.399***			0.269*
			(0.0952)			(0.1260)
Student Other			0.197000			-0.073100
			(0.1220)			(0.1560)
BG Total Crime	0.000325	0.000097	0.000038	0.000237**	0.000125	0.000127
	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0001)	(0.0001)
Tract Pop	0.000122**	0.0000928*	0.0000780*	0.000169***	0.000186***	0.000174**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0001)
Tract HH	-0.000276*	-0.000127	-0.000017	-0.000583***	-0.000775***	-0.000720***
	(0.0001)	(0.0002)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Tract Hispanic	-0.312000	-0.603000	-0.787000	0.902***	1.543***	1.342***
	(0.3550)	(0.4880)	(0.4260)	(0.1880)	(0.3600)	(0.4070)

Tract Black	-0.150000	-0.026900	-0.000355	0.245000	0.589**	0.555*
	(0.1990)	(0.2850)	(0.2570)	(0.1270)	(0.1910)	(0.2190)
Tract Other	0.855000	-0.153000	-0.651000	0.289000	-0.068700	0.300000
	(0.9890)	(1.2160)	(1.1070)	(0.8320)	(0.8980)	(0.9150)
Tract MedIncome	0.00000045	0.000002	0.00000328*	0.000001	0.000003	0.000003
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Tract BelowHS	4.693000	8.343000	10.67*	-0.638000	-8.392000	-7.595000
	(3.7150)	(5.4050)	(4.8420)	(2.9620)	(5.4990)	(5.6940)
Tract HS	0.817000	0.181000	-0.256000	0.045200	-0.131000	-0.039100
	(1.1390)	(1.3380)	(1.2220)	(0.9320)	(0.8960)	(0.9680)
Tract SomeCollege	-5.771000	-6.824000	-3.765000	-3.831000	-7.348*	-6.342000
	(5.1520)	(9.6180)	(8.5410)	(2.9860)	(3.5580)	(3.5760)
Newark	0.285*			0.064000		
	(0.1120)			(0.0683)		
New Brunswick	0.210000	0.384**	0.375**	-0.069500	-0.178000	-0.125000
	(0.1240)	(0.1410)	(0.1340)	(0.0833)	(0.1060)	(0.1060)
Trenton	0.315***	0.283**	0.304***	0.058600	-0.098700	-0.057800
	(0.0838)	(0.0978)	(0.0861)	(0.0680)	(0.1000)	(0.1010)
Constant	0.164000	0.155000	-0.062200	1.839***	1.810***	1.509**
	(0.2890)	(0.3400)	(0.2920)	(0.3340)	(0.3920)	(0.4620)
N	16367	12126	12113	11283	7069	6985
Within R^2	0.0026	0.0035	0.0093	0.0035	0.0021	0.0055
Between R^2	0.3748	0.4742	0.5011	0.6642	0.6368	0.6468
Overall R^2	0.0209	0.0233	0.0314	0.0178	0.0132	0.0167
Standard errors in parentheses						
*p<0.05, **p<0.01,***p<0.001						

Model Comparison: BMI Z Score with Counts of Outlets, including Race VS No-Race for All & Non-Newark Students

Variable	Pre-K, K & Elementary School			Middle and High School		
	All	Non-Newark		All	Non-Newark	
		No Race	With Race		No Race	With Race
LSR	-0.0022	-0.0151	-0.0165*	-0.00334	0.00823	0.0096
	(0.0096)	(0.0081)	(0.0073)	(0.0057)	(0.0050)	(0.0058)
Supermarket	-0.0952	-0.0784	-0.0392	0.0405	-0.290***	-0.312***
	(0.0620)	(0.0848)	(0.0767)	(0.0918)	(0.0332)	(0.0371)
SMALL GROCERY STORE	0.0122	0.164*	0.188**	-0.0822**	-0.157***	-0.140***
	(0.0356)	(0.0680)	(0.0579)	(0.0309)	(0.0325)	(0.0375)
Convenience Store	0.025	0.0343**	0.0261**	-0.0108	-0.00736	-0.0134
	(0.0139)	(0.0114)	(0.0101)	(0.0099)	(0.0106)	(0.0109)
Female	-0.0578**	-0.0467*	-0.0473*	0.0375	0.0214	0.0208
	(0.0182)	(0.0213)	(0.0207)	(0.0276)	(0.0304)	(0.0312)
Age	0.0023***	0.0028***	0.00278***	-0.00435***	-0.00339***	-0.0033***
	(0.0006)	(0.0007)	(0.0006)	(0.0007)	(0.0008)	(0.0008)
SchoolSize 2nd Tercile	0.133*	0.0825	0.0619	-0.247***	-0.249***	-0.225***
	(0.0649)	(0.0587)	(0.0544)	(0.0537)	(0.0523)	(0.0525)
SchoolSize 3rd Tercile	0.148*	0.0421	0.0156	-0.0696	-0.160***	-0.144***
	(0.0614)	(0.0374)	(0.0348)	(0.0509)	(0.0314)	(0.0341)
FreeReduced	0.00205	-0.00118	-0.00467*	-0.00291	-0.00518	-0.00542
	(0.0022)	(0.0023)	(0.0023)	(0.0025)	(0.0032)	(0.0033)
Student Black			0.204*			0.213
			(0.0885)			(0.1210)
Student Hispanic			0.403***			0.283*
			(0.0924)			(0.1270)
Student Other			0.203			-0.0631
			(0.1220)			(0.1570)
BG Total Crime	0.000366*	0.000167	0.000128	0.000294***	0.000189**	0.000159*
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Tract Pop	0.000106**	0.000101**	0.0000819**	0.000185***	0.000147***	0.000118**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Tract HH	-0.00035**	-0.000028	0.0000903	-0.00063***	-0.00058***	-0.00050**
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Tract Hispanic	-0.38	-1.211*	-1.420***	0.618**	1.144***	0.902*
	(0.3920)	(0.5030)	(0.4260)	(0.1910)	(0.3350)	(0.3700)
Tract Black	-0.16	-0.279	-0.272	0.128	0.289	0.199
	(0.1980)	(0.2260)	(0.1940)	(0.1190)	(0.1910)	(0.2090)
Tract Other	0.611	-0.803	-1.062	0.038	-0.127	0.274
	(1.0890)	(1.1310)	(1.0710)	(0.9230)	(0.7610)	(0.8960)

Tract MedIncome	0.000002	0.0000023	0.00000323*	-0.00000014	0.00000145	0.00000129
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Tract BelowHS	2.066	12.28**	15.89***	-2.581	-4.029	-3.115
	(4.4050)	(4.6030)	(3.9380)	(3.4900)	(4.6350)	(4.7220)
Tract HS	0.843	-0.305	-0.873	1.029	0.708	0.738
	(1.4060)	(1.4220)	(1.3610)	(1.1060)	(0.7460)	(0.8200)
Tract SomeCollege	-9.807	1.273	4.176	-8.152*	-9.872**	-9.823**
	(6.6620)	(8.2880)	(7.5550)	(4.0160)	(3.2860)	(3.3800)
Newark	0.318*			0.0512		
	(0.1320)			(0.0934)		
New Brunswick	0.3	0.570***	0.561***	-0.0491	-0.138	-0.151
	(0.1750)	(0.1440)	(0.1320)	(0.0882)	(0.0767)	(0.0848)
Trenton	0.356***	0.489***	0.512***	0.0318	-0.0256	-0.00814
	(0.1050)	(0.1100)	(0.0934)	(0.0559)	(0.0690)	(0.0717)
Constant	0.0111	-0.112	-0.217	1.781***	1.803***	1.650***
	(0.3400)	(0.3170)	(0.2780)	(0.3200)	(0.3890)	(0.4240)
N	16367	12126	12113	11283	7069	6985
Within R^2	0.0026	0.0035	0.0094	0.0035	0.0021	0.0055
Between R^2	0.3696	0.5121	0.5183	0.5415	0.6329	0.6818
Overall R^2	0.0223	0.0277	0.0348	0.0174	0.0137	0.017
Standard errors in parentheses						
*p<0.05, **p<0.01,***p<0.001						

Model Comparison: BMI Z Score with Distance (in 1000 ft.) of Outlets, including Race VS No-Race for All & Non-Newark Students

Variable	Pre-K, K & Elementary School			Middle and High School		
	All	Non-Newark		All	Non-Newark	
		No Race	With Race		No Race	With Race
LSR	0.0528	-0.0436	-0.0583	0.0966**	0.0838*	0.0895*
	(0.0323)	(0.0492)	(0.0465)	(0.0333)	(0.0373)	(0.0388)
Supermarket	0.00156	0.0106	0.00707	0.00345	0.0173	0.0196
	(0.0145)	(0.0149)	(0.0143)	(0.0100)	(0.0108)	(0.0118)
SMALL GROCERY STORE	0.0165	-0.0192	-0.0217	0.0357***	0.0379***	0.0363**
	(0.0179)	(0.0237)	(0.0224)	(0.0064)	(0.0113)	(0.0118)
Convenience Store	-0.0512	-0.00584	0.0194	-0.0000672***	-0.0000903**	-0.0000864*
	(0.0263)	(0.0290)	(0.0282)	(0.0204)	(0.0332)	(0.0362)
Large Park	0.0407	-0.068	-0.0713	-0.00554	-0.0253	-0.0309
	(0.0658)	(0.0992)	(0.0906)	(0.0300)	(0.0298)	(0.0303)
Female	-0.0578**	-0.0475*	-0.0479*	0.0362	0.0186	0.0173
	(0.0182)	(0.0215)	(0.0209)	(0.0275)	(0.0302)	(0.0306)
Age	0.00227***	0.00274***	0.00274***	-0.00431***	-0.00350***	-0.00347***
	(0.0006)	(0.0007)	(0.0006)	(0.0007)	(0.0008)	(0.0008)
SchoolSize 2nd Tercile	0.135	0.0759	0.0653	-0.221***	-0.136	-0.125
	(0.0738)	(0.0726)	(0.0686)	(0.0626)	(0.0747)	(0.0736)
SchoolSize 3rd Tercile	0.125*	0.0297	0.00449	-0.0459	-0.00243	0.02
	(0.0603)	(0.0478)	(0.0478)	(0.0564)	(0.0741)	(0.0718)
FreeReduced	-0.00144	-0.0029	-0.00463*	-0.00480*	-0.00792**	-0.00728*
	(0.0021)	(0.0024)	(0.0022)	(0.0024)	(0.0031)	(0.0030)
Student Black			0.196*			0.197
			(0.0903)			(0.1190)
Student Hispanic			0.391***			0.269*
			(0.0962)			(0.1240)
Student Other			0.193			-0.0724
			(0.1220)			(0.1540)
BG Total Crime	0.000377*	0.0000829	0.0000485	0.000260**	0.000198**	0.000195**
	(0.0002)	(0.0002)	(0.0002)	(0.0001)	(0.0001)	(0.0001)
Tract Pop	0.000106*	0.000102**	0.0000929**	0.000154***	0.000106	0.000101
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0001)
Tract HH	-0.000361**	-0.000128	-0.0000622	-0.000461***	-0.000124	-0.0000565
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
Tract Hispanic	-0.0794	-0.486	-0.583	0.601*	0.401	0.241
	(0.3590)	(0.4240)	(0.3870)	(0.2600)	(0.3170)	(0.3670)
Tract Black	-0.0662	-0.0515	0.0618	0.157	0.18	0.179

	(0.2190)	(0.2130)	(0.2010)	(0.1490)	(0.1800)	(0.2020)
Tract Other	1.402	-0.418	-0.619	-0.0226	-0.364	-0.248
	(1.1080)	(1.5250)	(1.4570)	(0.8710)	(1.0300)	(1.1450)
Tract MedIncome	0.00000244	0.00000382*	0.00000422*	-0.00000168	-0.00000252	-0.00000338
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Tract BelowHS	1.283	4.92	8.043	-1.516	0.306	1.991
	(5.0080)	(4.8920)	(4.1140)	(4.6440)	(5.3550)	(5.3440)
Tract HS	0.525	1.47	0.74	1.275	3.113	3.083
	(1.3460)	(1.6340)	(1.6030)	(1.2260)	(1.7940)	(1.8940)
Tract SomeCollege	-7.508	-6.526	-4.619	-5.907	-7.346	-5.358
	(5.6160)	(9.8070)	(9.3960)	(4.6100)	(4.3180)	(4.5580)
Newark	0.263*			0.146		
	(0.1230)			(0.1140)		
New Brunswick	0.212	0.387**	0.386**	0.000607	0.215	0.302*
	(0.1160)	(0.1410)	(0.1300)	(0.0974)	(0.1300)	(0.1360)
Trenton	0.291***	0.269*	0.292**	0.139	0.224*	0.283**
	(0.0841)	(0.1060)	(0.0946)	(0.0820)	(0.1020)	(0.1060)
Constant	0.147	0.24	0.0104	1.507***	1.166**	0.781
	(0.4600)	(0.5940)	(0.5640)	(0.3870)	(0.4270)	(0.4550)
N	16367	12126	12113	11283	7069	6985
Within R^2	0.0026	0.0035	0.0094	0.0035	0.0021	0.0055
Between R^2	0.3410	0.4850	0.5045	0.6132	0.6819	0.6894
Overall R^2	0.0207	0.0244	0.0315	0.0167	0.0129	0.0167
Standard errors in parentheses *p<0.05, **p<0.01,***p<0.001						

Model Comparison: Obese Weight Status with Presence of Outlets, including Race VS No-Race for All & Non-Newark Students

Variable	Pre-K, K & Elementary School			Middle and High School		
	All	Non-Newark		All	Non-Newark	
		No Race	With Race		No Race	With Race
LSR	-0.0112	0.00806	0.00973	-0.00397	0.0133	0.0126
	(0.0123)	(0.0118)	(0.0079)	(0.0138)	(0.0187)	(0.0200)
Supermarket	-0.013			-0.000883		
	(0.0251)			(0.0213)		
SMALL GROCERY STORE	-0.0142	-0.0223	-0.0196	-0.0460***	-0.0559**	-0.0629***
	(0.0153)	(0.0204)	(0.0166)	(0.0124)	(0.0182)	(0.0178)
Convenience Store	-0.00494	0.00593	-0.00533	-0.0154	-0.0139	-0.0212
	(0.0164)	(0.0158)	(0.0123)	(0.0161)	(0.0180)	(0.0171)
Large Park	-0.0156	-0.0171	-0.0237	-0.0148	-0.0335*	-0.0370*
	(0.0140)	(0.0161)	(0.0125)	(0.0121)	(0.0167)	(0.0160)
Female	-0.0201**	-0.0123	-0.0129	-0.0156	-0.018	-0.0177
	(0.0077)	(0.0074)	(0.0072)	(0.0102)	(0.0120)	(0.0116)
Age	0.00107***	0.00133***	0.00130***	-0.00162***	-0.00147***	-0.00149***
	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0004)	(0.0004)
SchoolSize 2nd Tercile	0.0199	0.0280*	0.0271*	-0.0867***	-0.0892***	-0.0936***
	(0.0148)	(0.0140)	(0.0119)	(0.0152)	(0.0230)	(0.0201)
SchoolSize 3rd Tercile	0.0336*	0.0191	0.0102	-0.0549***	-0.0750***	-0.0746***
	(0.0139)	(0.0141)	(0.0109)	(0.0138)	(0.0143)	(0.0135)
FreeReduced	0.000236	0.000688	-0.000093	-0.00189*	-0.00174	-0.00114
	(0.0006)	(0.0006)	(0.0005)	(0.0009)	(0.0014)	(0.0013)
Student Black			0.0325			0.0239
			(0.0321)			(0.0571)
Student Hispanic			0.122***			0.0576
			(0.0326)			(0.0622)
Student Other			0.0352			0.00351
			(0.0367)			(0.0710)
BG Total Crime	0.0000752*	0.0000248	0.00000185	0.0000677*	0.0000705*	0.0000845**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Tract Pop	0.0000318***	0.0000265**	0.0000199**	0.0000381***	0.0000521*	0.0000587**
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Tract HH	-0.000105***	-0.0000804*	-0.0000328	-0.000135***	-0.000165*	-0.000170*
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0001)
Tract Hispanic	-0.0855	-0.236	-0.316***	0.282***	0.416**	0.396*
	(0.0835)	(0.1240)	(0.0937)	(0.0583)	(0.1560)	(0.1660)
Tract Black	-0.0701	-0.061	-0.0412	0.0957**	0.14	0.155

	(0.0423)	(0.0652)	(0.0503)	(0.0313)	(0.0803)	(0.0828)
Tract Other	0.112	-0.0418	-0.234	0.294	0.287	0.249
	(0.2070)	(0.2410)	(0.1710)	(0.2550)	(0.5480)	(0.5000)
Tract MedIncome	-5.31E-08	-2.01E-08	0.000000314	0.000000342	0.00000115*	0.00000124
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Tract BelowHS	0.719	1.95	3.107***	0.645	0.069	0.145
	(0.9430)	(1.1640)	(0.8130)	(0.9740)	(2.2650)	(2.1220)
Tract HS	0.144	0.0324	-0.169	0.302	0.622	0.643
	(0.2260)	(0.3240)	(0.2760)	(0.2850)	(0.3980)	(0.3530)
Tract SomeCollege	-1.471	-3.627*	-2.438*	-2.969**	-3.681*	-2.822
	(1.1950)	(1.7830)	(1.2190)	(0.9740)	(1.6130)	(1.5690)
Newark	0.0564*			0.0248		
	(0.0239)			(0.0195)		
New Brunswick	0.0387	0.0907**	0.0898***	0.00435	-0.0332	-0.0203
	(0.0279)	(0.0304)	(0.0269)	(0.0259)	(0.0442)	(0.0426)
Trenton	0.0596**	0.0679**	0.0782***	0.0362	0.00563	0.015
	(0.0188)	(0.0218)	(0.0170)	(0.0209)	(0.0387)	(0.0370)
Constant	0.131	0.093	0.0491	0.620***	0.511**	0.397**
	(0.0715)	(0.0864)	(0.0695)	(0.1200)	(0.1640)	(0.1530)
N	16367	12126	12113	11283	7069	6985
Within R^2	0.0038	0.0057	0.0133	0.0029	0.0024	0.0036
Between R^2	0.2309	0.1630	0.2680	0.5497	0.5803	0.5785
Overall R^2	0.0107	0.0121	0.021	0.0114	0.0112	0.0129
Standard errors in parentheses *p<0.05, **p<0.01,***p<0.001						

Model Comparison: Obese Weight Status with Counts of Outlets, including Race VS No-Race for All & Non-Newark Students

Variable	Pre-K, K & Elementary School			Middle and High School		
	All	Non-Newark		All	Non-Newark	
		No Race	With Race		No Race	With Race
LSR	-0.0022	-0.00376	-0.00441*	-0.000709	0.00357*	0.00439*
	(0.0018)	(0.0020)	(0.0018)	(0.0017)	(0.0018)	(0.0019)
Supermarket	-0.0457***	-0.0409*	-0.0269	0.00883	-0.105***	-0.106***
	(0.0116)	(0.0201)	(0.0179)	(0.0238)	(0.0166)	(0.0161)
SMALL GROCERY STORE	0.00667	0.0201	0.0313**	-0.0168*	-0.0319*	-0.0344*
	(0.0060)	(0.0136)	(0.0104)	(0.0078)	(0.0136)	(0.0139)
Convenience Store	0.00314	0.00622**	0.00257	-0.00234	-0.00892**	-0.0101**
	(0.0025)	(0.0023)	(0.0021)	(0.0027)	(0.0033)	(0.0032)
Female	-0.0202**	-0.0124	-0.0128	-0.0161	-0.0187	-0.0189
	(0.0078)	(0.0074)	(0.0071)	(0.0102)	(0.0120)	(0.0115)
Age	0.0011***	0.00137***	0.00137***	-0.00173***	-0.00141***	-0.00138***
	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0004)	(0.0004)
SchoolSize 2nd Tercile	0.0225	0.0255*	0.0163	-0.0895***	-0.0760***	-0.0756***
	(0.0126)	(0.0122)	(0.0113)	(0.0171)	(0.0164)	(0.0155)
SchoolSize 3rd Tercile	0.0415***	0.0264**	0.0146	-0.0449**	-0.0666***	-0.0633***
	(0.0102)	(0.0083)	(0.0079)	(0.0152)	(0.0107)	(0.0121)
FreeReduced	0.00104*	0.000841	-0.00058	-0.00156	-0.00311**	-0.00288*
	(0.0005)	(0.0006)	(0.0006)	(0.0008)	(0.0011)	(0.0011)
Student Black			0.0327			0.0312
			(0.0317)			(0.0572)
Student Hispanic			0.120***			0.0636
			(0.0321)			(0.0624)
Student Other			0.0325			0.00755
			(0.0365)			(0.0709)
BG Total Crime	0.0000782**	0.0000423	0.0000253	0.0000698**	0.0000415	0.0000352
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Tract Pop	0.0000333***	0.0000352***	0.0000272***	0.0000411***	0.0000218	0.0000205
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Tract HH	-0.000109***	-0.0000919***	-0.0000429*	-0.000136***	-0.0000876	-0.0000886
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0001)
Tract Hispanic	-0.197*	-0.358**	-0.436***	0.236**	0.311*	0.298*
	(0.0795)	(0.1130)	(0.0891)	(0.0744)	(0.1360)	(0.1330)
Tract Black	-0.120**	-0.107*	-0.0934*	0.0832*	0.0277	0.0473
	(0.0393)	(0.0491)	(0.0388)	(0.0326)	(0.0876)	(0.0869)
Tract Other	-0.0557	-0.19	-0.284	0.216	0.389	0.515

	(0.2090)	(0.2410)	(0.2150)	(0.2810)	(0.5620)	(0.5720)
Tract MedIncome	-4.17E-08	-0.000000305	0.000000101	0.000000154	0.000000553	0.000000676
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Tract BelowHS	0.723	2.405*	3.975***	0.629	1.811	1.799
	(0.8910)	(1.1600)	(0.9340)	(1.0180)	(1.5920)	(1.5610)
Tract HS	0.212	-0.247	-0.5	0.324	0.65	0.625
	(0.2640)	(0.3510)	(0.3170)	(0.3810)	(0.4310)	(0.4000)
Tract SomeCollege	-2.326	-1.388	-0.276	-3.329*	-5.451***	-5.197***
	(1.4130)	(2.0760)	(1.7350)	(1.3320)	(1.6490)	(1.5680)
Newark	0.0851***			0.0383		
	(0.0244)			(0.0261)		
New Brunswick	0.0694*	0.136***	0.132***	0.0211	-0.0476	-0.0487
	(0.0321)	(0.0380)	(0.0347)	(0.0237)	(0.0346)	(0.0325)
Trenton	0.0802***	0.108***	0.118***	0.0368	0.0198	0.0191
	(0.0193)	(0.0257)	(0.0223)	(0.0207)	(0.0278)	(0.0257)
Constant	0.0845	0.0619	0.0628	0.607***	0.700***	0.625***
	(0.0654)	(0.0865)	(0.0806)	(0.1060)	(0.1620)	(0.1620)
N	16367	12126	12113	11283	7069	6985
Within R^2	0.0038	0.0057	0.0133	0.0029	0.0024	0.0036
Between R^2	0.2879	0.2009	0.3049	0.4528	0.6243	0.6908
Overall R^2	0.0116	0.0131	0.0214	0.011	0.0117	0.0134
Standard errors in parentheses						
*p<0.05, **p<0.01,***p<0.001						

Model Comparison: Obese Weight Status with Distance (in 1000 ft.) of Outlets, including Race VS No-Race for All & Non-Newark Students

Variable	Pre-K, K & Elementary School			Middle and High School		
	All	Non-Newark		All	Non-Newark	
		No Race	With Race		No Race	With Race
LSR	0.00704	-0.00631	-0.0133	0.0136	0.0161	0.0257
	(0.0072)	(0.0103)	(0.0093)	(0.0111)	(0.0174)	(0.0195)
Supermarket	0.00266	0.00416	0.00273	0.0011	0.00379	0.00612
	(0.0028)	(0.0025)	(0.0024)	(0.0037)	(0.0049)	(0.0062)
SMALL GROCERY STORE	0.0038	-0.00119	-0.00141	0.00648*	0.00887	0.0097
	(0.0038)	(0.0054)	(0.0049)	(0.0028)	(0.0050)	(0.0056)
Convenience Store	-0.000016**	-0.00922	0.000727	-0.0115	-0.0175	-0.0229
	(0.0054)	(0.0061)	(0.0059)	(0.0075)	(0.0155)	(0.0192)
Large Park	0.00172	-0.00535	-0.00647	0.00204	0.0065	0.0056
	(0.0119)	(0.0197)	(0.0183)	(0.0092)	(0.0136)	(0.0129)
Female	-0.0202**	-0.0123	-0.0128	-0.0166	-0.0189	-0.0191
	(0.0077)	(0.0074)	(0.0072)	(0.0101)	(0.0120)	(0.0114)
Age	0.00108***	0.00137***	0.00134***	-0.0017***	-0.0015***	-0.0015***
	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0004)	(0.0004)
SchoolSize 2nd Tercile	0.0187	0.0243	0.018	-0.0779***	-0.0548	-0.049
	(0.0148)	(0.0129)	(0.0116)	(0.0228)	(0.0318)	(0.0324)
SchoolSize 3rd Tercile	0.0292*	0.017	0.00322	-0.0412*	-0.0332	-0.0175
	(0.0116)	(0.0094)	(0.0092)	(0.0201)	(0.0315)	(0.0339)
FreeReduced	0.00018	0.000357	-0.000431	-0.00201	-0.00310*	-0.0027
	(0.0005)	(0.0005)	(0.0005)	(0.0010)	(0.0014)	(0.0014)
Student Black			0.0315			0.022
			(0.0326)			(0.0568)
Student Hispanic			0.119***			0.056
			(0.0332)			(0.0618)
Student Other			0.035			0.0028
			(0.0368)			(0.0704)
BG Total Crime	0.0000646	-0.00000523	-0.0000164	0.0000560*	0.000059	0.0000732*
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Tract Pop	0.0000284**	0.0000264***	0.0000227***	0.0000301*	0.0000295	0.0000332
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Tract HH	-0.00011***	-0.0000619	-0.0000367	-0.000096*	-0.000041	-0.0000004
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0001)	(0.0001)
Tract Hispanic	-0.0792	-0.263*	-0.296***	0.216**	0.18	0.0916
	(0.0773)	(0.1090)	(0.0874)	(0.0744)	(0.1690)	(0.2140)
Tract Black	-0.0779	-0.0947*	-0.0354	0.0854	0.0785	0.0727

	(0.0440)	(0.0442)	(0.0392)	(0.0443)	(0.0963)	(0.1110)
Tract Other	0.131	-0.217	-0.243	0.176	0.29	0.0386
	(0.2330)	(0.3130)	(0.2690)	(0.2870)	(0.6450)	(0.6950)
Tract MedIncome	0.000000289	0.000000435	0.000000615*	4.58E-08	-0.0000002	-0.00000066
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Tract BelowHS	-0.39	1.283	2.773**	0.594	1.523	2.203
	(1.1520)	(1.1210)	(0.8720)	(1.5060)	(2.3060)	(2.2570)
Tract HS	0.333	0.267	0.0306	0.262	1.004	1.18
	(0.2740)	(0.3360)	(0.3260)	(0.3640)	(0.7800)	(0.8880)
Tract SomeCollege	-2.424	-2.629	-2.301	-2.693	-3.955*	-2.815
	(1.3510)	(2.1290)	(1.8500)	(1.4950)	(1.8260)	(1.9390)
Newark	0.0537			0.0449		
	(0.0288)			(0.0369)		
New Brunswick	0.0468	0.0950**	0.100***	0.0157	0.0421	0.0935
	(0.0255)	(0.0319)	(0.0262)	(0.0359)	(0.0611)	(0.0708)
Trenton	0.0554**	0.0638*	0.0759***	0.0471	0.0678	0.102
	(0.0194)	(0.0251)	(0.0212)	(0.0264)	(0.0491)	(0.0539)
Constant	0.125	0.0942	0.0402	0.577***	0.465*	0.288
	(0.1100)	(0.1420)	(0.1420)	(0.1340)	(0.1830)	(0.1670)
N	16367	12126	12113	11283	7069	6985
Within R^2	0.0038	0.0057	0.0133	0.0029	0.0024	0.0036
Between R^2	0.2391	0.1647	0.2719	0.5032	0.6233	0.5628
Overall R^2	0.0111	0.0128	0.021	0.0107	0.0106	0.0126

Standard errors in parentheses

*p<0.05, **p<0.01,***p<0.001

Appendix B

The results of the relationship between students' BMI z score or weight status and the proximity of food outlets around schools are presented in the 6 tables above. The first 3 uses BMI z score as the dependent variable, and the second set uses the dichotomous obese weight status as dependent variable. The proximity of food outlets around schools is measured by presence of food outlets within a quarter mile of the schools, the counts of the food outlets within a quarter mile of schools, and the closes distance (in 1000 feet) between schools and their closest food outlet. School- and neighborhood-level characteristics used as control variables with the Census tract neighborhood-level data.

The analysis is conducted using pseudo panel data with Random Effect model and heteroskedasticity-robust standard errors, and the analysis is conducted by separating middle and high schools from elementary schools, kindergartens and pre-schools.

APPENDIX C

RELATIONSHIP BETWEEN STUDENTS' BMI Z SCORE OR WEIGHT STATUS, AND PROXIMITY TO FOOD OUTLETS AROUND THE SCHOOL WITH CENSUS BLOCK GROUP DATA

Model Comparison: BMI Z Score with Presence of Outlets, including Race VS No-Race for All & Non-Newark Students

Variable	Pre-K, K & Elementary School			Middle and High School		
	All	Non-Newark		All	Non-Newark	
		No Race	With Race		No Race	With Race
LSR	-0.0207	0.0905	0.106	-0.106*	-0.043	-0.0268
	(0.0584)	(0.0981)	(0.0943)	(0.0503)	(0.0331)	(0.0328)
Supermarket	-0.165*			-0.0385		
	(0.0789)			(0.0654)		
SMALL GROCERY STORE	0.034	0.0489	0.0658	-0.177***	-0.130***	-0.127***
	(0.0742)	(0.1170)	(0.1130)	(0.0450)	(0.0276)	(0.0271)
Convenience Store	-0.106	-0.0781	-0.118	0.0252	0.0207	0.0118
	(0.0751)	(0.0990)	(0.0934)	(0.0471)	(0.0396)	(0.0387)
Large Park	-0.115	-0.00351	0.0247	-0.115*	0.0615	0.0832
	(0.0785)	(0.1450)	(0.1430)	(0.0499)	(0.0498)	(0.0562)
Female	-0.0298	-0.013	-0.0149	0.0445	0.0293	0.0277
	(0.0179)	(0.0173)	(0.0168)	(0.0319)	(0.0360)	(0.0367)
Age	0.00244**	0.00295***	0.00308***	-0.00445***	-0.00383***	-0.00374***
	(0.0008)	(0.0008)	(0.0008)	(0.0007)	(0.0009)	(0.0009)
SchoolSize 2nd Tercile	0.177**	0.0923	0.102	-0.0419	-0.0869**	-0.0879**
	(0.0680)	(0.0647)	(0.0609)	(0.0320)	(0.0337)	(0.0340)
SchoolSize 3rd Tercile	0.202***	0.112	0.0989	-0.00468	-0.0312	-0.0366
	(0.0564)	(0.0797)	(0.0761)	(0.0540)	(0.0453)	(0.0440)
FreeReduced	-0.00061	-0.000825	-0.00169	-0.00692*	-0.00924***	-0.00887***
	(0.0024)	(0.0041)	(0.0041)	(0.0028)	(0.0020)	(0.0020)
Student Black			0.256*			0.14
			(0.1080)			(0.1280)
Student Hispanic			0.435***			0.217
			(0.1190)			(0.1340)
Student Other			0.179			-0.0635
			(0.1700)			(0.1830)
BG Total Crime	0.0000641	0.0000467	0.0000263	0.000101	0.0000414	0.0000376
	(0.0001)	(0.0002)	(0.0002)	(0.0001)	(0.0000)	(0.0000)
BG Hispanic	0.0000331	-0.00104	-0.00175	0.00195	-0.000545	-0.00128
	(0.0022)	(0.0025)	(0.0026)	(0.0010)	(0.0010)	(0.0011)
BG Black	-0.00329	-0.00247	-0.00287	-0.000768	-0.00195	-0.00231
	(0.0023)	(0.0030)	(0.0030)	(0.0010)	(0.0012)	(0.0013)
BG Other	-0.00212	-0.00248	-0.000917	-0.00582	-0.00889**	-0.00793*
	(0.0043)	(0.0077)	(0.0074)	(0.0044)	(0.0031)	(0.0034)
BG MedIncome	-0.000001	0.00000182	0.00000203	0.000000229	0.000000782	0.000000959
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
BG HS	0.0051	0.00454	0.00578	0.00188	0.000598	0.00104

	(0.0029)	(0.0045)	(0.0043)	(0.0015)	(0.0013)	(0.0014)
BG SomeCollege	0.00451	0.0011	0.00517	0.00252	0.000399	0.00135
	(0.0035)	(0.0057)	(0.0055)	(0.0026)	(0.0025)	(0.0028)
Newark	0.116			0.0894		
	(0.1000)			(0.0684)		
New Brunswick	0.231	0.268	0.179	0.151*	0.154***	0.178***
	(0.2480)	(0.2710)	(0.2590)	(0.0672)	(0.0329)	(0.0347)
Trenton	0.253***	0.164	0.17	0.125	0.108**	0.0995*
	(0.0762)	(0.1140)	(0.1110)	(0.0759)	(0.0381)	(0.0405)
Constant	0.461	0.309	-0.0528	2.039***	2.206***	1.983***
	(0.2760)	(0.3400)	(0.3640)	(0.3340)	(0.2720)	(0.3150)
N	12330	8595	8583	9582	5728	5683
Within R^2	0.0021	0.0035	0.0093	0.0040	0.0022	0.0048
Between R^2	0.4610	0.4510	0.4730	0.6932	0.7902	0.7946
Overall R^2	0.0269	0.0235	0.0304	0.0165	0.0161	0.019
Standard errors in parentheses						
*p<0.05, **p<0.01,***p<0.001						

Model Comparison: BMI Z Score with Counts of Outlets, including Race VS No-Race for All & Non-Newark Students

Variable	Pre-K, K & Elementary School			Middle and High School		
	All	Non-Newark		All	Non-Newark	
		No Race	With Race		No Race	With Race
LSR	-0.0044	-0.00224	-0.00177	-0.00139	-0.00618	-0.00483
	(0.0095)	(0.0108)	(0.0113)	(0.0054)	(0.0053)	(0.0065)
Supermarket	-0.0512			0.000474		
	(0.0942)			(0.0940)		
SMALL GROCERY STORES	0.00198	0.168*	0.144*	-0.0499	-0.133***	-0.133***
	(0.0362)	(0.0804)	(0.0731)	(0.0340)	(0.0223)	(0.0250)
Convenience Store	0.0258	0.0341	0.0378	0.000866	0.00761	0.00755
	(0.0200)	(0.0227)	(0.0233)	(0.0118)	(0.0070)	(0.0081)
Female	-0.0308	-0.0128	-0.0151	0.0445	0.0307	0.0294
	(0.0179)	(0.0176)	(0.0169)	(0.0319)	(0.0362)	(0.0372)
Age	0.00248**	0.00287***	0.00312***	-0.00463***	-0.0041***	-0.004***
	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0009)	(0.0008)
SchoolSize 2nd Tercile	0.147*	0.0698	0.0904	-0.0078	-0.0820**	-0.0919**
	(0.0682)	(0.0529)	(0.0534)	(0.0441)	(0.0275)	(0.0302)
SchoolSize 3rd Tercile	0.157*	0.126	0.118	0.0225	-0.0299	-0.0398
	(0.0702)	(0.0690)	(0.0678)	(0.0498)	(0.0465)	(0.0512)
FreeReduced	0.0011	0.00201	0.00143	-0.0041	-0.0083***	-0.008***
	(0.0025)	(0.0042)	(0.0042)	(0.0029)	(0.0017)	(0.0018)
Student Black			0.249*			0.15
			(0.1080)			(0.1290)
Student Hispanic			0.431***			0.223
			(0.1180)			(0.1360)
Student Other			0.18			-0.0618
			(0.1690)			(0.1840)
BG Total Crime	0.0000344	-0.0000105	-0.0000064	0.000141	0.0000471	0.0000335
	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0000)	(0.0001)
BG Hispanic	-0.00373	-0.00313	-0.00398	-0.000109	-0.00123	-0.00159
	(0.0031)	(0.0035)	(0.0035)	(0.0015)	(0.0007)	(0.0008)
BG Black	-0.00619*	-0.00409	-0.00402	-0.00153	-0.00159*	-0.0015
	(0.0028)	(0.0033)	(0.0034)	(0.0012)	(0.0007)	(0.0008)
BG Other	-0.00573	-0.00768	-0.00536	-0.00759	-0.0096***	-0.00917**
	(0.0062)	(0.0047)	(0.0045)	(0.0064)	(0.0028)	(0.0032)
BG MedIncome	-0.000001	0.00000265	0.00000336	0.000000709	0.00000117	0.00000135
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
BG HS	0.00482	0.00752	0.00711	0.00246	0.000872	0.000717
	(0.0031)	(0.0038)	(0.0038)	(0.0014)	(0.0015)	(0.0017)
BG SomeCollege	0.00675	0.00351	0.00546	0.00236	-0.000219	-0.000238

	(0.0046)	(0.0054)	(0.0055)	(0.0033)	(0.0022)	(0.0024)
Newark	0.159			0.0865		
	(0.0886)			(0.0725)		
New Brunswick	0.232	0.179	0.0874	0.215**	0.316**	0.311**
	(0.2440)	(0.2790)	(0.2610)	(0.0778)	(0.0985)	(0.1150)
Trenton	0.297***	0.209*	0.221**	0.0892	0.0599	0.0531
	(0.0768)	(0.0837)	(0.0814)	(0.0645)	(0.0473)	(0.0520)
Constant	0.33	-0.0383	-0.399	1.781***	2.225***	2.032***
	(0.2670)	(0.2990)	(0.3330)	(0.3330)	(0.2350)	(0.2800)
N	12330	8595	8583	9582	5728	5683
Within R^2	0.0021	0.0035	0.0093	0.0040	0.0022	0.0048
Between R^2	0.3974	0.5097	0.5222	0.4577	0.7785	0.7684
Overall R^2	0.0254	0.0277	0.034	0.0141	0.0159	0.0186
Standard errors in parentheses						
*p<0.05, **p<0.01,***p<0.001						

Model Comparison: BMI Z Score with Distance (in 1000 ft.) of Outlets, including Race VS No-Race for All & Non-Newark Students

Variable	Pre-K, K & Elementary School			Middle and High School		
	All	Non-Newark		All	Non-Newark	
		No Race	With Race		No Race	With Race
LSR	0.0323	-0.0606	-0.0733	0.0816*	0.0532**	0.0494**
	(0.0453)	(0.0655)	(0.0657)	(0.0377)	(0.0180)	(0.0169)
Supermarket	-0.00384	0.00967	0.0102	-0.00284	-0.00674	-0.00378
	(0.0148)	(0.0175)	(0.0172)	(0.0055)	(0.0048)	(0.0049)
SMALL GROCERY STORES	0.0221	-0.0414	-0.0442	0.0580***	0.0436*	0.0568**
	(0.0221)	(0.0297)	(0.0294)	(0.0143)	(0.0192)	(0.0174)
Convenience Store	0.0172	0.00333	0.034	-0.0123	-0.0956*	-0.105*
	(0.0681)	(0.0882)	(0.0804)	(0.0466)	(0.0462)	(0.0449)
Large Park	0.0573	-0.154	-0.166	0.0837**	-0.0376	-0.0169
	(0.0625)	(0.0958)	(0.0950)	(0.0289)	(0.0390)	(0.0398)
Female	-0.0322	-0.0124	-0.0144	0.0422	0.0276	0.0271
	(0.0177)	(0.0172)	(0.0168)	(0.0319)	(0.0361)	(0.0373)
Age	0.00228**	0.00301***	0.00314***	-0.0048***	-0.0036***	-0.0034***
	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0009)	(0.0009)
SchoolSize 2nd Tercile	0.181*	-0.0044	0.00091	-0.0278	-0.106***	-0.0981**
	(0.0740)	(0.0872)	(0.0846)	(0.0407)	(0.0278)	(0.0312)
SchoolSize 3rd Tercile	0.180**	0.0605	0.0461	0.00389	-0.0505	-0.0782*
	(0.0593)	(0.0726)	(0.0713)	(0.0442)	(0.0386)	(0.0386)
FreeReduced	-0.00273	-0.00314	-0.00423	-0.009***	-0.0094***	-0.0109***
	(0.0030)	(0.0047)	(0.0046)	(0.0026)	(0.0020)	(0.0018)
Student Black			0.257*			0.135
			(0.1090)			(0.1280)
Student Hispanic			0.435***			0.213
			(0.1190)			(0.1350)
Student Other			0.179			-0.0721
			(0.1710)			(0.1840)
BG Total Crime	0.000208	0.00000628	-0.0000137	0.000236*	0.00007	0.000035
	(0.0002)	(0.0003)	(0.0003)	(0.0001)	(0.0000)	(0.0000)
BG Hispanic	-0.000188	-0.00256	-0.00271	0.000843	-0.00307**	-0.00346*
	(0.0027)	(0.0036)	(0.0034)	(0.0013)	(0.0011)	(0.0014)
BG Black	-0.00423	-0.0029	-0.00264	-0.000846	-0.00318**	-0.00291*
	(0.0026)	(0.0034)	(0.0032)	(0.0009)	(0.0011)	(0.0012)
BG Other	-0.00126	-0.00468	-0.00329	-0.00108	-0.00866**	-0.00631
	(0.0054)	(0.0070)	(0.0066)	(0.0049)	(0.0032)	(0.0039)
BG MedIncome	-0.000002	0.00000221	0.00000224	-0.000001	0.00000141	0.00000174
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
BG HS	0.00279	0.00368	0.00448	0.0019	0.00000784	-0.000063

	(0.0033)	(0.0042)	(0.0039)	(0.0012)	(0.0010)	(0.0012)
BG SomeCollege	0.00539	-0.000512	0.00227	0.00267	0.00203	0.00372
	(0.0040)	(0.0053)	(0.0053)	(0.0024)	(0.0030)	(0.0031)
Newark	0.155			0.105		
	(0.1040)			(0.0660)		
New Brunswick	0.226	0.252	0.185	0.158*	0.0903	0.107*
	(0.2500)	(0.2440)	(0.2290)	(0.0689)	(0.0573)	(0.0452)
Trenton	0.283**	0.192*	0.200*	0.0868	0.0499	0.0246
	(0.0876)	(0.0964)	(0.0964)	(0.0730)	(0.0572)	(0.0512)
Constant	0.369	0.911	0.565	1.772***	2.289***	2.125***
	(0.2720)	(0.5180)	(0.5080)	(0.3180)	(0.2250)	(0.2360)
N	12330	8595	8583	9582	5728	5683
Within R^2	0.0021	0.0035	0.0093	0.0040	0.0022	0.0048
Between R^2	0.3600	0.4942	0.5089	0.6874	0.7758	0.8278
Overall R^2	0.0253	0.023	0.0299	0.0165	0.0161	0.0192

Standard errors in parentheses

*p<0.05, **p<0.01,***p<0.001

Model Comparison: Obese Weight Status with Presence of Outlets, including Race VS No-Race for All & Non-Newark Students

Variable	Pre-K, K & Elementary School			Middle and High School		
	All	Non-Newark		All	Non-Newark	
		No Race	With Race		No Race	With Race
LSR	-0.0153	0.000185	0.00534	-0.0171	0.00181	0.00585
	(0.0126)	(0.0149)	(0.0136)	(0.0162)	(0.0178)	(0.0182)
Supermarket	-0.0314			0.0129		
	(0.0240)			(0.0207)		
SMALL GROCERY STORES	-0.00615	-0.0185	-0.0128	-0.0572***	-0.0301	-0.0307
	(0.0156)	(0.0288)	(0.0262)	(0.0157)	(0.0232)	(0.0220)
Convenience Store	-0.00716	0.00426	-0.0146	-0.00773	-0.0123	-0.0133
	(0.0212)	(0.0194)	(0.0189)	(0.0178)	(0.0242)	(0.0263)
Large Park	-0.0174	-0.038	-0.0249	-0.0461**	-0.0107	0.0105
	(0.0146)	(0.0247)	(0.0238)	(0.0170)	(0.0320)	(0.0299)
Female	-0.0180*	-0.00412	-0.00529	-0.00863	-0.00621	-0.00784
	(0.0088)	(0.0066)	(0.0064)	(0.0107)	(0.0121)	(0.0123)
Age	0.00105***	0.00133***	0.00138***	-0.00165***	-0.00157***	-0.0016***
	(0.0002)	(0.0003)	(0.0002)	(0.0003)	(0.0005)	(0.0005)
SchoolSize 2nd Tercile	0.0218	0.022	0.0281*	-0.0265	-0.0304	-0.0411
	(0.0139)	(0.0127)	(0.0122)	(0.0152)	(0.0249)	(0.0269)
SchoolSize 3rd Tercile	0.0442***	0.0425***	0.0374***	-0.0211	-0.033	-0.048
	(0.0119)	(0.0127)	(0.0112)	(0.0232)	(0.0306)	(0.0332)
FreeReduced	0.0003	0.00148*	0.000958	-0.00230*	-0.00260*	-0.00272*
	(0.0006)	(0.0007)	(0.0007)	(0.0010)	(0.0012)	(0.0012)
Student Black			0.0515			-0.00256
			(0.0297)			(0.0598)
Student Hispanic			0.137***			0.0356
			(0.0327)			(0.0686)
Student Other			0.0231			-0.0159
			(0.0473)			(0.0805)
BG Total Crime	0.0000417	0.00000468	-0.00000309	0.0000145	0.0000236	0.0000273
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
BG Hispanic	-0.0000683	0.0000512	-0.0003	0.000994*	-0.000235	-0.000553
	(0.0006)	(0.0007)	(0.0008)	(0.0004)	(0.0007)	(0.0008)
BG Black	-0.00103	-0.000378	-0.00056	0.000256	-0.000586	-0.000705
	(0.0006)	(0.0008)	(0.0008)	(0.0004)	(0.0009)	(0.0009)
BG Other	-0.000944	-0.00177	-0.00112	-0.00104	-0.00181	-0.00155
	(0.0011)	(0.0017)	(0.0016)	(0.0014)	(0.0019)	(0.0017)
BG MedIncome	-0.0000005	0.000000281	0.000000351	0.000000321	0.000000323	0.00000055
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
BG HS	0.000727	0.00043	0.000869	0.000906	0.0000566	-0.0000228

	(0.0005)	(0.0007)	(0.0006)	(0.0006)	(0.0009)	(0.0009)
BG SomeCollege	0.000637	-0.00111	0.000635	0.000292	-0.000718	-0.0000162
	(0.0007)	(0.0011)	(0.0011)	(0.0007)	(0.0020)	(0.0019)
Newark	0.0417*			0.0269		
	(0.0193)			(0.0216)		
New Brunswick	0.0845	0.109	0.0654	0.0674**	0.0348	0.0572*
	(0.0536)	(0.0654)	(0.0615)	(0.0245)	(0.0271)	(0.0270)
Trenton	0.0632***	0.0438*	0.0467**	0.042	0.0357	0.0369
	(0.0164)	(0.0190)	(0.0175)	(0.0264)	(0.0269)	(0.0240)
Constant	0.13	0.0145	-0.0681	0.668***	0.783***	0.765***
	(0.0759)	(0.0879)	(0.0991)	(0.1330)	(0.1470)	(0.1200)
N	12330	8595	8583	9582	5728	5683
Within R^2	0.0032	0.0056	0.0136	0.0029	0.0019	0.0036
Between R^2	0.2179	0.1234	0.2178	0.5202	0.6404	0.6229
Overall R^2	0.0127	0.0133	0.022	0.0118	0.0121	0.0142
Standard errors in parentheses						
*p<0.05, **p<0.01,***p<0.001						

Model Comparison: Obese Weight Status with Counts of Outlets, including Race VS No-Race for All & Non-Newark Students

Variable	Pre-K, K & Elementary School			Middle and High School		
	All	Non-Newark		All	Non-Newark	
		No Race	With Race		No Race	With Race
LSR	-0.00243	-0.000239	-0.000825	-0.00153	-0.00116	-0.00015
	(0.0020)	(0.0026)	(0.0023)	(0.0019)	(0.0026)	(0.0029)
Supermarket	-0.0231			0.00194		
	(0.0189)			(0.0242)		
SMALL GROCERY STORES	0.0032	0.0188	0.0257*	-0.00797	-0.019	-0.0227
	(0.0059)	(0.0151)	(0.0116)	(0.0097)	(0.0158)	(0.0158)
Convenience Store	0.000303	0.00624	0.00398	0.00105	-0.00144	-0.00175
	(0.0043)	(0.0055)	(0.0050)	(0.0038)	(0.0041)	(0.0043)
Female	-0.0180*	-0.00442	-0.00558	-0.00873	-0.00621	-0.0079
	(0.0088)	(0.0065)	(0.0064)	(0.0108)	(0.0120)	(0.0122)
Age	0.00106***	0.00138***	0.00141***	-0.002***	-0.00165***	-0.00165***
	(0.0002)	(0.0003)	(0.0002)	(0.0003)	(0.0005)	(0.0005)
SchoolSize 2nd Tercile	0.0206	0.0182	0.0214	-0.02	-0.0325	-0.0423*
	(0.0128)	(0.0130)	(0.0110)	(0.0164)	(0.0202)	(0.0208)
SchoolSize 3rd Tercile	0.0437***	0.0383***	0.0359***	-0.00424	-0.0262	-0.0391
	(0.0124)	(0.0106)	(0.0089)	(0.0211)	(0.0280)	(0.0305)
FreeReduced	0.000626	0.00211*	0.00124	-0.0016	-0.00283**	-0.00282**
	(0.0005)	(0.0010)	(0.0009)	(0.0009)	(0.0009)	(0.0010)
Student Black			0.0514			-0.000925
			(0.0302)			(0.0599)
Student Hispanic			0.137***			0.0365
			(0.0327)			(0.0689)
Student Other			0.0228			-0.0157
			(0.0473)			(0.0807)
BG Total Crime	0.0000348	-0.0000006	-0.00000583	0.0000243	0.0000221	0.0000162
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
BG Hispanic	-0.000617	-0.000688	-0.000917	0.000183	-0.000477	-0.000558
	(0.0008)	(0.0010)	(0.0010)	(0.0007)	(0.0005)	(0.0005)
BG Black	-0.00154*	-0.00116	-0.00121	-0.000346	-0.000905	-0.000701
	(0.0007)	(0.0009)	(0.0009)	(0.0006)	(0.0006)	(0.0006)
BG Other	-0.00136	-0.00191	-0.00161	-0.00157	-0.00218	-0.00205
	(0.0014)	(0.0012)	(0.0013)	(0.0019)	(0.0018)	(0.0018)
BG MedIncome	-0.0000006	3.91E-08	0.000000298	-4.32E-08	0.000000168	0.000000443
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
BG HS	0.000719	0.00137*	0.00148*	0.000861	0.0000657	-0.000242
	(0.0006)	(0.0007)	(0.0006)	(0.0005)	(0.0007)	(0.0008)
BG SomeCollege	0.000846	0.000422	0.00148	0.000468	-0.000347	-0.000407

	(0.0007)	(0.0010)	(0.0010)	(0.0009)	(0.0016)	(0.0017)
Newark	0.0489**			0.0365		
	(0.0163)			(0.0188)		
New Brunswick	0.091	0.0825	0.0382	0.0783*	0.0499	0.0549
	(0.0620)	(0.0659)	(0.0637)	(0.0346)	(0.0274)	(0.0357)
Trenton	0.0660***	0.0526**	0.0535**	0.0508*	0.0342	0.0274
	(0.0168)	(0.0199)	(0.0163)	(0.0238)	(0.0246)	(0.0270)
Constant	0.128	-0.0754	-0.117	0.638***	0.823***	0.814***
	(0.0759)	(0.0943)	(0.1020)	(0.1320)	(0.1440)	(0.1340)
N	12330	8595	8583	9582	5728	5683
Within R^2	0.0032	0.0056	0.0136	0.0029	0.0019	0.0036
Between R^2	0.2318	0.1409	0.2091	0.4067	0.6177	0.6312
Overall R^2	0.0125	0.0137	0.0224	0.0104	0.012	0.0139
Standard errors in parentheses						
*p<0.05, **p<0.01,***p<0.001						

Model Comparison: Obese Weight Status with Distance (in 1000 ft.) of Outlets, including Race VS No-Race for All & Non-Newark Students

Variable	Pre-K, K & Elementary School			Middle and High School		
	All	Non-Newark		All	Non-Newark	
		No Race	With Race		No Race	With Race
LSR	0.0125	-0.000618	-0.00553	0.00128	-0.00573	-0.00559
	(0.0097)	(0.0097)	(0.0094)	(0.0123)	(0.0116)	(0.0131)
Supermarket	0.00119	0.00225	0.00197	-0.00182	-0.000938	-0.000109
	(0.0024)	(0.0026)	(0.0025)	(0.0022)	(0.0023)	(0.0023)
SMALL GROCERY STORES	0.00522	0.000916	0.000311	0.00834*	0.0247*	0.0259*
	(0.0042)	(0.0046)	(0.0041)	(0.0039)	(0.0109)	(0.0124)
Convenience Store	0.00248	-0.00219	0.0138	0.0266	0.00268	-0.00586
	(0.0136)	(0.0169)	(0.0134)	(0.0165)	(0.0272)	(0.0298)
Large Park	0.0111	0.000726	-0.00355	0.0217*	0.0468*	0.0382
	(0.0115)	(0.0151)	(0.0139)	(0.0103)	(0.0222)	(0.0245)
Female	-0.0184*	-0.00437	-0.00532	-0.00996	-0.00688	-0.00853
	(0.0088)	(0.0065)	(0.0064)	(0.0107)	(0.0121)	(0.0123)
Age	0.00101***	0.00134***	0.00139***	-0.00195***	-0.00152***	-0.00147**
	(0.0002)	(0.0003)	(0.0002)	(0.0003)	(0.0005)	(0.0005)
SchoolSize 2nd Tercile	0.0194	0.0132	0.0192	-0.0269	-0.0000943	-0.00892
	(0.0143)	(0.0170)	(0.0161)	(0.0150)	(0.0193)	(0.0208)
SchoolSize 3rd Tercile	0.0411***	0.0347**	0.0298**	-0.00963	-0.0503*	-0.0613**
	(0.0111)	(0.0127)	(0.0116)	(0.0199)	(0.0227)	(0.0226)
FreeReduced	0.000032	0.000992	0.000422	-0.00212*	-0.00501***	-0.00510***
	(0.0006)	(0.0008)	(0.0007)	(0.0008)	(0.0014)	(0.0014)
Student Black			0.0504			-0.00548
			(0.0298)			(0.0601)
Student Hispanic			0.138***			0.0327
			(0.0329)			(0.0690)
Student Other			0.0251			-0.0228
			(0.0472)			(0.0814)
BG Total Crime	0.0000475	-0.0000055	-0.0000071	0.0000616*	0.0000151	0.0000042
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
BG Hispanic	0.0000283	-0.0000939	-0.000149	0.000927	0.000076	-0.000421
	(0.0006)	(0.0009)	(0.0009)	(0.0005)	(0.0008)	(0.0008)
BG Black	-0.00106	-0.000739	-0.000576	0.000258	-0.000237	-0.000373
	(0.0005)	(0.0009)	(0.0008)	(0.0004)	(0.0007)	(0.0007)
BG Other	-0.000454	-0.000968	-0.00029	0.0000322	0.000095	0.000296
	(0.0012)	(0.0015)	(0.0014)	(0.0013)	(0.0023)	(0.0023)
BG MedIncome	-0.000000749*	-8.47E-08	-8.30E-08	-0.000000131	0.000000661	0.000000835
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
BG HS	0.000712	0.000954	0.00122*	0.000780*	0.000318	0.0000835

	(0.0006)	(0.0007)	(0.0006)	(0.0004)	(0.0007)	(0.0007)
BG SomeCollege	0.00111	0.000128	0.0013	-0.0000685	0.00176	0.00215
	(0.0006)	(0.0010)	(0.0009)	(0.0007)	(0.0017)	(0.0018)
Newark	0.0496*			0.0236		
	(0.0208)			(0.0197)		
New Brunswick	0.0965	0.103	0.0703	0.0762**	0.0122	0.0201
	(0.0578)	(0.0705)	(0.0644)	(0.0282)	(0.0257)	(0.0261)
Trenton	0.0678***	0.0525*	0.0558**	0.0312	-0.0234	-0.0236
	(0.0187)	(0.0205)	(0.0201)	(0.0210)	(0.0316)	(0.0339)
Constant	0.0675	0.00268	-0.0899	0.593***	0.734***	0.757***
	(0.0727)	(0.1110)	(0.1110)	(0.1290)	(0.1290)	(0.1110)
N	12330	8595	8583	9582	5728	5683
Within R^2	0.0032	0.0056	0.0136	0.0029	0.0019	0.0036
Between R^2	0.2118	0.1752	0.2854	0.5978	0.7319	0.7517
Overall R^2	0.0126	0.0131	0.022	0.0118	0.0123	0.0142

Standard errors in parentheses

*p<0.05, **p<0.01,***p<0.001

Appendix C

The results of the relationship between students' BMI z score or weight status and the proximity of food outlets around schools are presented in the 6 tables above. The first 3 uses BMI z score as the dependent variable, and the second set uses the dichotomous obese weight status as dependent variable. The proximity of food outlets around schools is measured by presence of food outlets within a quarter mile of the schools, the counts of the food outlets within a quarter mile of schools, and the closes distance (in 1000 feet) between schools and their closest food outlet. School- and neighborhood-level characteristics used as control variables with the Census block group neighborhood-level data.

The analysis is conducted using pseudo panel data with Random Effect model and heteroskedasticity-robust standard errors, and the analysis is conducted by separating middle and high schools from elementary schools, kindergartens and pre-schools.