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Schools as Moderators of Neighborhood Influences on Adolescent Academic
Achievement and Risk of Obesity: A Cross-Classified Multilevel Investigation

by

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A dissertation submitted in partial fulfillment
of the requirements for the degree of
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Nothing great was ever achieved without enthusiasm.

Ralph Waldo Emerson

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Bethany A. Bell-Ellison

ABSTRACT

Grounded in Bronfenbrenner's (1979) Ecological Systems Theory and through the application of cross-classified random effects models, the goal of this study was to examine simultaneously neighborhood and school influences on adolescent academic achievement and risk of obesity, as well as the moderating effects of schools on these outcomes. By examining concurrently neighborhood and school influences on achievement and risk of obesity, this study aimed to fill gaps in the social determinants literature. For example, it is unclear if where an adolescent lives or where she/he attends school has a stronger influence on academic achievement. We also do not know if schools can moderate neighborhood influences on adolescent achievement, nor do we know much about the relationships among schools, neighborhoods, and adolescent risk for obesity. Using data from the National Longitudinal Study of Adolescent Health and the Adolescent Health and Academic Achievement study, four research questions were investigated:

- (1) To what extent are neighborhood influences on U.S. middle and high school students' academic achievement moderated by school environments?

(2) What are the relative influences of neighborhood and school environments on U.S. middle and high school students' academic achievement? (3) To what extent are neighborhood influences on U.S. middle and high school students' risk of obesity moderated by school environments?

(4) What are the relative influences of neighborhood and school environments on U.S. middle and high school students' risk of obesity?

Findings did not suggest a moderating relationship between neighborhood and school factors examined in this study. In terms of relative relationships with academic achievement, three neighborhood factors (affluence, racial composition, and urbanicity) and two school characteristics (student body racial composition and school socioeconomic status) appeared to have the strongest relationships with adolescent achievement after controlling for individual and other neighborhood and school characteristics. For adolescent risk of obesity, neighborhood affluence and racial composition had statistically significant unique associations, whereas no school factors evidenced statistically significantly relationships with risk of obesity after controlling for other factors. Results of the study were interpreted in terms of contributions to the social determinants literature, as well as recommendations for the improvement of future large-scale surveys.

Chapter One

Introduction

Statement of the Problem

Academic achievement has been an outcome of interest to educational researchers since the beginning of education in the United States. To date, students' achievement has been studied from several perspectives. In the past, researchers tended to focus more on individual and family characteristics (e.g., Marsh & Yeung, 1997; Muijs, 1997; Wentzel, 1998; White, 1982) whereas, recently, an increasing amount of research has focused more on possible social determinants related to academic achievement, including neighborhood characteristics and school environments (e.g., Baker, Robinson, Danner, & Neukrug, 2001; Boardman & Saint Onge, 2005; Bowen & Bowen, 1999; Crosnoe & Muller, 2004; Darling-Hammond, 1999; Everson & Millsap, 2004). However, even though there has been an increase in the number of studies that have investigated academic achievement from a social determinants perspective, it is by no means a new concept.

For example, *Equality of Educational Opportunity* (Coleman et al., 1966) was the first comprehensive, nation-wide investigation into school influences on academic achievement (Dyer, 1972). Similarly, in his response to Coleman et al.'s (1966) findings and through a reexamination of the data, Armor (1972) attempted to look past the school environment and examined neighborhood influences on academic achievement. Albeit

Armor's neighborhood measure was crude and based solely on aggregated characteristics of students' families, it was still an early attempt to understand how a child's social environment relates to academic achievement. Likewise, Bronfenbrenner's (1979) Ecological Systems Theory emphasizes the fact that youth do not live in isolation. Instead, they develop in a variety of contexts, each of which interacts with their development (Bronfenbrenner, 1979).

However, despite previous research findings and suggestions that schools might be powerful moderators of neighborhood effects on adolescent development (Leventhal & Brooks-Gunn, 2000), few researchers have examined neighborhood and school influences simultaneously. For example, in their review of 42 neighborhood influence articles on child and adolescent developmental outcomes published using both local and national data, Leventhal and Brooks-Gunn (2000) found only two articles that examined neighborhoods and schools simultaneously. Moreover, in my own review of social context articles published using data from three nationally representative adolescent studies, I found 16 studies involving the examination of neighborhood influences on adolescent education and health outcomes, 12 studies wherein school environments were examined, and 4 studies involving the examination of the two environments simultaneously.

Yet, none of the studies, from either of the reviews, which included both neighborhood and school characteristics, employed the appropriate analytic techniques necessary to understand the simultaneous influences of these two social environments, nor did they examine the interaction, or moderating relationship, between these social

environments. One exception, not included in either review, is Raudenbush and Bryk's (2002) discussion of neighborhood and school contributions to educational attainment among adolescents in Scotland. However, they also did not investigate whether schools were moderators of neighborhood influences on achievement.

In addition to previous researchers' lack of investigating multiple environments in relation to adolescent development, they have also tended to limit their investigations to single areas of development and well-being. For example, within educational research, dependent variables are often related to cognitive development (e.g., IQ, grade point average, standardized test performance) whereas criterion variables in public health research are typically related to aspects of physical development (e.g., weight status, drinking and smoking, sexual initiation). However, an adolescent's development is often perceived to include four separate, yet related areas of well-being: spiritual, mental (intellectual), emotional, and physical (Seaward, 1999). Thus, consistent with the need to examine simultaneously neighborhood and school influences, it is also necessary for social and behavioral scientists to look beyond single areas of development and investigate multiple realms of adolescent well-being.

Rationale for the Study

Bronfenbrenner's (1979) Ecological Systems Theory posits that human development is influenced by the interrelations among settings in which a person actively participates (e.g., family, school, neighborhoods, religious institutions); thus, to study human development effectively, we need to look beyond a single environment and analyze the interactions among multiple environments. When neighborhoods and schools

are conceptualized as representing interrelated social environments, as advocated by Bronfenbrenner (1979), they are no longer simply places where an adolescent resides or simple institutions for educating our youth. Instead, they are viewed as intricate social structures that impact a child's overall well-being, including intellectual, emotional, and physical development, through complex social processes. Distinguishing between people and places is artificial—as noted by McIntyre and Ellaway (2003), “people create places and places create people” (p. 26).

In a quest to understand factors associated with adolescent educational outcomes, researchers have focused on individual and family characteristics, as well as on social and environmental influences. Over the past few decades, an increasing number of researchers have investigated possible environmental factors related to adolescent academic achievement, including neighborhood characteristics and school environments. Examples of significant neighborhood and school characteristics related to academic achievement include: neighborhood affluence, perceived neighborhood quality, aggregated school poverty, teacher quality, and school social climate (Bowen & Bowen, 1999; Crosnoe & Muller, 2004; Darling-Hammond, 1999; Everson & Millsap, 2004; Halpern-Felsher et al., 1997). In addition, in their example of cross-classified random effects models (CCREMs), Raudenbush and Bryk (2002) found neighborhood deprivation to be significantly related to attainment, while statistically controlling for individual and school characteristics.

However, the simultaneous investigation of neighborhood and school influences on adolescent achievement is rare and the examination of schools as moderators of

neighborhood influences appears to be non-existent. In addition, among studies in which neighborhoods and schools have been examined separately, most did not take into account the nested structure of the data. Consequently, results from these studies do not delineate how much variation in the educational outcome of interest is related to individual characteristics and how much is related to differences in the neighborhoods in which they live or the schools youth attend.

Interestingly, whereas neighborhoods and schools have been investigated separately for their influences on educational outcomes, as well as other health behaviors (e.g., smoking and drinking), considerably less research has been conducted on neighborhood and school influences on adolescent risk of obesity. Furthermore, although schools and school policies have been suggested as representing important channels to help prevent child and adolescent obesity (Carter, 2002), the limited social determinants research that has been conducted in this area is relatively new and has primarily focused on neighborhood, not school, influences on adolescent obesity. To date, based on the handful of studies that have involved an examination of neighborhood characteristics related to adolescent risk of obesity, initial findings suggest that neighborhood socioeconomic status (SES), recreational facilities, and collective efficacy are related to adolescent obesity (Cohen, Finch, Bower, & Sastry, 2006; Gordon-Larsen, Nelson, Page, & Popkin, 2006; Nelson, Gordon-Larsen, Song, & Popkin, 2006).

These initial findings and suggestions support further investigation of neighborhood and school influences on adolescent risk of obesity. Moreover, because of the growing epidemic of adolescent obesity as well as research findings that suggest

being at risk of obesity not only affects a teenager's future health as an adult, but also negatively impacts adolescent academic achievement during the middle and high school years (Crosnoe & Muller, 2004), investigation of the simultaneous and moderating neighborhood and school influences on adolescent risk of obesity is crucial.

Purpose of the Study

Grounded in Bronfenbrenner's (1979) Ecological Systems Theory and through the application of advanced multilevel modeling techniques (Raudenbush & Bryk, 2002), the primary goal of this study was to examine simultaneously neighborhood and school influences on academic achievement and adolescent risk of obesity and to examine the moderating effects of schools on these outcomes. By examining concurrently neighborhood and school influences on academic achievement and adolescent risk of obesity, this study aimed to fill an important gap in the social determinants literature. For example, it is unclear if where an adolescent lives or where she/he attends school has a stronger influence on academic achievement. We also do not know if schools can moderate neighborhood influences on adolescent academic achievement, nor do we know much about the relationships among schools, neighborhoods, and adolescent risk for obesity. Similarly, by investigating outcomes related to both mental and physical well-being, this study helps expand the traditional single-domain approach often undertaken in social and behavioral science research.

Research Questions

The following four research questions were investigated in the current study:

Research Question 1. To what extent are neighborhood influences on U.S. middle and high school students' academic achievement moderated by school environments?

Research Question 2. What are the relative influences of neighborhood and school environments on U.S. middle and high school students' academic achievement?

Research Question 3. To what extent are neighborhood influences on U.S. middle and high school students' risk of obesity moderated by school environments?

Research Question 4. What are the relative influences of neighborhood and school environments on U.S. middle and high school students' risk of obesity?

Overview of Study Design

This study employed a nonexperimental, retrospective, correlational research design. Secondary data analyses of the nationally representative National Longitudinal Study of Adolescent Health (Add Health; National Longitudinal Study of Adolescent Health [Add Health], 2005c) and Adolescent Health and Academic Achievement (AHAA; Adolescent Health and Academic Achievement Study [AHAA], n.d.) restricted-use data were conducted. The study design was also cross-sectional in nature because the data represented one point in time.

Although multilevel modeling techniques are being used with increasing frequency by educational and other social science researchers, use of CCREMs (Raudenbush & Bryk, 2002) is still rare in educational research. The lack of CCREMs in education is particularly troubling given the cross-classified nature of many education

data structures. For example, Level-1 units (students) are often cross-classified by two Level-2 factors (schools and neighborhoods) such that students from Neighborhood A might attend a school that students from Neighborhood B and Neighborhood C also attend, and students from the same neighborhood might attend different schools (Figure 1). When cross-classification of data is ignored, models are misspecified, causing them to lack the level of control necessary to detect important and possible confounding effects, which, in turn, can lead to spurious conclusions.

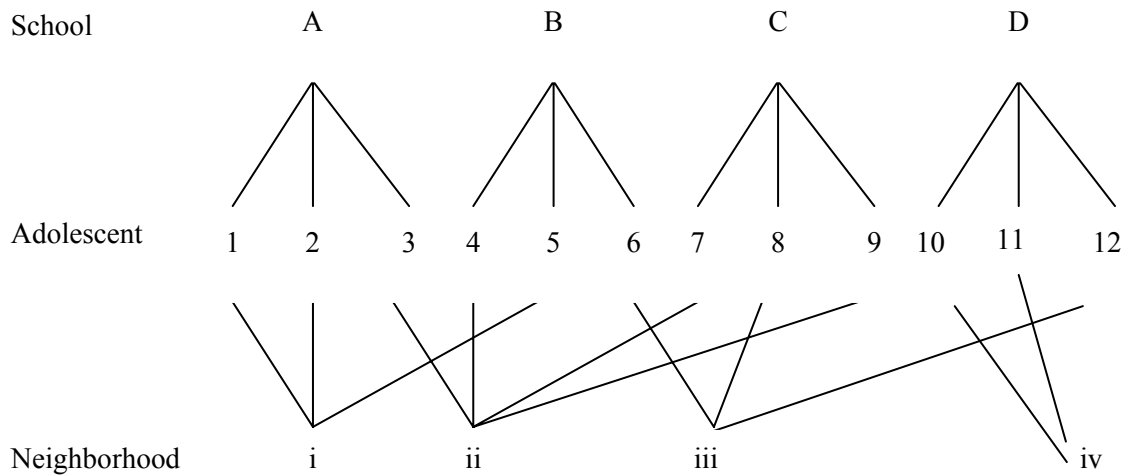


Figure 1. Example schematic of cross-classified data with adolescents nested within schools and neighborhoods.

For this study, the cross-classified multilevel analyses allowed the examination of the influence of multiple contexts on academic achievement and risk of obesity, while statistically controlling for one another. That is, because neighborhood and school environments were analyzed simultaneously, results represent each environment's unique influence on achievement and risk of obesity. Further, use of interactions within the

CCREMs allowed the investigation of the school environment as a moderator of neighborhood influences on each of the outcomes.

Data Sources

Data for the study were drawn from Wave I of Add Health (2005c) and AHAA (n.d.)—nationally representative studies with foci on the relationship between social environments and adolescent education and health outcomes. Within these studies, data were obtained from numerous sources including questionnaires, interviews, and existing contextual databases (e.g., U.S. Census). Currently, Add Health is the largest, most comprehensive study of adolescents ever conducted, with data at the individual, family, school, and neighborhood levels collected in three waves—1994 (Wave 1), 1996 (Wave 2), and 2001-2002 (Wave 3). AHAA data expand Add Health data by providing detailed measures of Add Health participants' educational experiences, including information on the educational contexts of Add Health schools. All data used for the current study came from the restricted-use version of the data sources. More information about the studies and the sampling procedures employed is provided in Chapter Three.

Significance of the Study

By examining simultaneously neighborhood and school influences on multiple adolescent outcomes, this study contributes to our understanding of the dynamic relationship between neighborhoods and schools and their relative influences on adolescent academic achievement and risk of obesity. Before this study, neighborhood and school environments had not been studied together; therefore, previous research findings needed to be interpreted with caution (i.e., when studying neighborhood effects,

it was unclear if neighborhood factors were responsible or if school factors were operating as well, and vice versa). However, given the advanced multilevel modeling techniques employed in the current study, findings from this study are likely to be less biased than previous findings. Nonetheless, given the correlational design of the current study, results from the current study still cannot be used to guide policies or programs related to adolescent development.

Instead, the most significant contribution of the current study is its addition to the social determinants literature. This study helps to advance our knowledge of social determinants of adolescent development and provides new findings for future researchers to build upon in the creation of experimental, quasi-experimental, and qualitative studies focused on the complex relationships between social environments and adolescent well-being. Likewise, by investigating academic achievement and risk of obesity, this study helps expand the single-domain focus often followed by social and behavioral science researchers.

Delimitations

The following delimitations were imposed on this study:

1. The study was limited to adolescents who participated in both the Wave I In-School Questionnaire and Wave I In-Home Interview, were in 7th through 12th grade at regular middle and high schools during the 1994-1995 academic year, and had responses to all variables included in the study.
2. The operationalization of academic achievement was restricted to adolescent's Add Health Picture Vocabulary Test (AHPVT) scores.

3. The operationalization of risk of obesity was constrained to self-report measures of height and weight.
4. The operationalization of neighborhood was restricted to neighborhoods defined at the census tract level.
5. The operationalization of school was limited to regular public and private junior high, middle, and high schools (i.e., not magnet or alternative schools).
6. The operationalization of school was constrained to the school building level.

Limitations

Although this study contributes to the social determinants literature and enhances our understanding of neighborhoods and schools and their relationships with adolescent academic achievement and risk of obesity, it is not without limitations. For example, this study utilized a non-experimental design, thus the most that could be concluded about the findings was whether the data contradicted or did not contradict the models used to answer the research questions. This limitation is strong enough that some would not use the term ‘influence’ in the title of a study such as this. However, acceptable use of the word ‘influence’ is not as clear and well-defined as many perceive it to be.

The degree to which causal inferences can be drawn from any study lies along a continuum (e.g., Frazier, Tix, & Barron, 2004) and the cut-points delineating such inferences are not the same across researchers or across disciplines. For example, in the social and behavioral sciences, studies that utilize a true experimental design are often deemed worthy of making causal inference statements whereas non-experimental and quasi-experimental studies are not (e.g., Games, 1990). However, even among studies

that appear to fulfill the three commonly referenced criteria for inferring causality in the social and behavioral sciences (i.e., relationship exists between X and Y, X precedes Y, and ruling out of alternative explanations; Shadish, Cook, & Campbell, 2002), true causal statements are still questionable.

First, to make sound causal statements, each person in a study needs to be exposed to all of the conditions (i.e., each person needs to be in the control group and treatment group; Holland, 1986; Sobel, 1995), which is virtually impossible in the social and behavioral sciences. For example, it is not possible to place a person in the treatment group first and then undo any knowledge or change that occurred as result of the treatment or intervention and then place him or her in the control group. Similarly, issues such as history and maturation prohibit researchers' ability to expose a person to the control condition first and then to the treatment group. Unless a person is in both conditions at the same time, he or she is never exactly the same entity, thus researchers are not able to fulfill the requirement of each person in a study being exposed to both conditions.

To address the impossibility of exposing people to both control and treatment groups, social and behavioral scientist often conduct their research under the stable-unit-treatment-value assumption (SUTVA), an

a priori assumption that the value of Y for unit u when exposed to treatment t will be the same no matter what mechanism is used to assign treatment t to unit u and no matter what treatments the other units receive (Rubin, 1986, p. 961).

Operating under SUTVA, social and behavioral scientists also apply various statistical solutions that allow them to estimate the average causal effect of X over a population (Holland, 1986). Consequently, even the results from well-designed experiments only represent the “average causal effect” and not causal effects at the individual level.

Second, even when possible “average causal effects” are discovered, social and behavioral scientists rarely address the mechanisms behind such relationships (i.e., the nature of the causal effect is usually ignored). In doing so, we are left with an incomplete understanding of the relationship between X and Y. Third, all alternative explanations are rarely able to be ruled out. Most researchers assume that random assignment creates equal groups, but we can never be 100% certain that even randomly assigned groups are equal on all possible extraneous variables (i.e., there is always the possibility of committing a Type 1 error).

In addition to true experiments, replication and extensions of non-experimental studies are other common methods for gathering evidence to support causal inferences in the social and behavioral sciences. Through this process, researchers aim to gather data, of varying quality, to rule out possible alternative explanations and to accumulate data that are consistent with causal effects. It is within this part of the research process that the current study fits. Although findings from a single correlational study cannot provide evidence of causation, they can and should be used to help inform hypotheses for experimental studies (Games, 1990). This study was developed by “standing on the shoulders of giants who have gone before” and it is hoped that the findings from this study will help inform hypotheses to be examined in future experimental research.

However, in order for this study to adequately contribute to the social determinants literature and future research, it was important that the language used in the this study is consistent with the language currently used in the social determinants literature [i.e., use of the word influence because this is the term commonly used in the literature (e.g., Beale Spencer, Cole, Jones, & Phillips Swanson, 1997; Boyle, Georgiades, Racine, & Mustard, 2007; Chase-Lansdale, Gordon, Brooks-Gunn, & Klebanov, 1997; Cohen et al., 2006; Dornbusch, Ritter, & Steinberg, 1991; Eamon, 2005; French, Story, & Jeffery, 2001; Janssen, Boyce, Simpson, & Pickett, 2006; Wickrama, Wickrama, & Bryant, 2006)]. If it is not consistent, other researchers in the field will be less likely to read and build upon the findings. However, with this said, it is also important to note that use of the word influence in the title of this study was not intended to show causal relationships. As previously stated, the most that could be concluded about the findings from this study was whether the data contradicted or did not contradict the models used to answer the research questions.

Other study limitations include several threats to external and internal validity. Specifically, ecological validity, specificity of variables, temporal validity, and crud factor (Onwuegbuzie, 2003) are four threats to external validity of the current study. Ecological validity is a threat because statistical software packages cannot include sampling weights with CCREMs, thus findings from the current study have limited generalizability and cannot be generalized to the national population. Similarly, because the variables included in the current study were collected at a specific location, under specific circumstances and are used under a specific operational definition

(Onwuegbuzie, 2003), specificity of variables is also a threat to external validity.

Temporal validity is a threat because the data were from 1990 and 1994, thus, it is likely that neighborhood and school characteristics are different today. Crud factor is a threat because the large sample size increases the likelihood of rejecting a null hypothesis even if the relationship between variables is trivial, thus leading to the potential interpretation of statistical artifacts and not meaningful associations between variables (Onwuegbuzie, 2003).

Instrumentation and model misspecification are two threats to internal validity in the current study. Instrumentation refers to the limitations that (a) individual-level variables included from the Add Health data were self-reported, (b) neighborhoods were defined administratively (i.e., at the census tract level) and not by respondents' definitions of their neighborhoods, and (c) schools were defined at the building level and not at a more specific unit such as classrooms or curricular track. Model misspecification refers to the limitations that variable selection was limited to variables available from the data sources and that the multilevel analysis only included two of the many social environments that adolescents navigate on a daily basis.

Definition of Terms

Academic achievement. For the current study, adolescents' Add Health Picture Vocabulary Test (Add Health, 2004c) standardized scores were used to operationalize academic achievement.

Add Health Picture Vocabulary Test (AHPVT). The AHPVT was a computerized, abridged version of the Peabody Picture Vocabulary Test—Revised, Form L; a

commonly used screening test of verbal ability (Dunn & Dunn, 1981). In this test, the interviewer reads each of the 87 words aloud and the adolescent selected one answer from four black-and-white illustrations that best fit its meaning (Add Health, 2004c).

Body mass index (BMI). Body mass index is a number calculated from a person's weight and height [$\text{weight (lbs)}/\text{height (in)}^2*703$]. BMI is considered a reliable indicator of body fatness for most people and is used to screen for weight categories (i.e., underweight, normal, overweight, and obese; Centers for Disease Control and Prevention [CDC], 2007).

Census tract. A census tract is an administratively defined statistical subdivision of U.S. counties that typically contain between 1,500 and 8,000 residents (U.S. Census Bureau, 2000).

Cross-classified random effects models (CCREMs). Cross-classified random effects models refer to an advanced multilevel modeling technique used when hierarchical data are not purely nested; lower-level units (e.g., students) share memberships in a unit of one factor (e.g., a neighborhood) and can belong to different units of a second factor (e.g., different schools; Raudenbush & Bryk, 2002).

Federal poverty level (FPL). Based on the Office of Management and Budget's Statistical Policy Directive 14, FPL is a set of money income thresholds that vary by family size and composition to determine who is living in poverty (U.S. Census Bureau, 2007).

Hierarchical linear modeling (HLM). Also commonly referred to as multilevel modeling, HLM is an analytic technique that is useful to examine data that are nested

within one another, such as individuals within neighborhoods or students within schools. HLM controls for the non-independence of observations that occurs due to this nesting as individuals who belong to a group (i.e., neighborhood) are likely to be similar to one another resulting in correlated data. Furthermore, HLM allows for the examination of the variability within and between individuals and groups as well as their interactions (Diez-Roux, 2003; Hox, 2002; Subramanian, Jones, & Duncan, 2003).

Influence. According to *The Merriam-Webster Dictionary* (Mish et al., 2004), influence is defined as “the power or capacity of causing an effect in indirect or intangible ways” (p. 372).

Intraclass correlation coefficient (ICC). The intraclass correlation coefficient represents “the proportion of variance in a dependent variable that is between groups (i.e., Level-2 units)” (Raudenbush & Bryk, 2002, p. 36).

Methodological variables. For this study, methodological variables refer to variables required to analyze complex sample data correctly—sample weights, neighborhood identification number, and school identification number.

Moderator. A moderator is a type of variable that affects the relationship between an independent and dependent variable; commonly referred to as an ‘interaction effect’ (Barron & Kenny, 1986; Frazier et al., 2004).

Neighborhood. A neighborhood refers to a geographical area where people reside, usually having distinguishing characteristics (Mish et al., 2004). In this study, these geographical areas corresponded to 1990 census tracts.

Neighborhood affluence. Neighborhood affluence is a measure often used to characterize the quality of a neighborhood; commonly operationalized as a composite measure of neighborhood-level income, percentage of people in a neighborhood with professional positions, and the percentage of neighborhood residents with a college education (Leventhal & Brooks-Gunn, 2003). For this study, the standardized neighborhood affluence composite variable was created from three variables: the proportion of families with income equal to or greater than \$50,000, proportion of employed persons aged 16 and over in managerial and professional occupations, and the proportion of residents age 25 and older with at least a college degree.

Neighborhood poverty. Neighborhood poverty is a measure often used to characterize the quality of a neighborhood; commonly operationalized as a composite measure of the percentage of people in a neighborhood who are poor, the percentage of female-headed households in a neighborhood, the percentage of neighborhood residents who receive public assistance, and percentage of residents who are unemployed (Leventhal & Brooks-Gunn, 2003). For this study, the standardized neighborhood poverty composite measure was created from three variables: the proportion of families living below the poverty line, proportion of female-headed households, and the proportion of unemployed adult residents.

Risk of obesity. For this study, risk of obesity was operationalized through standardized age-and-gender-adjusted BMI scores, calculated using the National Center for Health Statistics weight by age by gender tables (CDC, 2000a, 2000b).

School. According to *The Merriam-Webster Dictionary* (Mish et al., 2004), a school is “an institution for teaching and learning” (p. 646). For the current study, school was limited to traditional (i.e., no magnet or alternative schools) U.S. public middle and high schools that taught Grades 7 -12 during the 1994-1995 academic year.

Socioeconomic status (SES). Socioeconomic status is a prestige-based measure referring to a person’s position within a hierarchical social structure typically linked to occupation, education level, and income (Krieger, 2001). For this study, the standardized individual SES composite measure was created from three variables: parental education, parental occupation, and family income.

Organization of Remaining Chapters

The remaining chapters present pertinent information to the study. Chapter Two offers an overview of Bronfenbrenner’s (1979) Ecological Systems Theory followed by a review of the literature regarding neighborhood and school influences on adolescent academic achievement and risk of obesity. Chapter Three provides a discussion of the research method, including a description of the data sources, study sample, measures, and data analysis. Chapter Four describes the results yielded from the data analyses. Finally, Chapter Five offers a discussion of the results of the research, including limitations of the study, implications for the field, and directions for future research.

Chapter Two

Literature Review

Introduction

This chapter provides an overview of the theoretical framework, Ecological Systems Theory (Bronfenbrenner, 1979), that guided the study, followed by a synthesis of research that has addressed neighborhood and school influences on adolescent academic achievement and risk of obesity. The chapter concludes with a summary of significant neighborhood and school attributes that have been identified in the literature and a discussion on how the current study builds upon the existing knowledge base. A brief discussion on the methodological advances of the current study in relation to previous social determinants research also is provided at the end of this chapter.

When possible, information presented in this chapter is limited to studies that focused on neighborhood and school influences on adolescent academic achievement and risk of obesity. This decision was made based on the different developmental trajectories of adolescents versus younger children. For example, compared to younger children, adolescents spend more time away from home interacting with people in the physical and social spaces and places outside their homes (Boardman & Saint Onge, 2005; Halpern-Felsher et al., 1997). Not only does this time spent outside the home provide more opportunities for exposure to nonfamilial influences including positive and negative adult

role models (Halpern-Felsher et al., 1997), but adolescents tend to identify with and view themselves in terms of their daily activities, often drawing cues from their surrounding contexts (Boardman & Saint Onge, 2005).

Because adolescence is a time of identity formation (e.g., Erikson, 1963), it is likely that adolescents link their identities to the “normative” environment of their neighborhoods (Connell & Halpern-Felsher, 1997). For example, a key psychological change that occurs during adolescence is the need to “make meaning” of personal experiences, and most adolescents accomplish this through interactions with adults and peers outside the family (Connell & Halpern-Felsher, 1997). Through these interactions and observations of others’ behaviors, adolescents form beliefs about themselves, their abilities, acceptable behaviors, and their futures (Connell & Halpern-Felsher, 1997). However, this process is not the same for all youth. For example, the nature and availability of role models and the physical conditions of neighborhoods and schools of youth living in impoverished areas are likely different than for youth living in more affluent areas, thus the “normative” environments that serve as reference points for adolescent identify formation also vary (Connell & Halpern-Felsher, 1997).

The research reviewed in this chapter also has been restricted to U.S.-based studies. Given the large amount of variation from country to country in terms of population heterogeneity and economic, social, and political contexts, findings from countries outside the U.S. are not generalizable to the population of interest for the current study. Therefore, in an effort to present concisely the most relevant research

related to neighborhood and school influences on academic achievement and risk of obesity among U.S. adolescents, I chose to limit this chapter to U.S.-based studies.

Theoretical Framework

Bronfenbrenner's (1979) Ecological Systems Theory emphasizes the idea that youth do not live in isolation. Instead, they develop in a variety of contexts, each of which interacts with their development. According to Bronfenbrenner (1979), individuals exist among four interrelated systems—the microsystem, the mesosystem, the exosystem, and the macrosystem. The microsystem, which consists of the proximal environments in which an individual is active (e.g., family, school, peer group, and neighborhood), has the most immediate and earliest influence on a person, whereas the mesosystem, which is a system of microsystems, or connections among the different environments in which a person is active, has the second strongest influence on individual development (Bronfenbrenner, 1979). The next two levels, the exosystem and the macrosystem, are farther removed and have more indirect influences on human development (Bronfenbrenner, 1979). The exosystem contains settings in which an individual is not an active participant, but can still be affected by events that occur at this level (e.g., a parent's place of employment), whereas the macrosystem represents the larger cultural context in which a child lives (e.g., cultural norms, policies, politics; Bronfenbrenner, 1979).

According to Bronfenbrenner (1979), to study human development effectively, we need to look beyond a single environment and look at the interactions among individuals and multiple environments. In the past, although the majority of researchers

who have applied an ecological systems framework have focused their investigations at the mesosystem level, for the most part, they have primarily addressed the nature of a single environmental interaction (e.g., family influence on development or school influence on development). Some have focused on the influences of multiple environments at the same time (i.e., simultaneous neighborhood and school influences on development), but few appear to focus on the interrelations of two different microsystems within the mesosystem (e.g., the interaction between family and school contexts in relation to development). These less-investigated interactions between two different microsystems were the focus of this study; instead of examining the influence of a single environment on adolescent academic achievement and risk of obesity, the current study examined the nature of the interconnectedness between two microsystems-- neighborhood and school influences on adolescent academic achievement and risk of obesity as well as the interaction effect of these two microsystems.

Neighborhood Influences on Adolescent Academic Achievement

The investigation of neighborhood influences on adolescent academic achievement is not new. In fact, Brooks-Gunn, Duncan, and Aber (1997a, 1997b) published their two-volume collection on neighborhood poverty and child development a decade ago, in which they proposed six important neighborhood characteristics potentially related to child and adolescent outcomes: income, human capital, ethnic integration, social capital, social disorganization, and safety, with neighborhood income being the most important neighborhood characteristic related to educational outcomes. Of these six important neighborhood characteristics proposed by Brooks-Gunn et al. (1997a,

1997b), neighborhood effects on adolescent academic achievement research has most often focused on income (i.e., neighborhood SES), human capital (i.e., male joblessness), and social disorganization. Other neighborhood-level variables that researchers have examined include neighborhood racial and ethnic diversity and perceived neighborhood quality, cohesion, and resources. The following sections contain an overview of how these neighborhood-level variables relate to various measures of adolescent academic achievement. More details about each of the studies summarized in this section are provided in Appendix A, Table A-1 (e.g., type of statistical analysis conducted, list of all variables included in the models).

Neighborhood SES. Across studies, neighborhood affluence, and not neighborhood poverty, appears to be the most consistent characteristic associated with adolescent academic achievement (Boyle et al., 2007; Brooks-Gunn et al., 1997a; Leventhal & Brooks-Gunn, 2000). Common indicators used to operationalize high-SES/affluent neighborhoods include neighborhood-level income, percentage of people with professional positions, and percentage of residents with a college education (Leventhal & Brooks-Gunn, 2003). Low-neighborhood SES/poverty is typically operationalized through the percentage of poor residents, percentage of female-headed households, percentage of residents who receive public assistance, and the percentage of unemployed residents (Leventhal & Brooks-Gunn, 2003).

In Atlanta, Halpern-Felsher et al. (1997) found high-neighborhood SES to be positively associated with Iowa Test of Basic Skills scores among African American girls aged 11 to 16. Similarly, using two different samples (12 to 15 year olds and 15 to 20

year olds) from an urban, upstate New York school district, Halpern-Felsher et al. (1997) found that White boys' educational risk, including achievement, was reduced with a higher concentration of middle-class neighbors. Dornbusch et al. (1991) also found a positive association between neighborhood affluence and adjusted self-reported grades in a study of San Francisco high school students. Conversely, using data from a sample of youth aged 10 to 16 in New York City, Baltimore, and Washington, D.C., Halpern-Felsher et al. (1997) found a negative relationship between standardized reading and mathematics test scores and neighborhood poverty among White girls.

Within the Gautreaux (Rosenbaum, 1995) and Moving to Opportunity (MTO; Kling & Liebman, 2004; Leventhal, Fauth, & Brooks-Gunn, 2005) programs, researchers also have focused on the relationship between neighborhood socioeconomic status and adolescent academic achievement. Interestingly, unlike the findings from non-experimental studies, results from these quasi-experimental (Gautreaux) and experimental (MTO) programs do not reveal statistically significant improvements in adolescent academic achievement based on neighborhood affluence (Kling & Liebman, 2004; Leventhal et al., 2005; Rosenbaum, 1995). More specifically, in the Gautreaux program, Rosenbaum (1995) found no differences in grade point average (GPA) between high school youth who moved to the suburbs and those who stayed within Chicago city limits. Similarly, using MTO data from all five participating cities (Baltimore, Boston, Chicago, Los Angeles, and New York City), Kling and Liebman (2004) reported no differences in high school Woodcock-Johnson reading and mathematics test scores between adolescents, aged 15-20, who moved to low-poverty neighborhoods and their

peers who remained in impoverished urban housing projects. Conversely, Leventhal et al.'s (2005) 5-year follow-up study of New York City MTO youth suggests that control group youth, aged 14-19, who remained in traditional housing projects had statistically significantly higher GPAs than did their similarly aged peers who moved to low-poverty neighborhoods and those who were allowed to move out of the projects and reside in unrestricted Section 8 housing.

When thinking about the conflicting findings between non-experimental studies and quasi-experimental and experimental studies, several factors should be considered. Foremost, is the issue of model and variable specification—not only were the statistical models used in the studies different, but the research was conducted during different periods. Similarly, in terms of the variables examined in each study, not only was academic achievement operationalized differently across the studies, but when GPA was used as the criterion variable, it is important to remember that this measure is often considered unstable as it can vary from school to school. Furthermore, within the Gautreaux and MTO programs, the operationalization of neighborhood was weak. Poverty was the only variable examined to determine where participants could move—no other social contexts of the neighborhoods were considered. In addition, by moving Black families to White suburbs, theoretically this could have diminished adolescents' social support, which, in turn, could impact their well-being, including achievement. Lastly, given the aforementioned differences and weaknesses in the various neighborhood SES and academic achievement studies, more research, in particular, more theory-based research, is needed.

Neighborhood male joblessness. Albeit used less often than neighborhood SES, researchers also have used male joblessness as a measure of neighborhood quality in the investigation of neighborhood influences on adolescent academic achievement. For example, among 11- to 16-year-old African American boys in Atlanta, male joblessness was negatively associated with Iowa Test of Basic Skills scores (Halpern-Felsher et al., 1997). Male joblessness also was negatively associated with educational risk, including achievement, among 12- to 15- year-old African American boys and White females in an urban, upstate New York school district (Halpern-Felsher et al., 1997). The negative relationship between male joblessness and New York students' educational risk also was observed among White 15- to 20-year-old females in the same upstate, urban school district; however, the relationship for African American boys was not statistically significant among the older sample of students (Halpern-Felsher et al., 1997).

Neighborhood social disorganization. Originally developed to explain crime, Social Disorganization Theory (i.e., low-neighborhood SES, ethnic heterogeneity, and high residential mobility; Shaw & McKay, 1942) also has been used in the investigation of community influences on adolescent academic achievement. First, among eighth-grade students in Virginia public schools, community social disorganization was shown to explain a statistically significant amount of variance in Stanford 9 performance (Baker et al., 2001). Second, using a nationally representative sample of middle and high school youth and focusing on process variables linked to Social Disorganization Theory (i.e., lack of neighborhood support, perceptions of pro-social behaviors, and perceptions of

neighborhood crime and violence), Bowen, Bowen, and Ware (2002) reported a direct negative effect of neighborhood social disorganization and self-reported grades.

Perceived neighborhood quality. A variety of perceived neighborhood quality measures also have been shown to be associated with adolescent achievement. For example, Eamon (2005) found a positive relationship between mothers' ratings of overall neighborhood quality and Peabody Individual Achievement Test (PIAT) reading comprehension scores for young Latino adolescents aged 10 to 14. However, the same relationship was not observed for PIAT mathematics scores. Similarly, urban, African American adolescent girls aged 11 to 14 years in a southeastern city who perceived their neighborhoods as being non-cohesive reported lower grades than did their peers who reported high levels of neighborhood cohesion (Plybon, Edwards, Butler, Belgrave, & Allison, 2003).

Using a national probability sample of middle and high school students from the National School Success Profile (SSP) data, Bowen and Bowen (1999) also found a statistically significant relationship between adolescents' perceptions of neighborhood quality and school grades. More specifically, among middle and high school students, both perceived neighborhood peer culture and adolescents' personal experience with neighborhood crime and violence were negatively related to self-reported school grades (Bowen & Bowen, 1999). The associations between perceived neighborhood deterioration and resourcefulness and GPA also have been examined (Williams, Davis, Miller Cribbs, Saunders, & Williams, 2002). Among urban, African American ninth graders living in a large metropolitan area in the Midwest, perceived neighborhood

deterioration was inversely correlated with youth's official GPA; however, the relationship between GPA and perceived neighborhood resourcefulness was not statistically significant (Williams et al., 2002).

Other neighborhood measures. Neighborhood ethnic and racial diversity and socioeconomic resource inequality also have been examined in relation to adolescent academic achievement. For example, using data from the High School Effectiveness Study, Blau, Lamb, Stearns, and Pellerin (2001) investigated the relationship between cosmopolitan communities, characterized by low levels of socioeconomic resource inequality and high levels of ethnic and racial diversity, and two-year gain scores in social studies. Neighborhood socioeconomic resource inequality was negatively associated with gains in social studies achievement; neighborhood diversity was not statistically significantly related to social studies achievement (Blau et al., 2001).

Lastly, in an effort to understand better the impact of residential context on various elements of adolescent well-being (e.g., risk behaviors, educational outcomes, physical and mental health, and social integration), Boardman and Saint Onge (2005) used Add Health data to calculate adjusted intra-class correlation coefficients (ICC) for 34 adolescent outcomes. Two achievement outcomes included in the study were self-reported GPA and performance on the Add Health Picture Vocabulary Test (AHPVT). Based on ICC values, of all 34 outcomes, neighborhoods appeared to have the strongest impact on AHPVT performance (ICC = .25); the ICC for self-reported GPA was .10 (Boardman & Saint Onge, 2005).

Neighborhood Influences on Adolescent Risk of Obesity

Unlike neighborhood influences on adolescent academic achievement, the investigation of neighborhood influences on adolescent risk of obesity is a more recent area of inquiry. Not only is there a paucity of published articles in this area, but all of the articles that have examined neighborhood influences on adolescent obesity were published between 2004 and 2007. Even though there is scant published research, to date, common neighborhood factors that have been examined in relation to adolescent risk of obesity include neighborhood SES, the built environment, availability of food outlets, and urban sprawl. The following sections contain an overview of how these neighborhood-level variables relate to adolescent risk of obesity. More details about each of the studies summarized in this section are provided in Appendix A, Table A-2 (e.g., type of statistical analysis conducted, list of all variables included in the models).

Neighborhood SES. When studying neighborhood SES and its relationship with adolescent weight status, researchers have used traditional indicators of SES (e.g., education, income, and occupation information) as well as new indicators (e.g., clustered characteristics of neighborhoods). For example, by applying cluster analysis to measures of neighborhood environments associated with the home street addresses for Wave I Add Health participants, Nelson et al. (2006) identified six robust neighborhood patterns: rural working class, exurban, new suburban development, older suburban development, mixed-race/ethnicity urban, and low-SES inner city. In relation to adolescent weight, adolescents living in rural working class, exurban, and mixed-race urban neighborhoods were 30% to

40% more likely to be overweight than were their peers living in newer suburban developments (Nelson et al., 2006).

Next, in terms of traditional indicators of neighborhood SES, Chen and Paterson (2006) reported neighborhood education and neighborhood employment as predictors of St. Louis high school students' BMI, beyond the effects of family education and family occupation status. However, neighborhood income and neighborhood assets were not statistically significant predictors beyond the effects of family income and family assets (Chen & Paterson, 2006). Similarly, Kling and Liebman (2004) did not report any statistically significant differences in adolescent obesity status between MTO adolescents whose families moved to low-poverty neighborhoods and their peers who remained in impoverished urban housing projects.

Also interested in the relationship between neighborhood SES and adolescent weight status, Wickrama et al. (2006) used Add Health data to investigate if the impact of community poverty on adolescent obesity was moderated by adolescent race/ethnicity. Interestingly, community poverty had less of an impact on obesity status among racial and ethnic minorities (Asian, Hispanic, and African American) compared to White adolescents (Wickrama et al., 2006). In other words, being a racial or ethnic minority appeared to buffer the effect of community poverty on adolescent obesity.

Built environment. In addition to examining neighborhood sociodemographic influences on adolescent weight, two recent studies investigated the relationship between neighborhood recreational facilities and adolescent risk of being overweight or obese. For example, based on a sample of 11 to 15 years olds in San Diego County, Norman, Nutter,

Ryan, Sallis, Calfas, and Patrick (2006) reported no statistically significant relationship between the number of recreation facilities located within a one-mile radius of an adolescent's residence and BMI. On the other hand, using nationally representative Add Health data, Gordon-Larsen et al. (2006) found that an adolescent's relative odds of being overweight decreased as the number of recreational facilities per census-block group increased. For example, compared to living in a census block-group with no recreational facilities, residing in a census block-group with at least one recreational facility was associated with a 5% decrease in the relative odds of being overweight (Gordon-Larsen et al., 2006). Furthermore, adolescents living in a census-block with seven recreational facilities were 32% less likely to be overweight compared to their peers residing in census block-groups with no such facilities (Gordon-Larsen et al., 2006).

Other neighborhood measures. Residential context, urban sprawl, availability of food outlets, and collective efficacy also have been examined as neighborhood correlates of adolescent risk of obesity. For example, in addition to adolescent academic achievement, Boardman and Saint Onge (2005) also examined the relationship between residential context and adolescent risk of being overweight. However, unlike the relatively important relationship between neighborhoods and adolescent verbal achievement (ICC = .25), area of residence appeared to have a much smaller association with being overweight (ICC = .05; Boardman & Saint Onge, 2005).

In terms of urban sprawl's relationship with adolescent risk of obesity, findings are mixed. For example, based on cross-sectional analysis of the 1997 National Longitudinal Survey of Youth (NLSY) data, urban sprawl appeared to be correlated with

being overweight/risk of being overweight among U.S. adolescents (Ewing, Brownson, & Berrigan, 2006). However, when examined longitudinally, five years later, the relationship between urban sprawl and weight status was no longer statistically significant (Ewing et al., 2006).

Regarding availability of food outlets and adolescent risk of obesity, availability chain supermarkets and convenience stores have both been found to have statistically significant associations with adolescent BMI. More specifically, using MTF data, Powell, Auld, Chaloupka, O'Malley, and Johnston (2007) found a statistically significant negative association between neighborhood availability of chain supermarkets and adolescent BMI and a statistically significant positive relationship between the number of neighborhood convenience stores and adolescent BMI. Furthermore, the negative association between supermarket availability and adolescent BMI was larger for African-American youth compared to White or Hispanic youth (Powell et al., 2007).

Lastly, neighborhood collective efficacy (i.e., a measure of social cohesion and informal social control; Cohen et al., 2006) also has been suggested as a statistically significant predictor of adolescent weight. Adolescents aged 12 to 17 residing in Los Angeles County neighborhoods with high levels of collective efficacy were predicted to have BMI values one unit below their peers who lived in neighborhoods with low levels of collective efficacy (Cohen et al., 2006). In terms of being overweight, adolescents who lived in neighborhoods with low efficacy were 52% more likely to be overweight compared to their peers who lived in neighborhoods with average levels of collective efficacy (Cohen et al., 2006).

School Influences on Adolescent Academic Achievement

Just as the investigation of neighborhood influences on adolescent academic achievement is not new, nor is the investigation of school influences on adolescent academic achievement. For example, although criticized for its many methodological limitations, the well-known *Equality of Educational Opportunity* report (also commonly referred to as the Coleman Report; Coleman et al., 1966) was the first comprehensive, nationwide investigation into school influences on academic achievement (Dyer, 1972). However, based on the results of their examination of student body, school, and teacher influences on verbal achievement, Coleman et al. (1966) concluded:

That schools bring little influence to bear on a child's achievement that is independent of his [her] background and general social context; and that this very lack of an independent effect means that the inequalities imposed on children by their home, neighborhood, and peer environment are carried along to become the inequalities with which they confront adult life at the end of school. (p. 325)

Despite the less-than-promising results presented in the Coleman Report (Coleman et al., 1966), social and behavioral scientists continued investigating the relationship between school-level characteristics and academic achievement. More specifically, school characteristics commonly examined in relation to adolescent academic achievement include school sociodemographic characteristics, school resources and sector, teacher characteristics, perceived social climate and school quality, and organizational climate. The following sections contain an overview of how these school-level variables relate to various measures of adolescent academic achievement. More

details about each of the studies summarized in this section are provided in Appendix A, Table A-3 (e.g., type of statistical analysis conducted, list of all variables included in the models).

School sociodemographic characteristics. In recent years, several researchers have published findings that appear to contradict Coleman et al.'s (1966) findings that schools had little influence on academic achievement beyond what youth brought with them to school. For example, among U.S. high school students who graduated from high school in 1995 and had taken the Scholastic Aptitude Test (SAT) during their junior or senior year of high school, school size, school poverty, and school racial and ethnic composition were meaningful predictors of self-reported high school GPA (Everson & Millsap, 2004). Both school size and school racial and ethnic composition were negatively correlated with high school GPA, whereas, surprisingly, school poverty exhibited a positive association with high school GPA (Everson & Millsap, 2004). Similar findings were also found among Black and White public school 10th-grade students in Louisiana (Caldas & Bankston, III, 1997). School-level racial minority composition was negatively associated with standardized test performance whereas poverty and social class status of adolescents' schoolmates was positively associated with 10th-grade achievement.

Data from the base year of the National Education Longitudinal Study of 1988 (NELS:88) also suggest that the percentage of minority students in a school is inversely related to middle school students' reading achievement (Lee & Croninger, 1994). However, school locale, school SES, school sector, grade grouping, and grade size were

not statistically significant school-level predictors of reading achievement among U.S. middle school students (Lee & Croninger, 1994). Crosnoe (2004) also found a statistically significant, yet surprising, relationship between school sociodemographics and adolescent academic achievement. Among middle and high school students included in Wave I and II Add Health data, school-level parental education revealed a negative association with self-reported grades in school (Crosnoe, 2004).

Next, in their investigation of cosmopolitan environments and academic achievement, Blau et al. (2001) also examined the relationship between schools' sociodemographic environments and two-year gains in social studies achievement among high school students who participated in the High School Effectiveness Study. However, results from their study did not suggest that a school's sociodemographic environment was an important predictor of gains in social studies achievement (Blau et al., 2001). Lastly, in addition to their study of community social disorganization and academic achievement of eighth-grade students in Virginia, Baker et al. (2001) also investigated the relationship between school social disorganization and Stanford 9 scores among the same set of students. Results revealed an inverse association between school-level organization and eighth-grade students' Stanford 9 performance (Baker et al., 2001).

School resources and sector. In their meta-analysis of the effect of school resources on student achievement, Greenwald, Hedges, and Laine (1996) concluded that school resources, such as per-pupil expenditure (PPE), teacher salary, teacher/pupil ratio, and school size, appeared to be important factors related to students' standardized test achievement. More specifically, based on findings from 14 studies, the half-standardized

regression coefficient for PPE's relationship with achievement was .0003, with the units measured as dollars. Based on five studies, the half-standardized regression coefficient for teacher salary's association with achievement was .0263, with units as thousands of dollars. Also, using data from 21 and 15 studies, respectively, the standardized regression coefficients for teacher/pupil ratio and school size were .0295 and .0299 with $\beta > 0$ indicating greater achievement in smaller classes and smaller schools (Greenwald et al., 1996). To understand better the magnitude of these effect sizes, Greenwald et al. (1996) also presented the information in terms of the effect of \$500 per student on achievement. In this circumstance, the effect size for PPE increased to 0.15, teacher salary increased to 0.16, and teacher/pupil ratio increased to 0.04 (Greenwald et al., 1996). However, when interpreting these results, it is important to note that it is not possible to tell if the studies included in the meta-analysis focused on child and/or adolescent achievement; therefore, these findings cannot be interpreted solely in terms of adolescent academic achievement.

Attending religious schools also has been suggested as a positive correlate of Black and Hispanic adolescent academic achievement. For example, in their meta-analysis of studies that examined the impact of school sector on Black and Hispanic adolescent academic achievement, Jeynes (2002) found that middle school students who attended religious schools performed, on average, 0.25 standard deviations higher, for both GPA and achievement tests, than did their peers who did not attend religious schools. The same level of improvement (Hedges's $g = 0.26$) also was observed among high school students' GPA and achievement tests (Jeynes, 2002).

Teacher characteristics. In their meta-analysis, Greenwald et al. (1996) also found teacher ability, teacher education, and teacher experience to be important variables related to student achievement. For example, results from six studies produced a standardized regression coefficient of .0724 for teacher ability. However, based on 15 and 12 studies, respectively, the effects of teacher experience ($\beta = .0482$) and teacher education ($\beta = .0003$) were less than the effect of teacher ability (Greenwald et al., 1996). In terms of the effect of \$500 per student on achievement, the effect sizes for teacher experience and education become 0.18 and 0.22, respectively (Greenwald et al., 1996).

Next, to examine the relationship between teacher qualifications and student achievement at a national level, Darling-Hammond (1999) used teacher qualification data from the Schools and Staffing Survey and eighth-grade achievement data from the 1996 National Assessment of Educational Progress (NAEP). Findings from her study revealed both positive and inverse correlations between mathematics achievement and teacher qualifications. For example, the percentage of teachers out-of-field and the percentage of newly hired uncertified teachers were inversely correlated with eighth-grade mathematics achievement, whereas the percentage of well-qualified teachers was positively correlated with mathematics achievement (Darling-Hammond, 1999). However, when data were aggregated and examined at the state-level, the only statistically significant teacher quality predictor of eighth-grade mathematics achievement was the percentage of well-qualified teachers (Darling-Hammond, 1999).

Teacher practices and teacher empowerment also have been investigated as possible correlates of adolescent achievement. For example, in her examination of teacher practices and year-end grades among suburban sixth graders, Wentzel (2002) found an inverse relationship between negative feedback and achievement and a positive relationship between high expectations and sixth-grade achievement. Teacher practices that were not statistically significant predictors of sixth-grade achievement included fairness, teacher motivation, and rule setting. In terms of teacher empowerment, Sweetland and Hoy (2000) reported school-level teacher empowerment to be a statistically significant predictor of standardized reading and mathematics achievement among eighth graders in New Jersey public middle schools.

Perceived social climate and school quality. In a study focused on the relationship between risk of obesity, self-reported grades in school, and school social climate, Crosnoe and Muller (2004) reported some interesting findings. First, using Wave I and II Add Health data, Crosnoe and Muller (2004) found no statistically significant relationships between school climate variables and middle and high school students' academic achievement. However, they did report several cross-level interactions between individual risk of obesity and three school climate variables (rate of athletic participation, mean student romantic behavior, and mean BMI; Crosnoe & Muller, 2004). That is, the relationship between school climate variables and adolescent academic achievement varied based on adolescent risk of obesity status.

For example, adolescents who were at risk of obesity had lower levels of achievement when they attended schools with higher levels of mean student romantic

activity (Crosnoe & Muller, 2004). Conversely, adolescents who were at risk of obesity performed better academically in schools with higher average BMI values (Crosnoe & Muller, 2004). However, it is important to note that this relationship was reported as statistically significant at the .10 level. Adolescents who were at risk of obesity also performed better in schools with greater levels of athletic participation (Crosnoe & Muller, 2004). Surprised by this last finding, Crosnoe and Muller (2004) undertook further analyses and found that adolescents who were at risk of obesity became more academically involved when they attended schools with increased rates of athletic participation.

Various measures of school quality also have been suggested as being predictors of adolescent academic achievement. For example, among Latino adolescents, age 10 through 14, perceived school quality has been found to have a positive relationship with reading and mathematics achievement (Eamon, 2005). Also, in addition to examining perceived neighborhood peer culture and adolescents' personal experience with neighborhood crime and violence, Bowen and Bowen (1999) also explored the relationship between perceived school danger and self-reported grades using data from a national probability sample of middle and high school students. Both composite measures of school danger (perceived crime and violence, and personal threats) had inverse associations with achievement (Bowen & Bowen, 1999).

Factors such as school and student-teacher bonding also have been examined in relation to adolescent academic achievement. Among African American adolescents, aged 11 to 14, in a large Midwestern city, adolescents who reported feeling bonded to

their school were also more likely to report higher school grades (Zand & Thomson, 2005). In terms of student-teacher bonding, using Add Health data, Crosnoe (2004) reported that the relationship between student-teacher bonding and self-reported grades depended on how close an adolescent felt to his or her parents. Adolescents who were not close to their parents benefited less from attending schools with high levels of student-teacher bonding compared to their peers who felt close to their parents (Crosnoe, 2004). On the other hand, perceived teacher support was not shown to be related to self-reported GPA among urban, African American eighth graders (Sanders, 1998).

Organizational climate. In addition to examining the relationship between a school's social climate and adolescent academic achievement, researchers also have investigated how schools' organizational climate (from the teacher or principal's perspective) relates to adolescent academic achievement. For example, in New Jersey middle schools, two of the six dimensions of organizational climate were associated with youth performance on all three areas of New Jersey's Eighth Grade Early Warning Test (Hoy & Hannum, 1997). More specifically, teacher affiliation and institutional integrity were both positively associated with eighth-grade mathematics, reading, and writing achievement. Academic emphasis also was found to have a positive association with eighth-grade achievement; however, it was only related to mathematics and reading achievement (Hoy & Hannum, 1997). Henderson, Buehler, Stein, Dalton, Robinson, and Anfara, Jr. (2005) also found a positive correlation between academic emphasis and eighth-grade standardized test scores in a sample of 10 Tennessee middle schools.

School social and academic organization also have been suggested as being significant correlates of adolescent academic achievement. Using NELS:88 data, Lee, Smith, and Croninger (1997) reported that high school students who attended schools with higher levels of social organization, more mathematics and science course offerings, and higher levels of authentic instructional practices in mathematics and science had larger gains in science and mathematics achievement than did their peers who attended schools with low levels of social organization, fewer mathematics and science course offerings, and lower levels of authentic instructional practices. Analysis using NELS:88 data also suggested that teacher cooperation and the number of books used in eighth-grade English classes were positive correlates of eighth-grade reading achievement (Lee & Croninger, 1994). However, when school academic organization within the NELS:88 data was conceptualized in terms of authoritativeness, school environment was not a statistically significant predictor of eighth-grade standardized mathematics test scores (Gill, Ashton, & Algina, 2004).

School Influences on Adolescent Risk of Obesity

Whereas there has not been much research conducted on neighborhood influences on adolescent risk of obesity, there has been even less research focused on school influences on adolescent risk of obesity. Furthermore, unlike research that has examined school influences on adolescent academic achievement, the school influence and risk of obesity research has focused less on the social and demographic aspects of the school environment and more on the effectiveness of school-based interventions. In fact, there appears to be only one published study that has investigated the relationship between

various school characteristics and adolescent risk of obesity (O'Malley, Johnston, Delva, Bachman, & Schulenberg, 2007). Below is an overview of the limited literature on school influences on adolescent risk of obesity. Details about each of the studies summarized in this section are provided in Appendix A, Table A-4 (e.g., type of statistical analysis conducted, list of all variables included in the models).

Regarding school social and demographic attributes and adolescent risk of obesity, using MTF data, O'Malley et al. (2007) reported a statistically significant positive association between school SES and adolescent BMI. However, other school variables included in the analysis (school type, school size, and student body racial/ethnic composition) exhibited statistically non-significant relationships with adolescent BMI (O'Malley et al., 2007). O'Malley et al. (2007) also found that most of the variation in adolescent BMI was within, not between schools ($ICC = .03$).

Next, in terms of adolescent risk of obesity and school-based interventions, all three school-based interventions that have focused on adolescent obesity prevention targeted different elements within school environments. For example, in an effort to reduce obesity among the general population of Boston area middle school students, Planet Health worked with teachers to develop sessions that could be easily incorporated into existing curricula (Gortmaker et al., 1999). More specifically, the intervention curricula aimed to decrease the amount of time youth spent watching television, increase the amount of time youth spent engaging in moderate and vigorous physical activity, decrease consumption of high-fat foods, and increase daily fruit and vegetable consumption (Gortmaker et al., 1999). Another key component of the Planet Health

curriculum was that the intervention materials were incorporated into multiple academic subject areas (i.e., language arts, math, science, social studies) as well as PE classes (Gortmaker et al., 1999).

The New Moves intervention also was an education-focused program; however, unlike Planet Health, New Moves provided physical activity and nutrition education through girls-only alternative physical education classes in three Twin City area high schools (Neumark-Sztainer, Story, Hannan, Stat, & Rex, 2003). New Moves also differed from Planet Health in terms of its target population. Instead of focusing on obesity prevention among the general student population, New Moves was developed specifically for high school girls who were overweight or at risk of being overweight (Neumark-Sztainer et al., 2003). The specific aims of the New Moves intervention were to increase physical activity and improve eating behaviors as well as help girls avoid unhealthy dieting behaviors and feel better about themselves in a thin-oriented society (Neumark-Sztainer et al., 2003).

The third school-based adolescent obesity prevention trial, Middle-School Physical Activity and Nutrition study (M-SPAN; Sallis et al., 2003), was different from both Planet Health and New Moves in that it did not contain any classroom education. Instead, it included broad policy and social marketing interventions aimed at increasing middle school students' physical activity both in physical education classes and throughout the day, as well as marketing and providing low-fat foods at all food sources within the schools (Sallis et al., 2003). As a secondary outcome of interest, M-SPAN also aimed to reduce BMI among students in the intervention schools (Sallis et al., 2003).

Example components from the policy and social marketing interventions included providing funds for new PE equipment and adding signs to promote low-fat food options (Sallis et al., 2003).

Each of the three school-based interventions also reported different levels of program effectiveness. At the conclusion of the 2-year intervention, Planet Health researchers reported a statistically significant decrease in obesity for girls in the intervention schools compared to girls in the control schools; however, the decrease in obesity prevalence among boys in the intervention schools was not statistically significantly different than the post-intervention obesity prevalence among boys in the control schools (Gortmaker et al., 1999). Results from the New Moves post-intervention (16 weeks from baseline) and 8-month follow-up evaluations did not reveal any statistically significant differences in BMI between girls in the intervention schools and girls in the control schools (Neumark-Sztainer et al., 2003). Moreover, as with Planet Health, M-SPAN's effectiveness in reducing BMI appeared to vary by gender. Specifically, this program appeared to be more effective for boys than it was for girls. At the end of the 2-year intervention, boys in intervention schools had greater BMI reductions compared to boys in the control schools, but there was no effect on girls' BMI (Sallis et al., 2003).

The last study with published findings related to schools and adolescent risk of obesity is from the Trial of Activity in Adolescent Girls (TAAG; Scott et al., 2007). However, unlike Planet Health, New Moves, and M-SPAN, TAAG was not a randomized trial designed to test the effectiveness of a specific school-based intervention. Instead, it

was a coordinated school-and community-based project affiliated with six U.S. universities (Universities of Arizona, Maryland, Minnesota, and South Carolina; San Diego State; and Tulane University) with a primary goal of reducing the normal decline in physical activity in middle school girls (Scott et al., 2007). As part of assessing the “healthiness” of participants’ neighborhoods, TAAG researchers examined the relationship between weekend accessibility of school recreational facilities and obesity and found a statistically significant association between the number of locked schools within a half-mile of a sixth-grade girl’s home and BMI; each additional locked school was associated with a predicted 3% increase in BMI (Scott et al., 2007).

Lastly, although there is currently limited evidence of the role schools play in the prevention of adolescent obesity, several papers have been published that postulate arenas within the school environment that likely influence adolescent risk of obesity (Carter, 2002; Dietz & Gortmaker, 2001; Story, Kaphingst, & French, 2006). In addition to increasing physical activity opportunities and improving the healthfulness of food both served and sold in schools, schools should also provide health education and other programs aimed to increase both student and parent knowledge and attitudes toward nutrition and weight control (Carter, 2002; Dietz & Gortmaker, 2001; Story et al., 2006). Story et al. (2006) also discuss the important role that school health services can play in addressing adolescent risk of obesity. Endorsed by the Institute of Medicine, BMI reporting through health report cards also has been suggested as a way schools can help prevent adolescent obesity (Story et al., 2006).

Summary

Neighborhood SES has been commonly used in the investigation of both neighborhood influences on adolescent achievement and neighborhood influences on adolescent risk of obesity. However, neighborhood SES is often measured differently across these two outcomes. For example, when investigating the relationship between neighborhood SES and adolescent achievement studies have often included composite measures of neighborhood affluence and/or neighborhood poverty, whereas the majority of research focused on neighborhoods and adolescent risk of obesity has relied on individual indicators of neighborhood SES (i.e., neighborhood education or neighborhood employment). By using composite measures of neighborhood affluence and neighborhood poverty, the current study provides a new perspective into the neighborhood and adolescent risk of obesity literature.

In addition to neighborhood affluence and poverty, male joblessness, social disorganization, and perceived neighborhood quality are other commonly documented neighborhood correlates of adolescent academic achievement. However, to date, these same neighborhood characteristics have not been included in the investigation of neighborhood influences on adolescent risk of obesity. Besides neighborhood SES, availability of recreational facilities is the only other neighborhood-level variable that has been examined in relation to adolescent risk of obesity.

Unlike the neighborhood and academic achievement research, school and academic achievement research has tended to use single variables more often than composite variables when measuring SES (e.g., school-level poverty or school-level

parental education). Thus, use of a composite measure of school SES in the current study makes an important contribution to the school and academic achievement literature. In addition to SES, other common school-level variables that have been examined in relation to adolescent academic achievement include school-level racial composition, teacher quality, perceived social climate, and school resources. In terms of school characteristics and adolescent risk of obesity, the current study adds to the paucity of literature in this area by including a composite measure of weight promotion education as a potential predictor of adolescent risk of obesity.

Lastly, 68% of the neighborhood and school influence research reviewed in this chapter did not use hierarchical linear modeling techniques even though the data were hierarchical in nature. Thus, findings from studies that utilized nested data but that did not account for the nesting of the data in their analytic techniques need to be interpreted with caution. Also, even though some studies included variables from multiple social environments (e.g., neighborhood and school variables or family and school variables), the lack of appropriate HLM techniques in these studies prevents us from understanding each environment's unique influence on achievement. Furthermore, except for Crosnoe (2004), none of the research that included measures of two social environments investigated interactions between the environments. By utilizing advanced multilevel modeling techniques (i.e., CCREMs), the current study makes an important contribution to both the academic achievement and risk of obesity literature not only by providing information on each environment's unique influence on both outcomes, but also by

offering insight into the interconnectedness between neighborhoods and schools and adolescent academic achievement and risk of obesity.

Chapter Three

Method

Purpose of the Study

Grounded in Bronfenbrenner's (1979) Ecological Systems Theory and through the application of advanced multilevel modeling techniques (Raudenbush & Bryk, 2002), the primary goal of this study was to examine simultaneously neighborhood and school influences on academic achievement and adolescent risk of obesity and to examine the moderating effects of schools on these outcomes. By examining concurrently neighborhood and school influences on academic achievement and adolescent risk of obesity, this study aimed to fill an important gap in the social determinants literature. For example, it is unclear if where an adolescent lives or where she/he attends school has a stronger influence on academic achievement. We also do not know if schools can moderate neighborhood influences on adolescent academic achievement, nor do we know much about the relationships among schools, neighborhoods, and adolescent risk for obesity. Similarly, by investigating outcomes related to both mental and physical well-being, this study helps expand the traditional single-domain approach often undertaken in social and behavioral science research.

Research Questions

The following four research questions were investigated:

Research Question 1. To what extent are neighborhood influences on U.S. middle and high school students' academic achievement moderated by school environments?

Research Question 2. What are the relative influences of neighborhood and school environments on U.S. middle and high school students' academic achievement?

Research Question 3. To what extent are neighborhood influences on U.S. middle and high school students' risk of obesity moderated by school environments?

Research Question 4. What are the relative influences of neighborhood and school environments on U.S. middle and high school students' risk of obesity?

Study Design

This study employed a nonexperimental, retrospective, correlational research design. Secondary data analyses of nationally representative Add Health (2005c) and AHAA (n.d.) restricted-use data were conducted. The study design also was cross-sectional in nature because the data represented one point in time.

Although multilevel modeling techniques are used with increasing frequency by educational and other social science researchers, use of CCREMs (Raudenbush & Bryk, 2002) is still rare in educational research. The lack of CCREMs in education is particularly troubling given the cross-classified nature of many education data structures. For example, Level-1 units (students) are often cross-classified by two Level-2 factors (schools and neighborhoods) such that students from Neighborhood A might attend a school that students from Neighborhood B and Neighborhood C also attend, and students

from the same neighborhood might attend different schools. When cross-classification of data is ignored, models are misspecified, causing them to lack the level of control necessary to detect important and possible confounding effects, which, in turn, can lead to spurious conclusions.

For this study, the cross-classified multilevel analyses allowed the examination of the influence of multiple contexts on academic achievement and risk of obesity, while statistically controlling for one another. That is, because neighborhood and school environments were analyzed simultaneously, results represent each environment's unique influence on achievement and risk of obesity. Further, use of interactions within the CCREMs allowed the investigation of the school environment as a moderator of neighborhood influences on each of the outcomes. All procedures for the study were approved through the University of South Florida's Institutional Review Board.

Overview of the Add Health Study

Study design. Add Health is a nationally representative longitudinal study that seeks to advance the understanding of the relationships between individuals and different social contexts (family, friends and peers, schools, and neighborhoods) and U.S. adolescents' development. To date, three waves of data have been collected—Wave I (1994-1995), Wave II (1995-1996), and Wave III (2001-2002). Wave IV is scheduled to occur in 2007-2008. Data were collected through a complex sampling design that utilized a cluster sample, at the school level, with unequal probability of selection (Chantala & Tabor, 1999). Schools were selected to represent all high schools and middle schools in the U.S., thus the students attending the schools constitute a nationally representative

sample of adolescents in Grades 7 to 12 (Tourangeau & Shin, 1999). Because this study only included data from Wave I (1994-1995), the following information only pertains to the sampling and data collection for Wave I. Similar information for subsequent waves can be found on the Add Health website (Add Health, 2004b). Before presenting details about the sampling and data collection for Wave I, an overview of the different Add Health data sources is shown in Figure 2.

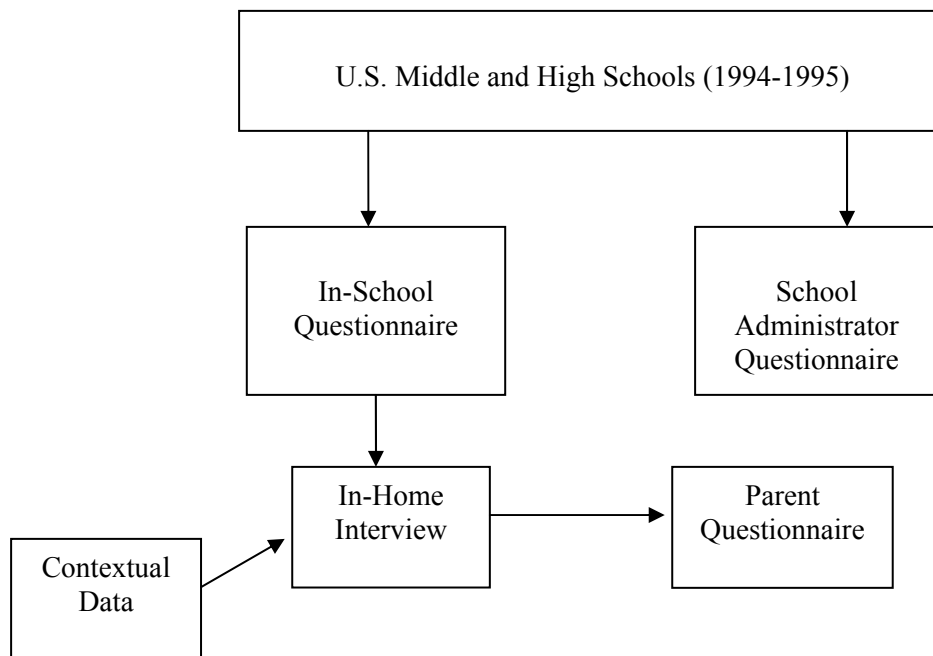


Figure 2. General overview of Add Health Wave I data sources.

In-School sampling frame. A total of 132 schools (80 high schools and 52 feeder schools) were included in the Add Health study. The initial 80 high schools approached about participating in the study were selected from the comprehensive Quality Education Data, Inc. (QED) database (Tourangeau & Shin, 1999). In creating the sampling frame,

all schools that included an 11th grade and enrolled more than 30 students were classified as high schools. Similarly, if the grade span of a school was not clear, the school was included in the original sampling frame. Through this process, a sampling frame of 26,666 public and private high schools in the QED database was generated (Tourangeau & Shin, 1999). Before sampling, the schools in the sampling frame were sorted by size, school type, census region, level of urbanicity, and percentage of White students to help ensure that the sample of schools selected were representative along the specified dimensions (Tourangeau & Shin, 1999). Schools then were systematically selected from the sorted lists with selection probabilities proportional to the school's enrollment (Tourangeau & Shin, 1999). This process, often referred to as implicit stratification, helped ensure that the sample of schools was representative along the previously mentioned stratification variables (Tourangeau & Shin, 1999).

Only 52 of the original 80 sampled high schools were eligible and agreed to participate in the study. The remaining 28 schools were replaced by similar high schools. Replacement schools were identified by first sorting the sampling frame by school size, school type, urbanicity, percentage of White students, grade span, percentage of Black students, census region, and census division (Tourangeau & Shin, 1999). Within each category, schools were sorted in a random order and the replacement school was the school that followed the originally sample school. If the first replacement school was not eligible or did not want to participate, this process was continued until an eligible and cooperative replacement school was found (Tourangeau & Shin, 1999).

To identify the feeder schools, high school administrators were asked to provide a list of all junior high and middle schools expected to send at least five students to the high school's entering class. High school administrators also were asked to indicate what percentage of the entering class was expected to come from each feeder school (Tourangeau & Shin, 1999). From these lists, researchers attempted to select a single feeder school for each high school; however, three different situations prevented the inclusion of one feeder school for every high school (Tourangeau & Shin, 1999). First, four of the high schools had no eligible feeder schools because students entered their school from a vast number of junior high and middle schools. Second, 20 of the high schools included in the sample had grade spans that included seventh and eighth grade, thus they served as their own feeder schools. Third, 4 of the 56 feeder schools that were asked to participate in the study declined; therefore, the final Add Health sample included 80 high schools and 52 feeder schools (Tourangeau & Shin, 1999). The probability of selection for each feeder school was proportional to the estimated percentage of the entering class that came from the feeder school (Tourangeau & Shin, 1999).

In-School Questionnaire. No sampling of students within the schools occurred for administration of the In-School Questionnaire. Instead, administrators at the sample schools were asked to have all students in the eligible grades (7th through 12th) complete the In-School Questionnaire (Tourangeau & Shin, 1999). All but four of the participating schools allowed their students to complete the In-School Questionnaire (Tourangeau & Shin, 1999). However, the schools that did not allow the In-School Questionnaire were

retained in the sample because they did allow students to be sampled for the in-home data collection (Tourangeau & Shin, 1999).

The In-School Questionnaire was self-administered during 45- to 60-minute class periods to 90,118 students between September 1994 and April 1995 (Add Health, 2004c). Schools notified parents in advance of the date the questionnaire was going to be administered so they could decide if their child was to participate or not (Add Health, 2004c). Also, there was no make-up day for students who were absent the day the questionnaire was administered at their schools. The following nine topics were included on the In-School Questionnaire: social and demographic information, parental education and occupation, household structure, risk behaviors, expectations for the future, self-esteem, health status, friendships, and extracurricular activities (Add Health, 2004c). In order to identify students for subsequent data collection points, each school provided a student roster and Add Health staff assigned identification numbers to each student. Also, to help gather data on students' peers, students were provided copies of their school roster to identify their friends as they completed the questionnaire (Add Health, 2004c).

School Administrator Questionnaire. In addition to the In-School Questionnaire given to the students, administrators at the 132 sample schools also were asked to complete a self-administered School Administrator Questionnaire (Chantala & Tabor, 1999). Areas covered on the questionnaire included issues dealing with school policy and procedures, teacher characteristics, health-service provision or referral, and student body characteristics (Add Health, 2004c). A total of 164 School Administrator Questionnaires were collected between September 1994 and April 1995 (Add Health, 2005b).

In-Home sampling. In addition to obtaining information from students through the In-School Questionnaire, 20,745 adolescents also participated in In-Home Interviews (Add Health, 2005b). Students were eligible for the In-Home Interview sample if they completed the In-School Questionnaire and/or were listed on a school roster. To generate a nationally representative sample of adolescents in Grades 7 through 12, students in each school were first stratified by grade and sex (Add Health, 2004c). Next, approximately 17 students from each stratum were randomly chosen for each of the 80 pairs of schools. This selection process yielded a core In-Home Interview sample of 12,105 adolescents (Add Health, 2004c). The remaining 8,640 adolescents included in the In-Home sample were from the special oversamples.

Oversampling was conducted for different ethnicities, students with disabilities, and genetic siblings who lived in the same household (Add Health, 2004c). To investigate social networks, oversampling, or saturation, also was conducted in 16 schools. All students enrolled in 14 small schools (enrollment less than 300) and 2 large schools (total combined enrollment exceeding 3,300) also were included in the In-Home Interview sample (Add Health, 2004c).

In-Home Interview. Wave 1 In-Home Interviews were conducted between April 1995 and December 1995. The In-Home Interviews varied in length from one to two hours, depending on the adolescent's age and experiences (Add Health, 2004c). For example, additional questions were asked of adolescents who indicated multiple behaviors (e.g., if a respondent indicated that he or she had used drugs and had sexual intercourse, he/she was also asked if he or she used drugs while engaging in sexual

intercourse; Add Health, 2004c). All interview data were recorded on laptop computers. Interviewers read less sensitive questions aloud and recorded each adolescent's responses. For more sensitive questions, adolescents listened to prerecorded questions via headphones and entered their responses into the computer themselves (Add Health, 2004c). This process of data collection helped maintain data security and helped minimize interviewer and parental influence.

The content of the In-Home Interviews covered a variety of topics including health status, healthcare utilization, nutrition, peer networks, decision-making processes, family composition and relationships, educational aspirations and expectations, employment experiences, romantic relationships, sexual experiences, substance use, and criminal activities (Add Health, 2004c). Respondents also were administered the Add Health Picture Vocabulary Test (AHPVT) at the beginning of the In-Home Interview sessions. This test was a computerized, shortened version of the Peabody Picture Vocabulary Test-Revised (Add Health, 2004c).

Parent Questionnaire. In addition to gathering information from adolescents during the Wave I In-Home Interview sessions, Add Health researchers also collected information from a parent of each adolescent respondent. When possible, the preferred parent was the adolescent's resident mother (Add Health, 2004c). Information obtained through the interviewer-assisted questionnaire included inheritable health conditions; marriages and other marriage-like relationships; perceived neighborhood characteristics; civic, volunteer, and school activity involvement; health-affecting behaviors; education and employment; household income and economic assistance; and parental

communication, interaction, and monitoring (Add Health, 2004c). A total of 17,700 Parent Questionnaires were completed between April 1995 and December 1995 (Add Health, 2005b).

Contextual data. Data about the neighborhoods where adolescents lived were based on state, county, tract, and block group levels derived from the Wave I addresses and were gathered from a variety of existing sources including but not limited to the U.S. Census, the Centers for Disease Control and Prevention, the National Center for Health Statistics, and the Federal Bureau of Investigation (Add Health, 2004a). Variables available in the Add Health Contextual data include geographic and household characteristics, labor force participation and unemployment, crime, social programs and policies, income and poverty, social integration, and availability of health services (Add Health, 2004a).

Sample weights. Add Health data contain multiple sampling weights to be used with different categories of analyses—analyses fitting population-average models, analyses fitting multilevel models that include adolescents and schools as the two levels of analysis, and analyses fitting population-average models for special subpopulations (binge drinkers, romantic partners of Add Health participants, and educational analyses involving high school transcript data; Chantala, 2006). Although sampling weights could not be used in the cross-classified random effects models conducted in this study, they were included in some preliminary univariate analyses. This section provides an overview of the creation of the sampling weight used in this study—the Wave I sampling weight for fitting population-average models. Information on sampling weights for other

waves and analytic procedures can be found on the Add Health website (Add Health, 2004d).

Adolescents in 1995 who were enrolled in Grades 7-12 during 1994-1995 represent the population of interest for the sampling weight used in this study—Wave I sampling weight for use with single-level analytic procedures (i.e., population-average models; Chantala, 2006). To calculate this sampling weight, Add Health researchers weighted Wave I In-Home samples using a four-step process. The first step included calculating a preliminary school weight (W_1) to compensate for probability selection differences among schools (Tourangeau & Shin, 1999). Next, W_1 was adjusted for feeder school ineligibility and nonresponse. The third step accounted for student selection probabilities across schools and across grades and sexes within schools in the creation of an initial student-level weight (Tourangeau & Shin, 1999). The final weight calculated during the fourth step of the weighting process was derived to compensate for student nonresponse to the Wave I In-Home Questionnaire. Thus, the sampling weight used in this study had been adjusted for both school-level and student-level selection probability and non-response (Tourangeau & Shin, 1999).

Overview of AHAA Study

AHAA is an educational supplement to Add Health. Whereas Add Health provides a great deal of data on a variety of social contexts, it has limited academic-related information (Muller et al., 2007b). By collecting official high school transcripts from all Wave III respondents who signed a Transcript Release Form (TRF) and by compiling contextual information about the schools adolescents attended, AHAA

provides the rich education-related data that Add Health is missing. Although AHAA was developed to supplement Add Health data, the data were selected separately from Add Health and were designed to create an educational data set that can be used in conjunction with Add Health or independently (Muller et al., 2007b). When used with the Add Health data, researchers are able to capture a more holistic view of the adolescent social, educational, and health-related behaviors and outcomes.

AHAA's study design is comparable to the 1987, 1990, 1994, 1998, and 2000 National Assessment of Educational Progress (NAEP) High School Transcript Studies; AHAA data collection and processing were modified from those used in NAEP transcript studies (Muller et al., 2007b). AHAA data were collected from a variety of sources including official student transcripts, course catalogs, textbook lists and course syllabi, School Information Forms, and several secondary data sources including two National Center for Education Statistics databases--Common Core of Data (CCD) and Private School Survey (PSS; Muller et al., 2007b).

Although the AHAA data contain detailed information about the educational trajectories of Add Health respondents, this study did not utilize the individual-level AHAA data. Instead, this study used the AHAA school context data obtained from the CCD. The CCD data included in the AHAA data were obtained from the 1990-1991, 1993-1994, 1994-1995, and 1999-2000 surveys. Example variables from the education contextual data include school-wide Title I eligibility, proportion of free lunch students, district size, school size, and racial composition indicators (e.g., proportion of White students, proportion of Black students; Muller et al., 2007a).

Study Sample

Data for this study were drawn from the combined Wave I Add Health and AHAA studies. Starting with the original sample of youth who completed both the In-School Questionnaire and In-Home Interview ($n = 15,356$), the sampling frame for this study was limited to adolescents who attended regular public middle or high schools (i.e., not magnet or alternative schools) during the 1994-1995 school year and who had complete data for all methodological variables ($n = 11,841$). Although limiting the sampling frame to regular public middle and high schools reduces external validity, doing so allowed for more parsimonious models to be examined (i.e., eliminated the need to statistically control for school type). Thus, given the complexity of the CCREMs used in the study, a reduction in external validity was deemed acceptable in exchange for models that were more parsimonious. This restriction removed 2,459 adolescents nested in 24 schools and 803 neighborhoods from the analyses. More details on the study sample are provided in the *Data management* portion of the *Data Analysis* section.

Measures

Two criterion variables, adolescent academic achievement and risk of obesity, were examined in the study. Individual control variables (Level-1) consisted of adolescent biological sex, age, race/ethnicity, family SES, and athletic participation. Neighborhood-level variables (Level-2) consisted of neighborhood affluence, neighborhood poverty, neighborhood racial composition, and urbanicity. School-level variables (Level-2) consisted of school-level SES, student body racial composition, teacher education, weight management education, and school-level athletic participation.

Below is a description of the Add Health and AAHA items used to measure the criterion and predictor variables as well as a description on how each SES composite variable (i.e., family SES, neighborhood affluence, neighborhood poverty, and school-level SES) was calculated. In addition, Table 1 provides a summary of how each variable was operationalized and the data source for each variable.

Family and school SES composite variables were created following the same standardization process used by Duncan and Aber (1997). First, the mean and standard deviation for each variable included in the composite variable was calculated using data from observations included in the sampling frame for this study. Second, because the variables included in these two measures were not originally measured on the same scale, *z*-scores were created for each adolescent for each variable included in the composite

$\left[z_i = \frac{x_i - \bar{x}_i}{s_i} \right]$. Third, the *z*-scores for each variable included in the composite were

averaged into a final composite score; for example,

$\left[SES\ Composite = \frac{z_1 + z_2 + z_3}{3} \right]$. Lastly, although this same general process was followed

for the family and school SES composite variables, the unit of analysis included in the creation of each composite varied. For family SES, individual adolescents were the unit of analysis and for school SES, schools were the unit of analysis.

Next, because all of the variables included in the neighborhood SES composite variables were originally measured on the same scale, these variables were standardized using a slightly different process than was used with family and school SES. Instead of

standardizing each variable before creating the composite measure, neighborhood affluence and neighborhood poverty were standardized after the individual variables were averaged into a neighborhood composite score. More specifically, after calculating the overall mean level of affluence and poverty across neighborhoods, neighborhood affluence and neighborhood poverty z -scores were created for each adolescent using the

following formula
$$\left[z_i = \frac{x_i - \bar{x}_i}{s_i} \right].$$

Table 1

List of Operationalized Variables and Data Source

Variable	Operational Definition	Data Source ¹
Criterion Variables		
Academic achievement	Standardized scores on the Add Health Picture Vocabulary Test (AHPVT).	IH
Risk of obesity	Age-and-gender-adjusted BMI z -scores	IH
Level-1 control variables		
Biological sex	Girl (0), boy (1)	IH
Age	Age in years, grand-mean centered	IH
Race/Ethnicity	Non-Hispanic White or non-Hispanic Asian (0), non-Hispanic Black, non-Hispanic Other, or Hispanic (1)	IH
Family SES	A composite variable calculated as the mean of standardized (z -score) measures of family income, parental educational level, and parental occupational prestige	PI, IH
Athletic participation	Number of sports-related activities adolescents reported participating in	IS
Level-2 neighborhood variables		
Neighborhood affluence	A composite variable calculated as a standardized (z -score) measure computed from the average proportion of neighborhood income, occupational prestige, and educational levels	CD

Table 1

List of Operationalized Variables and Data Source

Variable	Operational Definition	Data Source ¹
Neighborhood poverty	A composite variable calculated as a standardized (<i>z</i> -score) measure computed from the average proportion of neighborhood poverty, single-parent households, and unemployment	CD
Neighborhood racial composition	Proportion of White residents	CD
Urbanicity	Proportion of residents who live inside an urbanized area	CD
Level-2 school variables		
School-level SES	A composite variable calculated as the mean of standardized (<i>z</i> -score) measures of school-level poverty, parental education, and parental occupational prestige	PI, IH, AHAA
Student body racial composition	Proportion of White, non-Hispanic students	AHAA
Teacher education	Proportion of teachers with a Master's degree or higher	SA
Weight management education	Average proportion of students who reported being taught about four weight-related health topics--foods to eat, exercise, obesity, and being underweight	IH
School-level athletic participation	Proportion of students involved in at least one sports-related activity	IS

Notes: ¹AHAA = Adolescent Health and Academic Achievement, IS = Add Health In-School Questionnaire, SA = Add Health School Administrator Questionnaire, IH = Add Health In-Home Interview, PI = Add Health Parent Questionnaire, and CD = Add Health Contextual Database.

Criterion variables. Adolescent academic achievement and adolescent risk of obesity were the two criterion variables examined in this study.

Academic achievement. In this study, standardized Add Health Picture Vocabulary Test (AHPVT) scores were used as a measure of adolescent academic

achievement. AHPVT is a modified version of the Peabody Picture Vocabulary Test-Revised (PPVT-R), Form L. One-half of the original PPVT-R items were used in the AHPVT; odd-numbered items from 1 to 87 and even-numbered items from 90 to 175. Scores were standardized by age, with each age group having a mean of 100 and a standard deviation of 15. Score reliability and validity information on the AHPVT is not available (Joyce Tabor, personal communication, August 16, 2007). However, score reliability and validity information for the PPVT-R, Form L was obtained and is presented below.

Using a sampling plan based on population data from the 1970 U.S. Census and stratified by age, gender, geographic region, parental occupation, ethnicity, and community size and type, the PPVT-R was standardized in 1979 using a sample of 4,200 children and youth aged 2 1/2 years to 18 years and 828 persons aged 19 years to 40 years (Dunn & Dunn, 1981). Based on PPVT-R, Form L tests consisting of approximately 35 items, split-half reliability coefficients, by relevant age for this study (i.e., 11 to 20), ranged from a low of .77 for 11-year-olds to a high of .88 for 18-year-olds, with an average of .84 (Dunn & Dunn, 1981). However, the Spearman-Brown adjustment for AHPVT suggests a higher average reliability of .91. Immediate retest standard score reliability coefficients, by age, were slightly weaker, with a low of .71 for 17-year-olds, a high of .89 for 11-year-olds, and an average of .82 (Dunn & Dunn, 1981). Delayed retest standard score reliability coefficients, by age, also were lower than the split-half reliability coefficients, with a low of .56 for 18-year-olds, high of .90 for 11-year-olds, and an average of .77 (Dunn & Dunn, 1981).

In terms of content validity, the PPVT-R was designed to be representative of the content universe for hearing vocabulary—*Webster's New Collegiate Dictionary* (Merriam, 1953, as cited in Dunn & Dunn, 1981). The only restriction in selecting a word from the dictionary was that its meaning had to be able to be depicted by a picture (Dunn & Dunn, 1981). Regarding construct validity, words were included in the PPVT-R when they fit the curve for hearing vocabulary established by using the Rasch-Wright latent trait model (i.e., items with steep or flat item characteristic curves were not included; Dunn & Dunn, 1981).

Concurrent validity evidence was the only criterion-related validity available for the PPVT-R (Dunn & Dunn, 1981). Based on 55 correlations with other vocabulary tests, the PPVT-R was reported to have relatively high levels of correlation with other vocabulary tests (median correlation = .71; Dunn & Dunn, 1981). However, these data were not based on the PPVT-R directly. Instead, because the PPVT-R had a median correlation of .70 with the original PPVT, researchers applied validity research findings from the PPVT to the PPVT-R (Dunn & Dunn, 1981). No construct validity evidence, such as that related to convergent validity, was reported in the PPVT-R manual.

Risk of obesity. In this study, age-and-gender-adjusted BMI z-scores were used as a measure of risk of obesity. Although risk of obesity is often operationalized as having an age-and-gender-adjusted BMI \geq 85th percentile (CDC, 2007), CCREMs cannot be used with a dichotomous criterion variable; therefore, a continuous measure of risk of obesity was created—standardized age-and-gender-adjusted BMI. The age-and-gender-adjusted BMI z-scores were created through a three-step process.

First, adolescent BMI was calculated using the standard BMI formula [weight (lbs)/height (in)²*703]. Second, age-and-gender-adjusted percentiles (5, 10, 25, 50, 75, 85, 90, and 95) were calculated using the CDC (2000a, 2000b) age-and-gender BMI tables. Third, using the age-and-gender-adjusted percentiles linear interpolation was used to calculate more precise BMI percentiles. These percentiles were then standardized (i.e., expected normal scores) to create age-and-gender-adjusted BMI z-scores. Figures B-1 and B-2 in Appendix B contain box-and-whisker plots for the initial age-and-gender-adjusted BMI values.

The height and weight data used to create BMI values were ascertained through two In-Home Interview items—*What is your height in feet and inches?* and *What is your weight?* Although self-reported height and weight were used to calculate BMI, the correlation between interviewer-measured weight and self-reported weight in the Add Health data was .95 (Goodman, Hinden, & Khandelwal, 2000).

Predictor variables. Three categories of predictor variables were included in the current study: individual-level control variables, neighborhood-level variables, and school-level variables. Biological sex, age, race/ethnicity, family SES, and athletic participation comprised the individual control variables in the CCREMs. Neighborhood affluence, poverty, racial composition, and urbanicity comprised the neighborhood-level variables in the CCREMs. School-level variables consisted of school-level SES, student body racial composition, teacher education, weight management education, and school-level athletic participation.

Biological sex. Boys were coded one and girls were coded zero; values were obtained from the interview item, *Interviewer, please confirm that R's sex is (male) female. Ask if necessary.*

Age. Adolescent age was measured by subtracting the adolescent's date of birth from the Wave I In-Home interview date. In order to assign age-and-gender-adjusted BMI percentiles using the CDC (2007) BMI tables, age was computed and entered into the models as integers (i.e., full years) ranging from 11 to 20.

Race/ethnicity. A dichotomous race/ethnicity variable (0 = non-Hispanic White and non-Hispanic Asian, 1 = non-Hispanic Black, non-Hispanic Other, and Hispanic) was created from two interview items: *Are you of Hispanic or Latino origin?* (Response options were yes or no) and *What is your race?* (Response options were White, Black or African American, American Indian or Native American, Asian or Pacific Islander, or Other).

Family SES. Using the previously mentioned SES composite variable formula, this composite measure was created from three commonly used measures of family socioeconomic status: parental education, parental occupation, and family income. Parental education was ascertained during the Parent Interview—*How far did you go in school?* [Response options were never went to school (0); 8th grade or less (1); more than 8th grade, but did not graduate from high school (2); went to a business, trade, or vocational school instead of high school (3); completed GED (4); high school graduate (5); went to a business, trade, or vocational school after high school (6); went to college,

but did not graduate (7); graduated from a college or university (8); and professional training beyond a 4-year college or university (9)].

The parent who participated in the interview also was asked about his or her spouse's/partner's education—*How far did your current (spouse/partner) go in school?* (Response options same as above). When education data were available for two parents, an average parental education z-score was used in the family SES composite. For

$$\text{example, } \textit{parental education} = \left[\frac{z_{\textit{momedu}} + z_{\textit{dadedu}}}{2} \right].$$

Household income data also were obtained through the Parent Interview—*About how much total income, before taxes did your family receive in 1994?* The original variable was continuous in \$1,000 increments; however, for use in the composite score, income data were converted to ratios of income to 1995 federal poverty level (FPL) and coded 1 to 8: <100% (1), 100%-149% (2), 150%-199% (3), 200%-249% (4), 250%-299% (5), 300%-349% (6), 350%-399% (7), and $\geq 400\%$ (8).

Parent occupation data were obtained from the adolescent In-Home Interviews—*What kind of work does she do?* (for mom) and *What kind of work does he do?* (for dad). Original response options: professional 1, such as doctor, lawyer, scientist; professional 2, such as teacher, librarian, nurse; manager, such as executive, director; technical, such as computer specialist, radiologist; office worker, such as bookkeeper, office clerk, secretary; sales worker, such as insurance agent, store clerk; restaurant worker or personal service, such as waitress, housekeeper; craftsperson, such as toolmaker, woodworker; construction worker, such as carpenter, crane operator; mechanic, such as plumber, machinist; factory worker or laborer, such as assembler, janitor; transportation,

such as bus driver, taxi driver; military or security, such as police officer, soldier, fire fighter; farm or fishery worker; other; and none.

Occupation data were reclassified following the 1990 U.S. Census Bureau's occupation classifications included in the Add Health Contextual data: operators, fabricators, and laborers (1); production, craft or repair (2); farming, forestry or fishing (3); service occupations (4); military or security (5); technical, sales or administrative support (6); and managerial or professional (7). As with parental education, when occupation data were available for two parents, an average parental occupation z-score was used in the family SES composite, such as the following

$$parental\ occupation = \left[\frac{z_{momocc} + z_{dadocc}}{2} \right].$$

The intercorrelation of the three

variables included in the family SES variable and Cronbach's alpha are provided in Table 2.

Table 2

Intercorrelation of Variables Comprising the Family SES Composite Variable (n = 10,860)

	Parental education	Parental occupation	Household income
Parental education	1.0		
Parental occupation	.50	1.0	
Household income	.42	.26	1.0

Note: All variables were z-scores. Cronbach's $\alpha = .65$

Athletic participation. Adolescent athletic participation was derived from adolescents' responses to the In-School survey item, *Here is a list of clubs, organizations, and teams found at many schools. Darken the oval next to any of them that you are participating in this year, or that you plan to participate in later in the school year.*

Response options consisted of 33 common school activities, 13 of which asked about

different sports (cheerleading/dance team, baseball/softball, basketball, field hockey, football, ice hockey, soccer, swimming, tennis, track, volleyball, wrestling, other sport). To create the athletic participation variable for this study, adolescents' responses to the 13 sports-related response options were first summed and then winsorized such that the derived variable had values ranging from zero to four. The decision regarding how best to winsorize the athletic participation variable was informed by examining the relationship between athletic participation and adolescent BMI. More specifically, the initial relationship between BMI and athletic participation was non-linear such that BMI decreased as the number of sports-related activities increased until the value four; after four reported sports-activities, the relationship between BMI and athletic participation diminished. Therefore, all athletic participation values greater than four were collapsed into four such that a value of four on the derived variable represents participation in four or more sports-related activities.

Neighborhood affluence. Using the previously mentioned neighborhood SES composite variable formula, this composite measure was created from three variables: the proportion of families with income equal to or greater than \$50,000, proportion employed persons aged 16 and over in managerial and professional occupations, and the proportion of residents age 25 and older with at least a college degree, as reported from the 1990 census in the Add Health contextual data. The intercorrelation of these three variables and Cronbach's alpha for this composite variable are provided in Table 3.

Table 3

Intercorrelation of Variables Comprising the Neighborhood Affluence Composite Variable (n = 10,860)

	Proportion of families with income \geq \$50,000	Proportion of managerial & professional occupations	Proportion with at least a college degree
Proportion of families with income \geq \$50,000	1.0		
Proportion of managerial & professional occupations	.72	1.0	
College degree Proportion with at least a college degree	.75	.91	1.0

Note: All variables were z-scores. Cronbach's $\alpha = .89$

Neighborhood poverty. Using the previously mentioned neighborhood SES composite variable formula, this composite measure was created from three variables: the proportion of families living below the poverty line, proportion of female-headed households, and the proportion of unemployed adult residents, as reported from the 1990 census in the Add Health contextual data. The intercorrelation of these three variables and Cronbach's alpha for this composite variable are provided in Table 4.

Table 4

Intercorrelation of Variables Comprising the Neighborhood Poverty Composite Variable (n = 10,860)

	Proportion of families below the poverty line	Proportion of female- headed households	Proportion of unemployed adults
Proportion of families below the poverty line	1.0		
Proportion of female- headed households	.18	1.0	
Proportion of unemployed adults	.77	.16	1.0

Note: All variables were z-scores. Cronbach's $\alpha = .44$

Neighborhood racial composition. The proportion of White residents in a neighborhood, as reported from the 1990 census in the Add Health contextual data, was used to measure neighborhood racial composition.

Urbanicity. The proportion of residents who live inside an urbanized area, as reported from the 1990 census in the Add Health contextual data, was used to measure urbanicity.

School-level SES. Using the previously mentioned SES composite variable formula, this composite measure was created from three variables: aggregated parental education (as previously defined), aggregated parental occupation (as previously defined), and proportion of students not eligible for the free lunch program (as a proxy for income), as reported from the 1994-1995 CCD in the AAHA data. The intercorrelation of these three variables and Cronbach's alpha for this composite variable are provided in Table 5.

Table 5

Intercorrelation of Variables Comprising the School SES Composite Variable (n = 10,860)

	School-level parent education	School-level parental occupation	Proportion of students not eligible for free lunch
School-level parent education	1.0		
School-level parental occupation	.49	1.0	
Proportion of students not eligible for free lunch	.41	.79	1.0

Note: All variables were measured as z-scores. Cronbach's $\alpha = .80$

Student body racial composition. As reported from the 1994-1995 CCD in the AHAA data, the proportion of White, non-Hispanic students was used to measure student body racial composition.

Teacher education. The proportion of teachers at a school with a Master's degree or higher, as reported by school administrators in response to the School Administrator Questionnaire item, *Approximately what percentage of your full-time classroom teachers hold Master's degrees or higher? (WRITE IN PERCENT).*

Weight management education. A composite variable created from responses to the In-Home Interview item, *Please tell me whether you have learned about each of the following things in a class at school.* Response options consisted of 17 health-related topics, 4 of which were related to maintaining a healthy weight (foods you should and should not eat; the importance of exercise; the problems of being overweight; and the problems of being underweight). To create the weight education variable, first the proportion of students per school who reported learning about each of these four topics was calculated and then the average of the four proportions was derived. The intercorrelation of these four variables and Cronbach's alpha for this composite variable are provided in Table 6.

Table 6

Intercorrelation of Variables Comprising the Weight Education Composite Variable (n = 10,860)

	Foods you should and should not eat	Importance of exercise	Problems of being overweight	Problems of being underweight
Foods you should and should not eat	1.0			
Importance of exercise	.67	1.0		
Problems of being overweight	.71	.60	1.0	
Problems of being underweight	.73	.59	.85	1.0

Cronbach's $\alpha = .862$

School-level athletic participation. The proportion of students involved in at least one sports-related activity.

Data Analysis

Data management. All data used in this study came from the restricted-use data files versus the public-use data files because the public-use data only contain information on 6,504 adolescents and cannot be linked to the contextual neighborhood data included in this study (Add Health, 2005a). For security purposes, all electronic files associated with and generated from the restricted data (e.g., SAS programs and output) were encrypted and stored on a password protected external hard drive that was kept in a locked file cabinet when not in use. The researcher was the only person who knew the password to access the encrypted files. Similarly, the researcher's laptop, which was used to conduct the data analysis, was password protected and programmed to lock after 10 minutes of inactivity. Only the researcher knew the password to unlock the computer.

Prior to conducting any analysis, several data management tasks were completed. First, to improve data analysis processing time, a smaller data set that contained only methodological variables (e.g., sample weights, respondent identification, strata variables) and substantive variables of interest (e.g., criterion and predictor variables) was created. Second, non-applicable response options were examined for all variables included in the study to determine if they could be recoded into theoretically conceivable responses. For example, not all schools have athletics, thus, non-applicable responses to the items used to assess student athletic participation could have been conceived of as a response of no. Upon examination of the variables, it was determined that none of the variables had non-applicable responses that could be recoded in this manner. In fact, the athletic participation items did not contain non-applicable responses.

Third, the study sample was restricted to adolescents who participated in the In-School Questionnaire and In-Home Interview, attended a regular public junior high, middle or high school during the 1994-1995 academic year, and had complete data on all methodological and substantive variables included in the study. Also, because Add Health data contain pairs of siblings, one sibling from the sample of adolescents who met the aforementioned criteria was randomly selected for inclusion in the study sample.

Fourth, because employing sample filters can alter the generalizability of findings, missing and refusal data (when applicable) were examined to determine the frequency of missing data across observations and to what extent the missingness and refusals were random (i.e., correlations between missing and refusal indicators and all variables included in the analyses were examined). Although researchers typically treat refusal

responses as missing, these responses were analyzed separately because theoretically refusal responses are different than missing (i.e., a refusal to respond to an item is itself a response and should not be treated as if it were simply missing). However, given the non-sensitive nature of the majority of variables included in the study, it was not surprising that the only variable with a substantial amount of refusal responses was household income [$n = 1,060$ (11%)]. Therefore, examination of refusal data focused only on the extent to which refusals for household income were random.

When systematic missingness and/or refusals were observed, statements about conclusions and interpretations of the data have been tempered with appropriate cautions and caveats. For example, because the variable used to measure household income did not appear to be missing at random, the obtained parameter estimate for family SES, as well as the parameter estimates for variables correlated with household income and/or family SES have been interpreted with additional caution as they are likely to be biased. All data management tasks were executed in SAS v9.1.3 (SAS Institute Inc., 2003).

Also, although imputation is a common method for dealing with missing data (e.g., Allison, 2002; Rubin, 1996; Schafer & Graham, 2002), it is not always the best missing-data treatment. For example, when data are missing completely at random and the amount of missing data are not extreme researchers have shown that imputation methods do not perform better than listwise deletion as used in the current study (Allison, 2002; Kromrey & Hines, 1994). Furthermore, when data are not missing completely at random and less than 30% of data are missing, listwise deletion yields less biased regression parameter estimates than do other common imputation methods (Kromrey &

Hines, 1994). Thus, even though the data do not appear to be missing at random, less than 30% of data were missing; therefore, limiting the sample to those with complete data on all variables of interest (i.e., listwise deletion) was an appropriate missing-data treatment.

Univariate and bivariate analyses. Descriptive univariate statistics were examined to gain an understanding of the data distribution and bivariate correlational analyses were conducted to gain a better understanding of how the variables of interest were interrelated. Because sample weights could not be used in the multivariate analyses, univariate statistics were examined both weighted and unweighted and then compared. Doing so helped inform the generalizability of the multivariate findings. All univariate and bivariate analyses were conducted using SAS v9.1.3 (SAS Institute Inc., 2003).

Multivariate analyses. Research questions were examined using cross-classified random effects hierarchical linear models with individuals nested within schools and neighborhoods. All multivariate data analyses were conducted using PROC MIXED in SAS v9.1.3 (SAS Institute Inc., 2003). However, before conducting any multivariate analyses, data were screened for violations of assumptions often associated with multilevel models (i.e., multicollinearity, normality, linearity, and homogeneity of variance). Further, the data screening techniques described below are the same as those recommended by Hox (2002) and Raudenbush and Bryk (2002).

First, the data were examined for multicollinearity. In addition to the bivariate examination of independent variables via zero-order correlation coefficients, multicollinearity was assessed by examining tolerance values from four multiple regression models for each of the criterion variables. The first multiple regression model

contained the main effects for all Level-1 predictor variables, the second multiple regression model contained the main effects for all Level-2 neighborhood predictor variables, the third multiple regression model contained the main effects for all Level-2 school predictor variables, and the fourth multiple regression model contained the main effects for all Level-2 neighborhood and school predictor variables. All variables from all eight regression models (i.e., four for academic achievement and four for risk of obesity) exhibited acceptable tolerance values (Berry, 1993), therefore, all variables were retained and included in the CCREMs.

Next, Level-1 and Level-2 residuals from the full academic achievement CCREM (Model 5-AA) were examined for potential violations of normality, linearity, and homogeneity of variance. To examine the normality assumption of Level-1 residuals, a box-and-whisker plot of the residuals was created and the skewness and kurtosis of the residuals were calculated. Normality, linearity, and heteroscedasticity also were examined by plotting the Level-1 residuals against the predicted values for academic achievement.

Because CCREMs contain data for two different Level-2 structures (i.e., neighborhoods and schools), Level-2 residuals were examined separately for neighborhoods and schools. To examine the normality assumption of neighborhood Level-2 residuals, a box-and-whisker plot of the neighborhood Level-2 residuals was created and the skewness and kurtosis of the residuals were calculated. Normality, linearity, and heteroscedasticity also were examined by plotting the neighborhood Level-2 residuals against the predicted values for academic achievement. The same process was

repeated using school Level-2 residuals. Similarly, the Level-1 and Level-2 residuals from the full risk of obesity CCREM (Model 5-RO) were examined for potential violations of normality, linearity, and homogeneity of variance following the same process as described above for the academic achievement analysis.

To allow comparison of models that differed in their fixed effects, the cross-classified random effects hierarchical linear models were estimated using maximum likelihood estimation. All continuous predictor variables, without a meaningful interpretation of zero, were grand-mean centered. Grand-mean centering was used instead of group-mean centering because (a) the focus of the study was on Level-2 predictors, while statistically controlling for Level-1 variables and (b) the interactions included in the study were between Level-2 predictors (Enders & Tofighi, 2007). To determine the moderating effects of schools on neighborhoods as well as the unique influence of neighborhoods and schools, six CCREMs were examined for each criterion variable. A description of the models examined in this study is presented below. See Table 7 for a general overview of the structure of each CCREM for each criterion variable.

Table 7

Summary of the Model Structure for each Cross-Classified Random Effects Model

Model	Academic Achievement Predictor Variables	Risk of Obesity Predictor Variables
Model 1: Unconditional model	None	None
Model 2: Level-1 control model	Biological sex, age, race, family SES	Biological sex, age, race, family SES, athletic participation
Model 3: Neighborhood model	Affluence, poverty, racial composition, Urbanicity	Affluence, poverty, racial composition, Urbanicity

Table 7

Summary of the Model Structure for each Cross-Classified Random Effects Model

Model	Academic Achievement Predictor Variables	Risk of Obesity Predictor Variables
Model 4: School model	School SES, student body racial composition, teacher education	School SES, weight management Education, school athletic participation
Model 5: Neighborhood and school main effects model	Affluence, poverty, racial composition, Urbanicity, school SES, student body racial composition, teacher education	Affluence, poverty, racial composition, urbanicity, school SES, weight management education, school athletic participation
Model 6: Neighborhood, school, and interaction model	Affluence, poverty, racial composition, Urbanicity, school SES, student body racial composition, teacher education, affluence*school SES, poverty*school SES, affluence*teacher education, poverty*teacher education	Affluence, poverty, racial composition, urbanicity, school SES, weight management education, school athletic participation, affluence*school SES, poverty*school SES, affluence*weight education, poverty*weight education

Following a model-building strategy as discussed by Raudenbush and Bryk (2002), the cross-classified random effects models were examined in order of complexity, starting with the simplest model that had no predictors and ending with the most complex model with multiple interaction terms. The first academic achievement model was a fully unconditional model with no predictors (Model 1-AA). At Level-1, the model was

$$Y_{i(j_1j_2)} = \pi_{intercept(j_1j_2)} + e_{i(j_1j_2)} \quad (1)$$

where $Y_{i(j_1j_2)}$ symbolizes the achievement outcome (AHPVT) for student i in neighborhood j_1 and school j_2 . The intercept, $\pi_{intercept(j_1j_2)}$, represents the predicted AHPVT score for students from neighborhood j_1 and school j_2 . The residual, $e_{i(j_1j_2)}$,

represents the deviation of a student's AHPVT score from the student's neighborhood and school predicted intercept value and is assumed $\sim N(0, \sigma^2)$.

At Level-2, the Level-1 intercept, $\pi_{intercept(j_1j_2)}$, was modeled as a random effect in the fully unconditional model.

$$\pi_{intercept(j_1j_2)} = \theta_{intercept} + b_{0j_10} + c_{00j_2} \quad (2)$$

The overall intercept, $\theta_{intercept}$, represents the grand mean AHPVT score. The neighborhood residual, b_{0j_10} , represents the neighborhood effect for neighborhood j_1 (averaged across schools) and is assumed $\sim N(0, \tau_{b00})$. The school residual, c_{00j_2} , represents the school effect for school j_2 (averaged across neighborhoods) and is assumed $\sim N(0, \tau_{c00})$.

Next, a Level-1 control model (Model 2-AA) examined the extent to which academic achievement varied based on individual-level characteristics.

$$Y_{i(j_1j_2)} = \pi_{intercept(j_1j_2)} + \pi_{bio_sex(j_1j_2)} bio_sex_{i(j_1j_2)} + \pi_{age(j_1j_2)} age_{i(j_1j_2)} + \pi_{race/eth(j_1j_2)} race/eth_{i(j_1j_2)} + \pi_{ses(j_1j_2)} ses_{i(j_1j_2)} + e_{i(j_1j_2)} \quad (3)$$

At Level-1, $Y_{i(j_1j_2)}$ still symbolizes the achievement outcome (AHPVT) for student i in neighborhood j_1 and school j_2 . The intercept, $\pi_{intercept(j_1j_2)}$, is now the expected AHPVT score when all predictor variables are set to zero. More specifically, for this model, $\pi_{intercept(j_1j_2)}$, represents the predicted AHPVT score for an average age, non-Hispanic Black/non-Hispanic Other/Hispanic female with an average family SES. π_{bio_sex} and $\pi_{race/eth}$ represent the expected difference in AHPVT scores between a student in

neighborhood j_1 and school j_2 with a value of 0 for each variable and a student in neighborhood j_1 and school j_2 with a value of 1 for each variable. For example, because males are coded 1, π_{bio_sex} is the expected difference in AHPVT scores between boys and girls in neighborhood j_1 and school j_2 while statistically controlling for all other predictors in the model. For age, π_{age} represents the expected change in AHPVT score for a student in neighborhood j_1 and school j_2 for every one-year change in age while statistically controlling for all other predictors in the model. For family SES, π_{ses} represents the expected change in AHPVT score for a student in neighborhood j_1 and school j_2 for every one standard deviation change in family SES while statistically controlling for all other predictors in the model.

At Level-2, the Level-1 intercept, $\pi_{intercept(j_1 j_2)}$, was modeled as a random effect in the Level-1 control model.

$$\begin{aligned}
 \pi_{intercept(j_1 j_2)} &= \theta_{intercept} + b_{0j_1 0} + c_{00 j_2} \\
 \pi_{bio_sex(j_1 j_2)} &= \theta_{bio_sex} \\
 \pi_{age(j_1 j_2)} &= \theta_{age} \\
 \pi_{race/eth(j_1 j_2)} &= \theta_{race/eth} \\
 \pi_{ses(j_1 j_2)} &= \theta_{ses}
 \end{aligned} \tag{4}$$

The overall intercept, $\theta_{intercept}$, represents the grand mean AHPVT score when all Level-1 predictor variables are set to zero. More specifically, $\theta_{intercept}$ represents the predicted AHPVT score for an average age, non-Hispanic Black/non-Hispanic Other/Hispanic female with an average family SES. The neighborhood residual, $b_{0j_1 0}$, represents the

neighborhood effect for neighborhood j_1 (averaged across schools). The school residual, c_{00j_2} , represents the school effect for school j_2 (averaged across neighborhoods). Each π_x represents the same value as discussed above in Equation 3 and each θ_x represents the fixed effects for each corresponding Level-1 predictor variable. For example, θ_{bio_sex} represents the effect of biological sex that was modeled not to vary across neighborhoods or schools. The Level-1 portion of Model 2-AA (Equation 3) served as the Level-1 model for all remaining academic achievement models.

Adding to Model 2-AA, the third model (Model 3-AA) examined neighborhood-level correlates of achievement while statistically controlling for individual differences at Level-1 (Equation 3). At Level-2, the Level-1 intercept, $\pi_{intercept(j_1j_2)}$, was modeled as a random effect and a function of four neighborhood variables: affluence, poverty, racial composition, and urbanicity.

$$\begin{aligned}
 \pi_{intercept(j_1j_2)} &= \theta_{intercept} + \gamma_{neigh_affl}neigh_affl_{j_1} + \gamma_{neigh_pov}neigh_pov_{j_1} + \\
 &\gamma_{neigh_race}neigh_race_{j_1} + \gamma_{urban}urban_{j_1} + b_{0j_10} + c_{00j_2} \\
 \pi_{bio_sex(j_1j_2)} &= \theta_{bio_sex} \\
 \pi_{age(j_1j_2)} &= \theta_{age} \\
 \pi_{race/eth(j_1j_2)} &= \theta_{race/eth} \\
 \pi_{ses(j_1j_2)} &= \theta_{ses}
 \end{aligned} \tag{5}$$

The intercept, $\theta_{intercept}$, now represents the expected adjusted (for Level-1 predictors) AHPVT score when all Level-2 predictor variables are set to zero. More specifically, $\theta_{intercept}$ is the expected adjusted AHPVT score for a student from a neighborhood with average affluence and poverty levels and no urbanicity or White

residents. Each γ_x represents the fixed effect of variable X that is assumed constant over all neighborhoods (e.g., γ_{neigh_pov} represents the effect of neighborhood poverty on AHPVT scores across all neighborhoods). The neighborhood residual, b_{0j_1} , represents the neighborhood effect for neighborhood j_1 (averaged across schools) while statistically controlling for all Level-2 predictors. The school residual, c_{00j_2} , represents the school effect for school j_2 (averaged across neighborhoods) while statistically controlling for all Level-2 predictors. Each π_x and θ_x represent the same values as discussed in Equations 3 and 4.

Next, also building on Model 2-AA, the fourth model (Model 4-AA) investigated school-level predictors of achievement while statistically controlling for individual variables (Equation 3). At Level-2, the Level-1 intercept, $\pi_{intercept(j_1j_2)}$, was modeled as a random effect and a function of three school variables: school SES, student body racial composition, and teacher education.

$$\begin{aligned}
 \pi_{intercept(j_1j_2)} &= \theta_{intercept} + \beta_{sch_ses} sch_ses_{j_2} + \beta_{stu_race} stu_race_{j_2} + \\
 &\beta_{tch_edu} tch_edu_{j_2} + b_{0j_1} + c_{00j_2} \\
 \pi_{bio_sex(j_1j_2)} &= \theta_{bio_sex} \\
 \pi_{age(j_1j_2)} &= \theta_{age} \\
 \pi_{race/eth(j_1j_2)} &= \theta_{race/eth} \\
 \pi_{ses(j_1j_2)} &= \theta_{ses}
 \end{aligned} \tag{6}$$

The intercept, $\theta_{intercept}$, now represents the expected adjusted (for Level-1 predictors) AHPVT score when all Level-2 predictor variables are set to zero. More specifically, $\theta_{intercept}$ is the expected adjusted AHPVT score for a student who attends an

average SES school with no White, non-Hispanic students and no teachers with graduate degrees. Each β_x represents the fixed effect of variable X that is assumed constant over all schools (e.g., β_{sch_ses} represents the effect of school SES on AHPVT scores across all schools). The neighborhood residual, b_{0j_1} , represents the neighborhood effect for neighborhood j_1 (averaged across schools) while statistically controlling for all Level-2 predictors. The school residual, c_{00j_2} , represents the school effect for school j_2 (averaged across neighborhoods) while statistically controlling for all Level-2 predictors. Each π_x and θ_x represent the same values as discussed above in Equations 3 and 4.

Model 5-AA was a combination of Models 3-AA and 4-AA and examined achievement as a function of both neighborhood and school factors simultaneously, while statistically controlling for individual characteristics (Equation 3). At Level-2, the Level-1 intercept, $\pi_{intercept(j_1j_2)}$, was modeled as a random effect and a function of four neighborhood variables and three school variables: neighborhood affluence, neighborhood poverty, neighborhood racial composition, urbanicity, school SES, student body racial composition, and teacher education.

$$\begin{aligned}
\pi_{intercept(j_1j_2)} &= \theta_{intercept} + \gamma_{neigh_affl}neigh_affl_{j_1} + \gamma_{neigh_pov}neigh_pov_{j_1} + \\
&\gamma_{neigh_race}neigh_race_{j_1} + \gamma_{urban}urban_{j_1} + \beta_{sch_ses}sch_ses_{j_2} + \beta_{stu_race}stu_race_{j_2} + \\
&\beta_{tch_edu}tch_edu_{j_2} + b_{0j_1} + c_{00j_2} \\
\pi_{bio_sex(j_1j_2)} &= \theta_{bio_sex} \\
\pi_{age(j_1j_2)} &= \theta_{age} \\
\pi_{race/eth(j_1j_2)} &= \theta_{race/eth} \\
\pi_{ses(j_1j_2)} &= \theta_{ses}
\end{aligned} \tag{7}$$

The intercept, $\theta_{intercept}$, now represents the expected adjusted (for Level-1 predictors) AHPVT score when all Level-2 predictor variables are set to zero. More specifically, $\theta_{intercept}$ is the expected adjusted AHPVT score for a student from a neighborhood with average affluence and poverty levels and no urbanicity or White residents and who attends an average SES school with no White, non-Hispanic students and no teachers with graduate degrees. Each γ_x represents the fixed effect of variable X that is assumed constant over all neighborhoods (e.g., γ_{neigh_pov} represents the effect of neighborhood poverty on AHPVT scores across all neighborhoods). Each β_x represents the fixed effect of variable X that is assumed constant over all schools (e.g., β_{sch_ses} represents the effect of school SES on AHPVT scores across all schools). The neighborhood residual, b_{0j_1} , represents the neighborhood effect for neighborhood j_1 (averaged across schools) while statistically controlling for all Level-2 predictors. The school residual, c_{00j_2} , represents the school effect for school j_2 (averaged across neighborhoods) while statistically controlling for all Level-2 predictors. Each π_x and θ_x represent the same values as discussed in Equations 3 and 4.

Lastly, Model 6-AA extended Model 5-AA and examined whether the association between achievement and neighborhoods and schools depended on four different moderating effects while statistically controlling for individual differences at Level-1 (Equation 3). At Level-2, the Level-1 intercept, $\pi_{intercept(j_1j_2)}$, was modeled as a random effect and a function of four neighborhood variables, three school variables, and four interactions: neighborhood affluence, neighborhood poverty, neighborhood racial

composition, urbanicity, school SES, student body racial composition, teacher education, neighborhood affluence*school SES, neighborhood poverty*school SES, neighborhood affluence*teacher education, and neighborhood poverty*teacher education.

$$\begin{aligned}
\pi_{intercept(j_1 j_2)} &= \theta_{intercept} + \gamma_{neigh_affl} neigh_affl_{j_1} + \gamma_{neigh_pov} neigh_pov_{j_1} + \\
&\gamma_{neigh_race} neigh_race_{j_1} + \gamma_{urban} urban_{j_1} + \beta_{sch_SES} sch_ses_{j_2} + \beta_{stu_race} stu_race_{j_2} + \\
&\beta_{tch_edu} tch_edu_{j_2} + \delta_{neigh_affl*sch_ses} neigh_affl_{j_1} * sch_ses_{j_2} + \\
&\delta_{neigh_pov*sch_ses} neigh_pov_{j_1} * sch_ses_{j_2} + \delta_{neigh_affl*tch_edu} neigh_affl_{j_1} * tch_edu_{j_2} \\
&+ \delta_{neigh_pov*tch_edu} neigh_pov_{j_1} * tch_edu_{j_2} + b_{0j_1 0} + c_{00j_2} \\
\pi_{bio_sex(j_1 j_2)} &= \theta_{bio_sex} \\
\pi_{age(j_1 j_2)} &= \theta_{age} \\
\pi_{race/eth(j_1 j_2)} &= \theta_{race/eth} \\
\pi_{ses(j_1 j_2)} &= \theta_{ses}
\end{aligned} \tag{8}$$

The intercept, $\theta_{intercept}$, now represents the expected adjusted (for Level-1 predictors) AHPVT score when all Level-2 predictor variables are set to zero. More specifically, $\theta_{intercept}$ is the expected adjusted AHPVT score for a student from a neighborhood with average affluence and poverty levels and no urbanicity or White residents and who attends an average SES school with no White, non-Hispanic students, and no teachers with graduate degrees. Each γ_x represents the fixed effect of variable X that is assumed constant over all neighborhoods (e.g., γ_{neigh_pov} represents the effect of neighborhood poverty on AHPVT scores across all neighborhoods). Each β_x represents the fixed effect of variable X that is assumed constant over all schools (e.g., β_{sch_ses} represents the effect of school SES on AHPVT scores across all schools).

The interactions, $\delta_{neigh_affl*sch_ses}$ represents the moderating effect of school SES on neighborhood affluence (i.e., the relationship between neighborhood affluence and AHPVT scores may differ depending on the level of school SES). $\delta_{neigh_pov*sch_ses}$ represents the moderating effect of school SES on neighborhood poverty (i.e., the relationship between neighborhood poverty and AHPVT scores may differ depending on the level of school SES). $\delta_{neigh_affl*tch_edu}$ represents the moderating effect of teacher education on neighborhood affluence (i.e., the relationship between neighborhood affluence and AHPVT scores may differ depending on the level of teacher education). $\delta_{neigh_pov*tch_edu}$ represents the moderating effect of teacher education on neighborhood poverty (i.e., the relationship between neighborhood poverty and AHPVT scores may differ depending on the level of teacher education).

The neighborhood residual, b_{0j_1} , represents the neighborhood effect for neighborhood j_1 (averaged across schools) while statistically controlling for all Level-2 predictors. The school residual, c_{00j_2} , represents the school effect for school j_2 (averaged across neighborhoods) while statistically controlling for all Level-2 predictors. Each π_x and θ_x represent the same values as discussed in Equations 3 and 4.

When predicting risk of obesity, the same model-building procedure was conducted. The first risk of obesity model was a fully unconditional model with no predictors (Model 1-RO). At Level-1, the model was

$$Y_{i(j_1j_2)} = \pi_{intercept(j_1j_2)} + e_{i(j_1j_2)} \quad (9)$$

where $Y_{i(j_1j_2)}$ symbolizes the risk of obesity outcome [age-and-gender-adjusted BMI z-score] for student i in neighborhood j_1 and school j_2 . The intercept, $\pi_{intercept(j_1j_2)}$, represents the predicted BMI z-score for students from neighborhood j_1 and school j_2 . The residual, $e_{i(j_1j_2)}$, represents the deviation of a student's BMI z-score from the student's neighborhood and school predicted intercept value and is assumed $\sim N(0, \sigma^2)$.

At Level-2, the Level-1 intercept, $\pi_{intercept(j_1j_2)}$, was modeled as a random effect in the fully unconditional model.

$$\pi_{intercept(j_1j_2)} = \theta_{intercept} + b_{0j_10} + c_{00j_2} \quad (10)$$

The overall intercept, $\theta_{intercept}$, represents the grand mean BMI z-score. The neighborhood residual, b_{0j_10} , represents the neighborhood effect for neighborhood j_1 (averaged across schools) and is assumed $\sim N(0, \tau_{b00})$. The school residual, c_{00j_2} , represents the school effect for school j_2 (averaged across neighborhoods) and is assumed $\sim N(0, \tau_{c00})$.

Next, a Level-1 control model (Model 2-RO) examined the extent to which risk of obesity varied based on individual-level characteristics.

$$Y_{i(j_1j_2)} = \pi_{intercept(j_1j_2)} + \pi_{athlete(j_1j_2)} athlete_{i(j_1j_2)} + \pi_{bio_sex(j_1j_2)} bio_sex_{i(j_1j_2)} + \pi_{age(j_1j_2)} age_{i(j_1j_2)} + \pi_{race/eth(j_1j_2)} race/eth_{i(j_1j_2)} + \pi_{ses(j_1j_2)} ses_{i(j_1j_2)} + e_{i(j_1j_2)} \quad (11)$$

At Level-1, $Y_{i(j_1j_2)}$ still symbolizes the risk of obesity outcome (BMI z-score) for student i in neighborhood j_1 and school j_2 . The intercept, $\pi_{intercept(j_1j_2)}$, is now the expected BMI z-score when all predictor variables are set to zero. More specifically, for this model, $\pi_{intercept(j_1j_2)}$, represents the predicted BMI z-score for an average age, non-

Hispanic Black/non-Hispanic Other/Hispanic female with an average family SES. π_{bio_sex} and $\pi_{race/eth}$ represent the expected difference in BMI z-scores between a student in neighborhood j_1 and school j_2 with a value of 0 for each variable and a student in neighborhood j_1 and school j_2 with a value of 1 for each variable. For example, because males are coded 1, π_{bio_sex} is the expected difference in BMI z-scores between boys and girls in neighborhood j_1 and school j_2 while statistically controlling for all other predictors in the model. For age, π_{age} represents the expected change in BMI z-score for a student in neighborhood j_1 and school j_2 for every one-year change in age while statistically controlling for all other predictors in the model. For family SES, π_{ses} represents the expected change in BMI z-score for a student in neighborhood j_1 and school j_2 for every one standard deviation change in family SES while statistically controlling for all other predictors in the model.

At Level-2, the Level-1 intercept, $\pi_{intercept(j_1j_2)}$, was modeled as a random effect in the Level-1 control model.

$$\begin{aligned}
\pi_{intercept(j_1j_2)} &= \theta_{intercept} + b_{0j_10} + c_{00j_2} \\
\pi_{athlete(j_1j_2)} &= \theta_{athlete} \\
\pi_{bio_sex(j_1j_2)} &= \theta_{bio_sex} \\
\pi_{age(j_1j_2)} &= \theta_{age} \\
\pi_{race/eth(j_1j_2)} &= \theta_{race/eth} \\
\pi_{ses(j_1j_2)} &= \theta_{ses}
\end{aligned} \tag{12}$$

The overall intercept, $\theta_{intercept}$, represents the grand mean BMI z -score when all Level-1 predictor variables are set to zero. More specifically, $\theta_{intercept}$ represents the predicted BMI z -score for an average age, non-Hispanic Black/non-Hispanic Other/Hispanic female with an average family SES. The neighborhood residual, b_{0j_1} , represents the neighborhood effect for neighborhood j_1 (averaged across schools). The school residual, c_{00j_2} , represents the school effect for school j_2 (averaged across neighborhoods). Each π_x represents the same value as discussed above in Equation 11 and each θ_x represents the fixed effects for each corresponding Level-1 predictor variable. For example, θ_{bio_sex} represents the effect of biological sex that was modeled not to vary across neighborhoods or schools. The Level-1 portion of Model 2-RO (Equation 11) served as the Level-1 model for all remaining risk of obesity models.

Adding to Model 2-RO, the third model (Model 3-RO) examined neighborhood-level correlates of risk of obesity while statistically controlling for individual differences at Level-1 (Equation 11). At Level-2, the Level-1 intercept, $\pi_{intercept(j_1, j_2)}$, was modeled as a random effect and a function of four neighborhood variables: affluence, poverty, racial composition, and urbanicity.

$$\begin{aligned}
\pi_{intercept(j_1 j_2)} &= \theta_{intercept} + \gamma_{neigh_affl} neigh_affl_{j_1} + \gamma_{neigh_pov} neigh_pov_{j_1} + \\
&\gamma_{neigh_race} neigh_race_{j_1} + \gamma_{urban} urban_{j_1} + b_{0j_1 0} + c_{00j_2} \\
\pi_{athlete(j_1 j_2)} &= \theta_{athlete} \\
\pi_{bio_sex(j_1 j_2)} &= \theta_{bio_sex} \\
\pi_{age(j_1 j_2)} &= \theta_{age} \\
\pi_{race/eth(j_1 j_2)} &= \theta_{race/eth} \\
\pi_{ses(j_1 j_2)} &= \theta_{ses}
\end{aligned} \tag{13}$$

The intercept, $\theta_{intercept}$, now represents the expected adjusted (for Level-1 predictors) BMI z-score when all Level-2 predictor variables are set to zero. More specifically, $\theta_{intercept}$ is the expected adjusted BMI z-score for a student from a neighborhood with average affluence and poverty levels and no urbanicity or White residents. Each γ_x represents the fixed effect of variable X that is assumed constant over all neighborhoods (e.g., γ_{neigh_pov} represents the effect of neighborhood poverty on BMI z-scores across all neighborhoods). The neighborhood residual, $b_{0j_1 0}$, represents the neighborhood effect for neighborhood j_1 (averaged across schools) while statistically controlling for all Level-2 predictors. The school residual, c_{00j_2} , represents the school effect for school j_2 (averaged across neighborhoods) while statistically controlling for all Level-2 predictors. Each π_x and θ_x represent the same values as discussed in Equations 11 and 12.

Next, also building on Model 2-RO, the fourth model (Model 4-RO) investigated school-level predictors of risk of obesity while statistically controlling for individual variables (Equation 11). At Level-2, the Level-1 intercept, $\pi_{intercept(j_1 j_2)}$, was modeled as a

random effect and a function of three school variables: school SES, weight management education, and school-level athletic participation.

$$\begin{aligned}
\pi_{intercept(j_1 j_2)} &= \theta_{intercept} + \beta_{sch_ses} sch_ses_{j_2} + \beta_{weight} weight_{j_2} + \\
&\beta_{athletics} athletics_{j_2} + b_{0j_1 0} + c_{00j_2} \\
\pi_{athlete(j_1 j_2)} &= \theta_{athlete} \\
\pi_{bio_sex(j_1 j_2)} &= \theta_{bio_sex} \\
\pi_{age(j_1 j_2)} &= \theta_{age} \\
\pi_{race/eth(j_1 j_2)} &= \theta_{race/eth} \\
\pi_{ses(j_1 j_2)} &= \theta_{ses}
\end{aligned} \tag{14}$$

The intercept, $\theta_{intercept}$, now represents the expected adjusted (for Level-1 predictors) BMI z-score when all Level-2 predictor variables are set to zero. More specifically, $\theta_{intercept}$ is the expected adjusted BMI z-score for a student who attends an average SES school with no weight management education and no student athletes. Each β_x represents the fixed effect of variable X that is assumed constant over all schools (e.g., β_{sch_ses} represents the effect of school SES on BMI z-scores across all schools). The neighborhood residual, $b_{0j_1 0}$, represents the neighborhood effect for neighborhood j_1 (averaged across schools) while statistically controlling for all Level-2 predictors. The school residual, c_{00j_2} , represents the school effect for school j_2 (averaged across neighborhoods) while statistically controlling for all Level-2 predictors. Each π_x and θ_x represent the same values as discussed above in Equations 11 and 12.

Model 5-RO was a combination of Models 3-RO and 4-RO and examined risk of obesity as a function of both neighborhood and school factors simultaneously, while statistically controlling for individual characteristics (Equation 11). At Level-2, the

Level-1 intercept, $\pi_{intercept(j_1 j_2)}$, was modeled as a random effect and a function of four neighborhood variables and three school variables: neighborhood affluence, neighborhood poverty, neighborhood racial composition, urbanicity, school SES, weight management education, and school-level athletic participation.

$$\begin{aligned}
\pi_{intercept(j_1 j_2)} &= \theta_{intercept} + \gamma_{neigh_affl} neigh_affl_{j_1} + \gamma_{neigh_pov} neigh_pov_{j_1} + \\
&\gamma_{neigh_race} neigh_race_{j_1} + \gamma_{urban} urban_{j_1} + \beta_{sch_ses} sch_ses_{j_2} + \beta_{weight} weight_{j_2} + \\
&\beta_{athletics} athletics_{j_2} + b_{0j_1 0} + c_{00j_2} \\
\pi_{athlete(j_1 j_2)} &= \theta_{athlete} \\
\pi_{bio_sex(j_1 j_2)} &= \theta_{bio_sex} \\
\pi_{age(j_1 j_2)} &= \theta_{age} \\
\pi_{race/eth(j_1 j_2)} &= \theta_{race/eth} \\
\pi_{ses(j_1 j_2)} &= \theta_{ses}
\end{aligned} \tag{15}$$

The intercept, $\theta_{intercept}$, now represents the expected adjusted (for Level-1 predictors) BMI z-score when all Level-2 predictor variables are set to zero. More specifically, $\theta_{intercept}$ is the expected adjusted BMI z-score for a student from a neighborhood with average affluence and poverty levels and no urbanicity or White residents and who attends an average SES school with no weight management education and no student athletes. Each γ_x represents the fixed effect of variable X that is assumed constant over all neighborhoods (e.g., γ_{neigh_pov} represents the effect of neighborhood poverty on BMI z-scores across all neighborhoods). Each β_x represents the fixed effect of variable X that is assumed constant over all schools (e.g., β_{sch_ses} represents the effect of school SES on BMI z-scores across all schools). The neighborhood residual, $b_{0j_1 0}$,

represents the neighborhood effect for neighborhood j_1 (averaged across schools) while statistically controlling for all Level-2 predictors. The school residual, c_{00j_2} , represents the school effect for school j_2 (averaged across neighborhoods) while statistically controlling for all Level-2 predictors. Each π_x and θ_x represent the same values as discussed in Equations 11 and 12.

Lastly, Model 6-RO expanded Model 5-RO and examined whether the association between risk of obesity and neighborhoods and schools depended on four different moderating effects while statistically controlling for individual differences at Level-1 (Equation 11). At Level-2, the Level-1 intercept, $\pi_{intercept(j_1j_2)}$, was modeled as a random effect and a function of four neighborhood variables, three school variables, and four interactions: neighborhood affluence, neighborhood poverty, neighborhood racial composition, urbanicity, school SES, weight management education, school-level athletic participation, neighborhood affluence*school SES, neighborhood poverty*school SES, neighborhood affluence*weight management education, and neighborhood poverty*weight management education.

$$\begin{aligned}
\pi_{intercept(j_1 j_2)} &= \theta_{intercept} + \gamma_{neigh_affl} neigh_affl_{j_1} + \gamma_{neigh_pov} neigh_pov_{j_1} + \\
&\gamma_{neigh_race} neigh_race_{j_1} + \gamma_{urban} urban_{j_1} + \beta_{sch_ses} sch_ses_{j_2} + \beta_{weight} weight_{j_2} + \\
&\beta_{athletics} athletics_{j_2} + \delta_{neigh_affl*sch_ses} neigh_affl_{j_1} * sch_ses_{j_2} + \\
&\delta_{neigh_pov*sch_ses} neigh_pov_{j_1} * sch_ses_{j_2} + \delta_{neigh_affl*weight} neigh_affl_{j_1} * weight_{j_2} \\
&\delta_{neigh_pov*weight} neigh_pov_{j_1} * weight_{j_2} + b_{0j_1 0} + c_{00j_2} \\
\pi_{athlete(j_1 j_2)} &= \theta_{athlete} \\
\pi_{bio_sex(j_1 j_2)} &= \theta_{bio_sex} \\
\pi_{age(j_1 j_2)} &= \theta_{age} \\
\pi_{race/eth(j_1 j_2)} &= \theta_{race/eth} \\
\pi_{ses(j_1 j_2)} &= \theta_{ses}
\end{aligned} \tag{16}$$

The intercept, $\theta_{intercept}$, now represents the expected adjusted (for Level-1 predictors) BMI z-score when all Level-2 predictor variables are set to zero. More specifically, $\theta_{intercept}$ is the expected adjusted BMI z-score for a student from a neighborhood with average affluence and poverty levels and no urbanicity or White residents and who attends an average SES school with no weight management education and no student athletes. Each γ_x represents the fixed effect of variable X that is assumed constant over all neighborhoods (e.g., γ_{neigh_pov} represents the effect of neighborhood poverty on BMI z-scores across all neighborhoods). Each β_x represents the fixed effect of variable X that is assumed constant over all schools (e.g., β_{sch_ses} represents the effect of school SES on BMI z-scores across all schools).

For the interactions, $\delta_{neigh_affl*sch_ses}$ represents the moderating effect of school SES on neighborhood affluence (i.e., the relationship between neighborhood affluence and BMI z-scores may differ depending on the level of school SES). $\delta_{neigh_pov*sch_ses}$ represents

the moderating effect of school SES on neighborhood poverty (i.e., the relationship between neighborhood poverty and BMI z -scores may differ depending on the level of school SES). $\delta_{neigh_affl*weight}$ represents the moderating effect of weight management education on neighborhood affluence (i.e., the relationship between neighborhood affluence and BMI z -scores may differ depending on the level of weight management education at an adolescent's school). $\delta_{neigh_pov*weight}$ represents the moderating effect of weight management education on neighborhood poverty (i.e., the relationship between neighborhood poverty and BMI z -scores may differ depending on the level of weight management education at an adolescent's school).

The neighborhood residual, b_{0j_1} , represents the neighborhood effect for neighborhood j_1 (averaged across schools) while statistically controlling for all Level-2 predictors. The school residual, c_{00j_2} , represents the school effect for school j_2 (averaged across neighborhoods) while statistically controlling for all Level-2 predictors. Each π_x and θ_x represent the same values as discussed in Equations 11 and 12.

Model interpretation. To determine what percentage of adolescent academic achievement variance was among neighborhoods, what percentage was among schools, and what percentage was among adolescents within neighborhoods and schools, three different ICC values were calculated based on the results from the unconditional academic achievement model (Model 1- AA). See Equations 17, 18, and 19 for more details on how each ICC was be calculated.

$$\text{Neighborhood ICC} = \frac{\tau_{b00}}{\tau_{b00} + \tau_{c00} + \sigma^2} \quad (17)$$

$$\text{School ICC} = \frac{\tau_{c00}}{\tau_{b00} + \tau_{c00} + \sigma^2} \quad (18)$$

$$\text{Neighborhood and School ICC} = \frac{\tau_{b00} + \tau_{c00}}{\tau_{b00} + \tau_{c00} + \sigma^2} \quad (19)$$

Next, to assess the relative strength of association between sets of independent variables and adolescent academic achievement, model pseudo- R^2 values were calculated for each academic achievement model. See Equations 20 to 24 for details on how the model pseudo- R^2 values were calculated for Model 2-AA, Model 3-AA, Model 4-AA, Model 5-AA, and Model 6-AA, respectively.

$$\frac{[\tau_{b00} + \tau_{c00}]_{\text{Model1-AA}} - [\tau_{b00} + \tau_{c00}]_{\text{Model2-AA}}}{[\tau_{b00} + \tau_{c00}]_{\text{Model1-AA}}} \quad (20)$$

$$\frac{[\tau_{b00} + \tau_{c00}]_{\text{Model1-AA}} - [\tau_{b00} + \tau_{c00}]_{\text{Model3-AA}}}{[\tau_{b00} + \tau_{c00}]_{\text{Model1-AA}}} \quad (21)$$

$$\frac{[\tau_{b00} + \tau_{c00}]_{\text{Model1-AA}} - [\tau_{b00} + \tau_{c00}]_{\text{Model4-AA}}}{[\tau_{b00} + \tau_{c00}]_{\text{Model1-AA}}} \quad (22)$$

$$\frac{[\tau_{b00} + \tau_{c00}]_{\text{Model1-AA}} - [\tau_{b00} + \tau_{c00}]_{\text{Model5-AA}}}{[\tau_{b00} + \tau_{c00}]_{\text{Model1-AA}}} \quad (23)$$

$$\frac{[\tau_{b00} + \tau_{c00}]_{Model1-AA} - [\tau_{b00} + \tau_{c00}]_{Model6-AA}}{[\tau_{b00} + \tau_{c00}]_{Model1-AA}} \quad (24)$$

After calculating the pseudo- R^2 values, a series of model pseudo- R^2 comparisons were made. First, to determine if the proportion of variance accounted for by the set of neighborhood and school interactions was statistically significantly above and beyond the main effects of neighborhood and school characteristics, the pseudo- R^2 for Model 6-AA was compared to the pseudo- R^2 for Model 5-AA (Equation 25). Second, to determine if the proportion of variance accounted for by neighborhoods and schools together was statistically significantly greater than the proportion of variance accounted for by school characteristics alone, the pseudo- R^2 for Model 5-AA was compared to the pseudo- R^2 for Model 4-AA (Equation 26). Third, the pseudo- R^2 for Model 5-AA was compared to Model 3-AA to determine if the proportion of variance accounted for by neighborhoods and schools was statistically significantly greater than the proportion of variance accounted for by neighborhood characteristics alone (Equation 27).

$$(Pseudo-R^2_{Model6-AA}) - (Pseudo-R^2_{Model5-AA}) \quad (25)$$

$$(Pseudo-R^2_{Model5-AA}) - (Pseudo-R^2_{Model4-AA}) \quad (26)$$

$$(Pseudo-R^2_{Model5-AA}) - (Pseudo-R^2_{Model3-AA}) \quad (27)$$

Also, although the research questions did not focus on individual characteristics, to gain a more holistic understanding of the data, the pseudo- R^2 for Model 5-AA was compared to the pseudo- R^2 for Model 2-AA to determine if the proportion of variance accounted for by neighborhoods and schools was statistically significantly greater than

the proportion of variance accounted for by individual characteristics alone (Equation 28). The pseudo- R^2 for Model 2-AA also was examined to determine how much variability in adolescent academic achievement was accounted for by individual characteristics alone.

$$(\text{Pseudo-}R^2_{\text{Model5-AA}}) - (\text{Pseudo-}R^2_{\text{Model2-AA}}) \quad (28)$$

To determine if each of the abovementioned differences in pseudo- R^2 values were statistically significant, likelihood ratio tests were conducted on the difference between the -2 Log Likelihood values for each of the model comparisons. For example, to determine if the difference in the proportion of variance accounted for between Model 6-AA and Model 5-AA was statistically significant, a likelihood ratio test was conducted on the difference between the -2 Log Likelihood from Model 6-AA and the -2 Log Likelihood from Model 5-AA, where the degrees of freedom equaled the difference in the number of fixed effect parameters between the models. When the difference in model fit was statistically significant (i.e., the χ^2 statistic associated with the likelihood ratio test was statistically significant), then it was inferred that the difference in pseudo- R^2 values was statistically significant. Each model comparison was conducted at $\alpha = .05$.

Lastly, in an effort to unpack further the magnitude of the relationship among neighborhoods, schools, and adolescent academic achievement, the parameter estimates from Model 5-AA were also examined and tested for significance using $\alpha = .05$. Statistically significant parameter estimates from Model 5-AA were also transformed by dividing each obtained estimate by the AHPVT sample standard deviation, thereby, allowing interpretation of these estimates of predicted change in terms of standard

deviation units. The results from the risk of obesity cross-classified random effects hierarchical linear models were examined and interpreted following the same process, except for the parameter estimate transformation, as described for the academic achievement cross-classified random effects hierarchical linear models.

Chapter Four

Results

Study Sample

The sampling frame for this study consisted of adolescents in Grades 7 – 12 who participated in the Add Health Wave I In-School Questionnaire and In-Home Interview; who attended regular, public middle and high schools during the 1994-1995 school year; and who had data for all methodological variables ($n = 11,841$). From this sampling frame, the study sample was then restricted to adolescents with complete data on substantive variables of interest related to the study and one randomly sampled sibling from families that had more than one child in the Add Health data. After applying the inclusion criteria, 10,860 adolescents were included in the study sample. The adolescents in the study sample were dispersed across 99 schools (density = 5 to 1,135) and 1,111 neighborhoods (density = 1 to 189). As shown in Table 8, there were no substantial characteristic differences of adolescents in the original sampling frame and those included in the study sample.

Table 8

Unweighted Individual, Neighborhood, and School Characteristics for Original Sample and Study Sample

	Original sample (<i>n</i> = 11,841)	Study sample (<i>n</i> = 10,860)
	% (<i>n</i>)	% (<i>n</i>)
Biological sex		
Female	51.92 (6147)	51.55 (5598)
Male	48.08 (5692)	48.45 (5262)
Race		
White/Asian	60.29 (7133)	60.25 (6543)
Underserved minority	39.71 (4699)	39.75 (4317)
	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)
Age	15.64 (1.70)	15.66 (1.68)
Family SES	-0.08 (0.76)	-0.07 (0.75)
Athletic Participation	1.03 (1.18)	1.04 (1.18)
Neighborhood affluence	-0.09 (0.87)	-0.09 (0.86)
Neighborhood poverty	-0.08 (0.91)	-0.08 (0.91)
Neighborhood racial composition	.76 (.28)	.76 (.28)
Urbanicity	.56 (.48)	.56 (.48)
School SES	-0.04 (0.73)	-0.03 (0.73)
Teacher education	.44 (.27)	.44 (.26)
Student body racial composition	.60 (.36)	.60 (.36)
Weight education	.76 (.08)	.76 (.08)
School athletic participation	.55 (.50)	.55 (.50)
Add Health Peabody	98.92 (14.77)	99.06 (14.62)
Vocabulary Test		
Age-and-gender-adjusted BMI <i>z</i> -score	0.33 (0.92)	0.37 (0.88)

In terms of missing data, the amount of missing data for each adolescent ranged from 0 to 13 variables ($M = 0.55$, $SD = 0.91$). Overall, two-thirds of adolescents had no missing data and another 30% had missing data on one or two of the variables examined (Appendix C, Table C-1). Most of the phi coefficients (i.e., the correlations between missingness on pairs of variables) were within an acceptable range of $-.02$ to $.35$;

however, a few slightly stronger correlations were observed (Appendix C, Figure C-1). The strongest associations between missingness on two variables were found among Level-1 demographic variables. More specifically, missingness on household income and parental education was the strongest correlation ($\phi = .90$), followed by missingness on age and each of the five race variables ($\phi = .51$) and missingness on age and biological sex ($\phi = .50$). Because the missingness on these demographic variables did not appear to be random, caution was used when interpreting the parameter estimates for these variables, as well as the parameter estimates of composite variables that include any of the original variables (i.e., family SES) and the parameter estimates of other variables correlated with these demographic variables. Conversely, no strong correlations were found between missingness and observed values; correlation coefficients ranged from $-.15$ to $.19$ (Appendix C, Figure C-2).

Next, the data also were examined for possible correlations between a refusal response for the household income variable and other variables included in the study. After removing cases that were missing household income data and converting a refusal response for household income into missing, less than 1% of adolescents had missing data on more than two variables and 71% had no missing data (Appendix C, Table C-2). Unlike the strong correlation between missing household income and missing parental education, refusing to provide household income did not appear to be systematic (phi coefficients ranged from $-.02$ to $.39$; Appendix C, Figure C-3). Similarly, no strong correlations were found between missingness and observed values; correlation coefficients ranged from $-.13$ to $.20$ (Appendix C, Figure C-4).

Univariate Analyses

To help inform the generalizability of the multivariate findings, both weighted and unweighted descriptive statistics were examined for level-1 variables and school-level variables. However, based on the Add Health study design, sample weights could not be used with neighborhood-level variables; therefore, only unweighted descriptive statistics were calculated for neighborhood variables. As shown in Table 9, although the majority of differences between unweighted and weighted descriptive statistics were relatively small, differences in the race variable were rather pronounced. Given this large difference and the inability to use sample weights with neighborhood-level variables, unweighted statistics were interpreted for all statistical analyses and findings are not considered generalizable at the national level.

Table 9

Descriptive Statistics of Individual, Neighborhood, and School Characteristics (n = 10,860)

	Unweighted Statistics	Weighted Statistics
	% (n)	% (n)
Biological sex		
Female	51.55 (5598)	50.06 (5437)
Male	48.45 (5262)	49.94 (5423)
Race		
White/Asian	60.25 (6543)	74.08 (8045)
Underserved minority	39.75 (4317)	25.92 (2815)
	<i>M (SD)</i>	<i>M (SD)</i>
Age	15.66 (1.68)	15.35 (1.76)
Family SES	-0.07 (0.75)	-0.04 (0.74)
Athletic participation	1.04 (1.18)	1.10 (1.22)
Neighborhood affluence	-0.09 (0.86)	NA
Neighborhood poverty	-0.08 (0.91)	NA
Neighborhood racial composition	.76 (.28)	NA
Urbanicity	.56 (.48)	NA
School SES	-0.03 (0.73)	-0.03 (0.76)
Teacher education	.44 (.26)	.49 (.25)

Table 9

Descriptive Statistics of Individual, Neighborhood, and School Characteristics (n = 10,860)

	Unweighted Statistics	Weighted Statistics
Student body racial composition	.60 (.36)	.72 (.31)
Weight education	.76 (.08)	.76 (.10)
School athletic participation	.55 (.50)	.56 (.50)
Add Health Peabody Vocabulary Test	99.06 (14.62)	100.85 (14.01)
Age-and-gender-adjusted BMI z-score	0.37 (0.88)	0.37 (0.88)

Overall, adolescents included in the study sample were primarily non-Hispanic White and non-Hispanic Asian (60%) and lived in slightly below-average SES households ($M = -0.07$, $SD = 0.75$). There were slightly more girls than boys (52% vs. 48%) and the mean age was 15.66 years ($SD = 1.68$). Also, on average, adolescents in the study sample reported participating in one school sport. In terms of the criterion variables, the average achievement for adolescents in the study sample was slightly less than the Add Health standardized average of 100 ($M = 99.06$, $SD = 14.62$). Conversely, for risk of obesity, the study sample had slightly above average age-and- gender-adjusted BMI scores ($M = 0.37$, $SD = 0.88$).

In terms of the neighborhoods where the study sample resided, on average, adolescents lived in neighborhoods with high proportions of White residents ($M = .76$, $SD = .28$) and moderate levels of urbanicity ($M = .56$, $SD = .48$). In terms of neighborhood socioeconomic status, adolescents in the study sample lived in neighborhoods with slightly below-average levels of affluence and slightly below-average levels of poverty ($M = -0.09$. and -0.08 ., respectively). Similarly, adolescents in the study sample attended schools with slightly below-average SES ($M = -0.03$, $SD = 0.52$). Regarding other school characteristics, on average, adolescents in the study sample

attended schools with high proportions of White students ($M = .60$, $SD = .36$), high levels of weight education ($M = .76$, $SD = .08$), and moderate levels of masters educated teachers ($M = .44$, $SD = .26$).

Bivariate Analyses

Correlation coefficients for the bivariate relationships between all of the variables included in the model ranged from $-.002$ to $.78$. Only 18 bivariate associations had absolute values equal to or greater than $.30$. Furthermore, of these 18 relationships, only 4 were between a criterion variable and a predictor variable; the other 14 were between pairs of predictor variables. For example, the academic achievement criterion variable (AHPVT) had four bivariate relationships stronger than $.30$ or $-.30$ (neighborhood racial composition, $.31$; school racial composition, $.34$; family SES, $.36$; and race, $-.32$). No bivariate relationships between standardized age-and-gender-adjusted BMI were stronger than $.30$ or $-.30$. All of the bivariate associations between predictor variables and age-and-gender-adjusted BMI z-scores had absolute values less than $.10$. The two strongest bivariate associations were between neighborhood racial composition and school racial composition ($.75$) and between individual athletic participation and school-level athletic participation ($.78$). Table 10 contains the complete correlation matrix of criterion and predictor variables.

Table 10

Unweighted Bivariate Correlation Matrix for all Criterion and Predictor Variables (n = 10,860)

	AHPVT	BMI	Affluence	Poverty	Neigh racial comp	Urbanicity	Teacher education	School racial comp	School SES	Age	Family SES	Biological sex	Race	Athlete	School athletic
BMI	-.012														
Affluence	.166	-.092													
Poverty	-.121	.054	-.436												
Neigh racial comp	.314	-.066	.096	-.224											
Urbanicity	-.119	-.006	.232	-.002	-.197										
Teacher education	.130	-.028	.018	.126	.352	-.020									
School racial comp	.338	-.042	-.011	-.047	.748	-.384	.409								
School SES	.250	-.090	.587	-.238	.252	-.005	.138	.374							
Age	-.066	-.086	.006	-.036	-.068	.079	-.055	-.106	.032						
Family SES	.356	-.066	.337	.158	.182	-.033	.095	.216	.359	-.098					
Biological sex	.064	.056	.008	-.022	.018	-.008	-.002	.012	.011	.040	.040				
Race	-.321	.088	-.102	.192	-.506	.251	-.130	-.560	-.228	.041	-.258	-.022			
Athlete	.058	.006	.028	-.016	.084	-.087	.008	.150	.054	-.162	.132	.099	-.076		
School athletics	.066	.003	.026	-.026	.054	-.068	-.022	.112	.035	-.110	.126	.093	-.062	.782	
Weight education	.192	-.022	.018	-.080	.308	-.224	-.026	.418	.310	.134	.127	.022	-.263	.048	.065

The bivariate relationships between variables included in the interaction terms examined in the CCREMs were also examined. Overall, there was not much cross-over between the variables included in the interaction terms (e.g., the majority of youth that lived in high-affluent neighborhoods also attended high-SES schools). Plots of each of these relationships are presented in Figures 3 to 8.

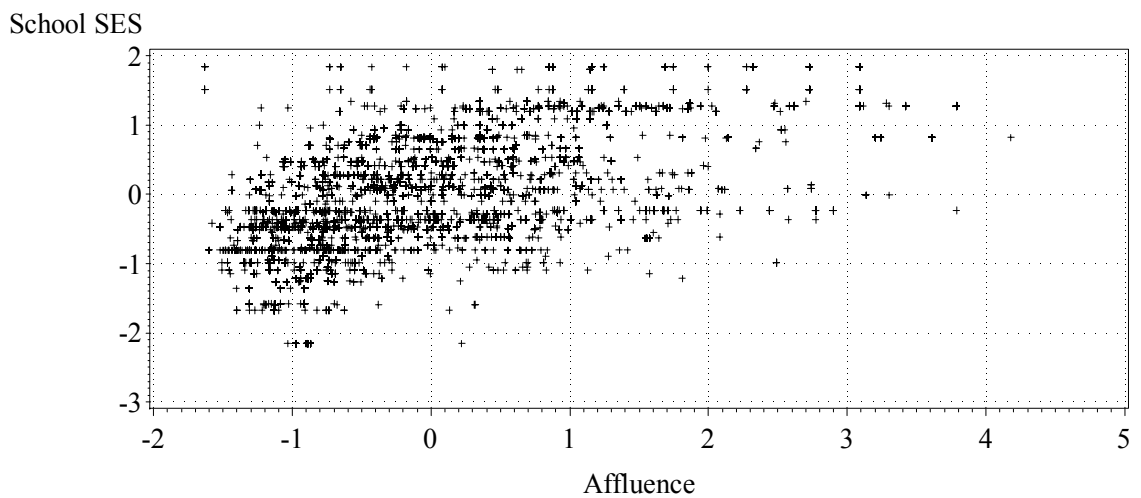


Figure 3. School SES*neighborhood affluence.

Sixty-four percent of kids living in low-affluent neighborhoods (z -score < 0) attended low-SES schools (z -score < 0). Sixty-seven percent of kids living in high-affluent neighborhoods (z -score ≥ 0) attended high-SES schools (z -score ≥ 0).

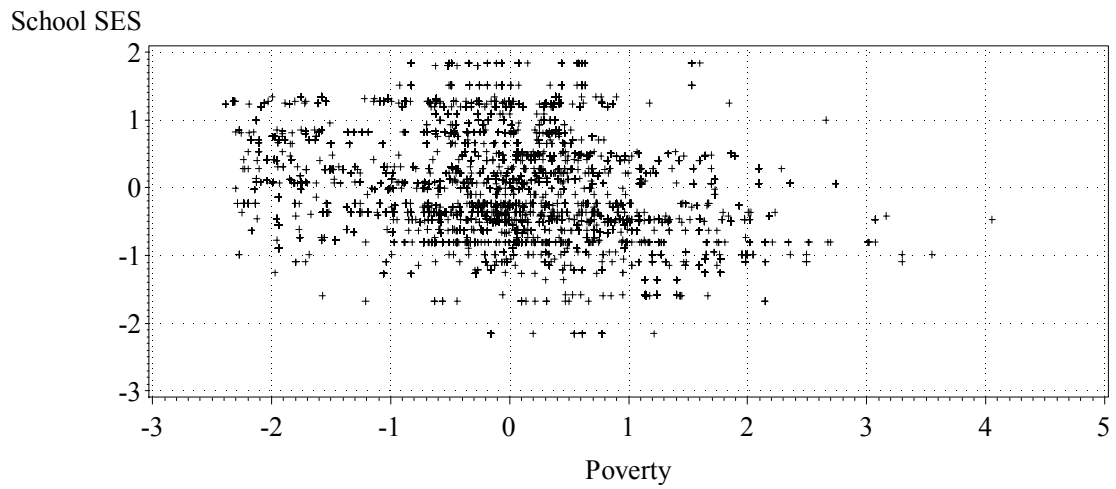


Figure 4. School SES*neighborhood poverty.

Forty-eight percent of kids living in non-poor neighborhoods (z -score < 0) attended high-SES schools (z -score ≥ 0). Fifty-two percent of kids living in poor neighborhoods (z -score ≥ 0) attended low-SES schools (z -score ≥ 0).

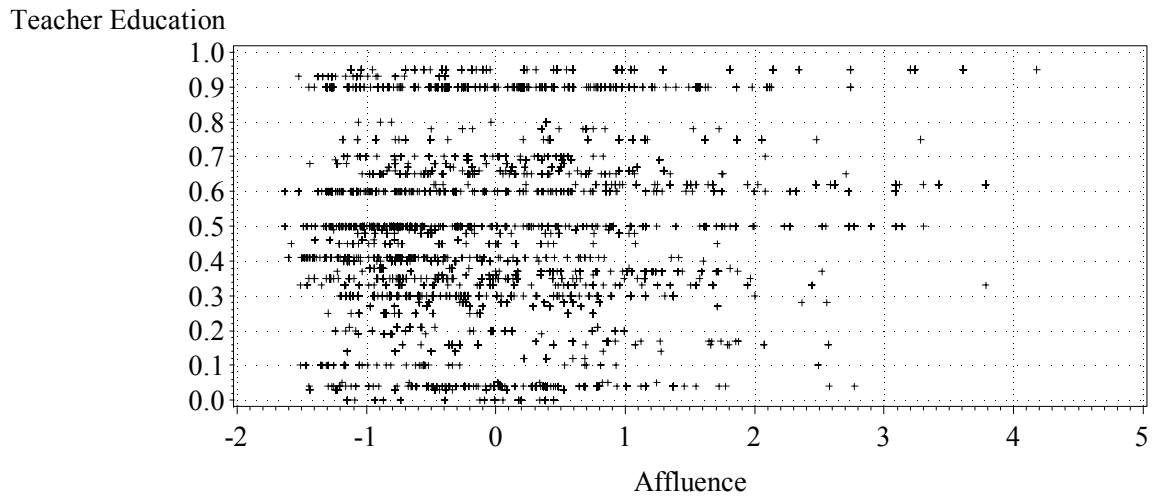


Figure 5. Teacher education*neighborhood affluence.

Fifty-seven percent of kids living in low-affluent neighborhoods (z -score < 0) attended schools with low levels of teacher education (proportion of teachers with graduate degree $< .50$). Forty-two percent of kids in high-affluent neighborhoods (z -score ≥ 0) attended schools with high levels of teacher education (proportion of teachers with graduate degree $\geq .50$).

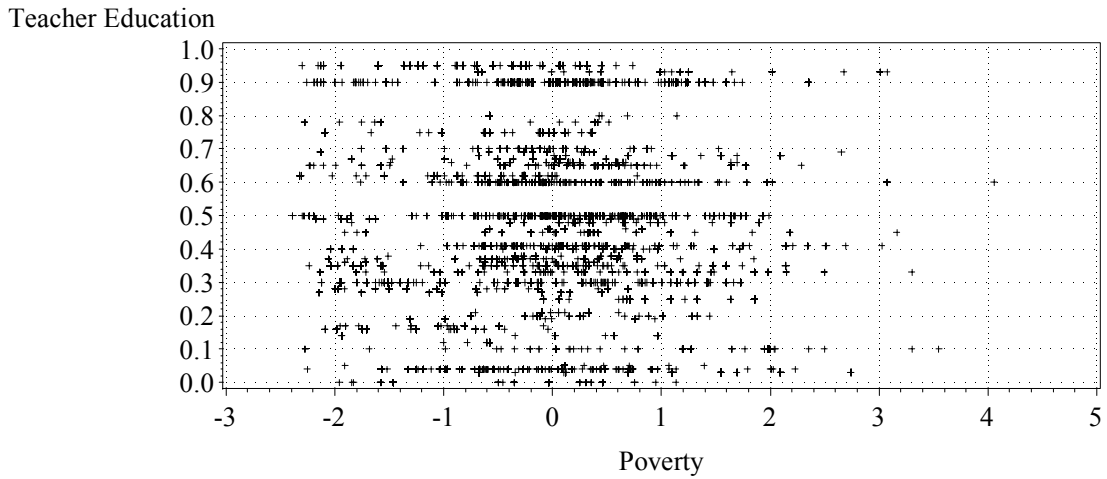


Figure 6. Teacher education*neighborhood poverty.

Thirty-seven percent of kids living in non-poor neighborhoods (z -score < 0) attended schools with high levels of teacher education (proportion of teachers with graduate degree $\geq .50$). Fifty-two percent of kids living in poor neighborhoods (z -score ≥ 0) attended schools with low levels of teacher education (proportion of teachers with graduate degree $< .50$).

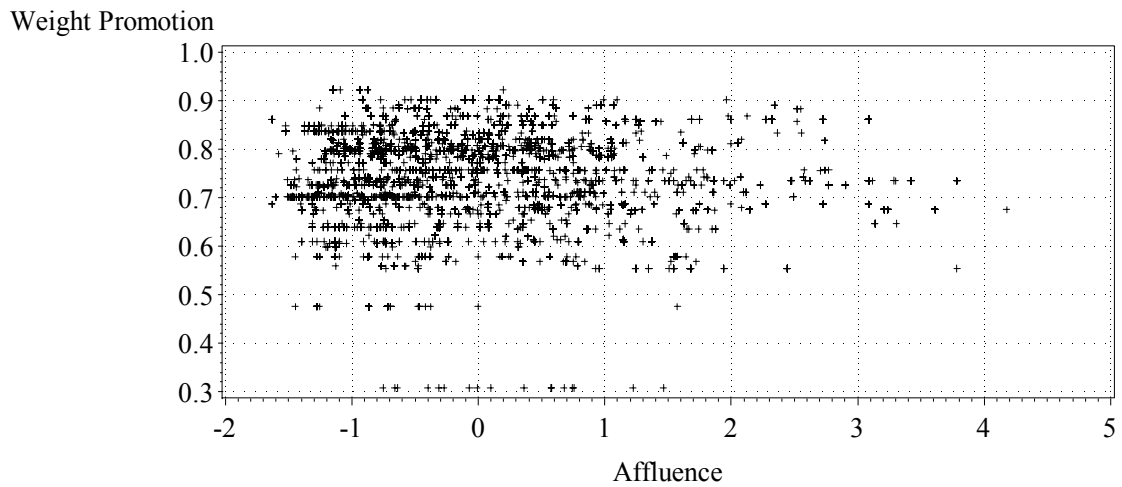


Figure 7. Weight promotion*neighborhood affluence.

Less than one percent of kids living in low-affluent neighborhoods (z -score < 0) attended low-weight promoting schools (average proportion of students who reported being taught about weight-related health topics $< .50$). Ninety-eight percent of kids living in high-affluent neighborhoods (z -score ≥ 0) attended high-weight promoting schools (average proportion of students who reported being taught about weight-related health topics $\geq .50$).

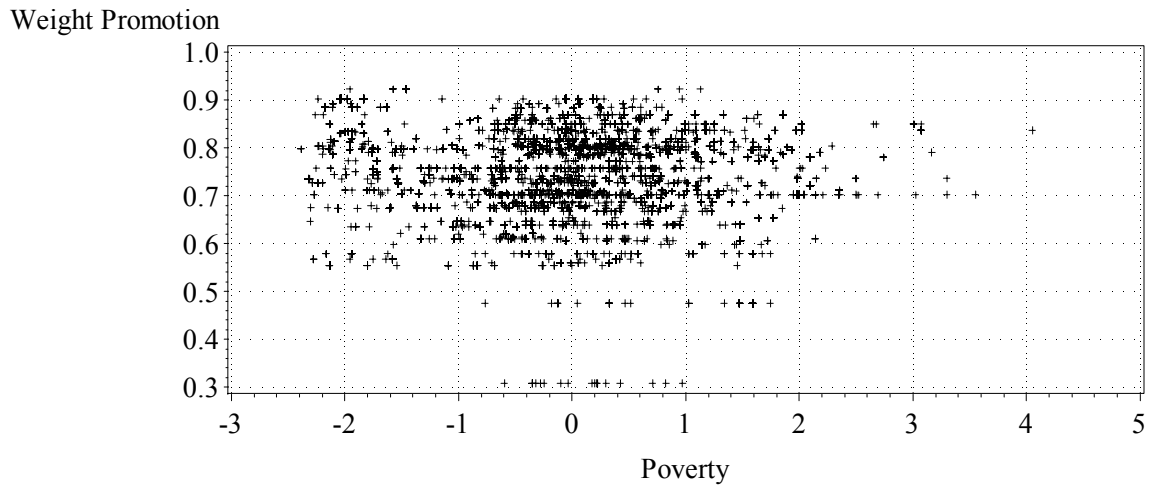


Figure 8. Weight promotion*neighborhood poverty.

Ninety-eight percent of kids living in non-poor neighborhoods (z -score < 0) attended high-weight promoting schools (average proportion of students who reported being taught about weight-related health topics $\geq .50$). Less than one percent of kids living in poor neighborhoods (z -score ≥ 0) attended low-weight promoting schools (average proportion of students who reported being taught about weight-related health topics $< .50$).

Multivariate Analyses

Research questions were examined using cross-classified random effects hierarchical linear models (CCREMs) with individuals nested within schools and neighborhoods. However, before interpreting any multivariate analyses, data were screened for violations of assumptions associated with multilevel models.

More specifically, data were examined for multicollinearity and Level-1 and Level-2 residuals, from models 5-AA and 5-RO, were screened for potential violations of normality, linearity, and homogeneity of variance. No assumptions appeared to be seriously violated when predicting academic achievement or risk of obesity; therefore, it was presumed reasonable to conduct the CCREMs for each criterion variable, using the model-building strategy as presented in Chapter 3. Tables and figures documenting the examination of assumptions are found in Appendix D.

For academic achievement, tolerance values for all of the independent variables ranged from .28 to .99 (Appendix D, Table D-1). Thus, with the relatively weak zero-order correlation coefficients among predictor variables presented in Table 10 and acceptable tolerance values (Berry, 1993), there was no evidence of multicollinearity when predicting adolescent academic achievement. Examination of box-and-whisker plots and skewness and kurtosis values for Level-1 residuals and neighborhood and school residuals did not suggest serious violation of the normality assumption (Appendix D, Figures D-1, D-2, and D-3). More specifically, Level-1 residuals and Level-2 school residuals were relatively normally distributed ($sk = -0.37$, $ku = 1.72$ and $sk = -0.21$, $ku = -0.06$, respectively; Appendix D, Figures D-1 and D-3). However, although Level-2 neighborhood residuals were relatively symmetric ($sk = -0.44$) they were also leptokurtic ($ku = 7.83$; Appendix D, Figure D-2). Lastly, an examination of Level-1, school-level, and neighborhood-level residuals plotted against predicted values for academic achievement revealed no evidence of heteroscedasticity (Appendix D, Figures D-4, D-5, and D-6).

Results from the examination of assumptions for predicting risk of obesity were similar to those found for academic achievement. Tolerance values for all of the independent variables used to predict adolescent risk of obesity ranged from .49 to .99 (Appendix D, Table D-2). Thus, with the relatively weak zero-order correlation coefficients among predictor variables presented in Table 10 and acceptable tolerance values (Berry, 1993), there was no evidence of multicollinearity when predicting adolescent risk of obesity. Examination of box-and-whisker plots and skewness and kurtosis values for Level-1 and both Level-2 residuals from Model 5-RO did not suggest serious violation of the normality assumption (Appendix D, Figures D-7, D-8, and D-9). More specifically, Level-1 residuals and school residuals were relatively normally distributed ($sk = -0.32$, $ku = -0.58$ and $sk = 0.12$, $ku = 0.28$, respectively; Appendix D, Figures D-7 and D-9), whereas neighborhood residuals were relatively symmetric ($sk = -0.49$) but also leptokurtic ($ku = 7.69$; Appendix D, Figure D-8). Lastly, scatter plots of Level-1, school-level, and neighborhood-level residuals plotted against predicted values for risk of obesity revealed no evidence of heteroscedasticity (Appendix D, Figures D-10, D-11, and D-12).

Next, by plotting neighborhood residuals*neighborhood size for both academic achievement and risk of obesity, findings suggest that the high kurtosis values for these residuals are driven by the singletons (i.e., neighborhoods that contain only one adolescent). As shown in Appendix D, Figures D-13 and D-14, level-2 neighborhood residuals for neighborhoods with only one observation are tightly clustered around zero. This is likely occurring because the residuals for singletons are pulled closer to zero more

than other neighborhoods because the EB adjustment uses sampling error and neighborhoods with only one adolescent have oodles of sampling error in them. Thus, if the singletons contained more adolescents, the standard deviation of the neighborhood residuals would be larger and the ends of tails would not appear as extreme.

Tables 11 - 14 contain summary results from the academic achievement CCREMs and the risk of obesity CCREMs. The intraclass correlations for academic achievement were relatively small (neighborhood ICC = .049, school ICC = .117, and within neighborhood and school ICC = .166) and the intraclass correlations for risk of obesity were minuscule (neighborhood ICC = .008, school ICC = .014, and within neighborhood and school ICC = .022). Using results from the model-building process, each of the four research questions are answered below.

Research Question 1. To what extent are neighborhood influences on U.S. middle and high school students' academic achievement moderated by school environments?

Based on the results from the academic achievement CCREMs, the data do not suggest a moderating relationship between these neighborhood and school characteristics in relation to U.S. middle and high school students' academic achievement. Not only were none of the parameter estimates for the four neighborhood*school interactions statistically significant (Model 6-AA, Table 12), but the change in pseudo- R^2 values between Model 6-AA and Model 5-AA also was not statistically significant (Table 11). Thus, inclusion of these interaction terms did not account for a greater proportion of variance in academic achievement than individual, neighborhood, and school main effects. Given these results, Model 5-AA was used as the complete academic

achievement CCREM when interpreting the academic achievement multivariate findings. See Table 11 for more details about each of the model pseudo- R^2 comparisons.

Table 11

Model Pseudo- R^2 Comparisons for Academic Achievement CCREMs

	Model 6 -AA to Model 5-AA	Model 5-AA to Model 4-AA	Model 5-AA to Model 3-AA	Model 5-AA to Model 2-AA	Model 2-AA to Model 1-AA
Δ pseudo- R^2	.003	.028*	.073*	.272*	.585*
Δ -2 log likelihood (obtained χ^2)	2.4	55.9	36.5	133.5	1108.8
Δ fixed effects (DF)	4	4	3	7	4
χ^2 critical value	9.49	9.49	7.82	14.07	9.49
* $p < .05$	Pseudo- R^2 Model 6-AA = .862 Pseudo- R^2 Model 4-AA = .830 Pseudo- R^2 Model 2-AA = .585	Pseudo- R^2 Model 5-AA = .858 Pseudo- R^2 Model 3-AA = .785 Pseudo- R^2 Model 1-AA = .000			

Note: Model 6-AA = Neighborhood, school, and interaction model
 Model 5-AA = Neighborhood and school main effects model
 Model 4-AA = School model
 Model 3-AA = Neighborhood model
 Model 2-AA = Level-1 control model
 Model 1-AA = Unconditional model

Research Question 2. What are the relative influences of neighborhood and school environments on U.S. middle and high school students' academic achievement?

Because the proportion of variance accounted for by neighborhood and school characteristics together was statistically significantly greater than the proportion of variance accounted for by school characteristics alone and neighborhood characteristics

alone (Model 5-AA to Model 4-AA and Model 5-AA to Model 3-AA in Table 11), the relative influences of neighborhood and school environments on U.S. middle and high school students' academic achievement were determined by examining the parameter estimates from Model 5-AA. However, before discussing neighborhood and school's relative influences, it is important to note that after controlling for all Level-2 predictors, the variability in average achievement across neighborhoods, averaged across schools, and the variability in average achievement across schools, averaged across neighborhoods, both remained statistically significant ($\tau_{b00} = 1.64$ and $\tau_{c00} = 3.30$, respectively). Thus, although the proportion of variance accounted for by neighborhood and school characteristics together was statistically significantly greater than the proportion of variance accounted for by each environment alone, the neighborhood and school variables used in this study did not account for all the variability in average adolescent academic achievement among environments.

Also, to help the interpretation of the relationships between neighborhood, school, and individual characteristics and adolescent academic achievement, the obtained parameter estimates from Model 5-AA were divided by the sample standard deviation of AHPVT scores, thereby allowing the observed relationships to be discussed in terms of predicted standard deviation changes in adolescent academic achievement. Similarly, to ease the interpretation of variables scaled as proportions (e.g., neighborhood racial composition, urbanicity, and student body racial composition), parameter estimates were multiplied by .10, thus transforming a conceptual unit for these variables to equal 10%. For example, the parameter estimate for neighborhood racial composition from Model 5-

AA (4.54) was first multiplied by .10 and then divided by the study sample standard deviation (14.62) yielding the interpreted value 0.03.

Table 12

Summary Table for Academic Achievement CCREMs (n = 10,860)

	Model 1-AA	Model 2-AA	Model 3-AA	Model 4-AA	Model 5-AA	Model 6-AA
<i>Fixed Effects</i>						
Intercept	99.57* (0.56)	100.49* (0.42)	93.36* (1.20)	95.60* (0.77)	92.08* (1.23)	91.43* (1.75)
Age		0.54* (0.10)	-0.45* (0.09)	-0.43* (0.08)	-0.40* (0.08)	-0.40* (0.08)
Biological sex		1.46* (0.24)	1.44* (0.24)	1.44* (0.24)	1.44* (0.24)	1.44* (0.24)
Race		-4.65* (0.32)	-3.98* (0.33)	-4.22* (0.32)	-3.76* (0.33)	-3.76* (0.33)
Family SES		4.90* (0.18)	4.75* (0.18)	4.84* (0.18)	4.70* (0.18)	4.70* (0.18)
Neighborhood affluence			1.13* (0.24)		0.998* (0.26)	0.89 (0.49)
Neighborhood poverty			0.20 (0.22)		0.08 (0.21)	0.46 (0.40)
Neighborhood racial composition			6.79* (0.92)		4.54* (1.02)	4.31* (1.04)
Urbanicity			-1.58* (0.54)		-1.12* (0.50)	-1.08* (0.50)
School SES				1.40* (0.34)	0.84* (0.38)	0.20 (1.07)
School-level teacher education				0.23 (1.01)	0.15 (1.01)	1.93 (3.02)
Student body racial composition				7.16* (0.88)	4.93* (1.08)	5.18* (1.08)
Neighborhood affluence* school SES						-0.03 (0.28)
Neighborhood poverty* school SES						0.25 (0.28)
Neighborhood affluence* school-level teacher education						0.22 (0.88)

Table 12

Summary Table for Academic Achievement CCREMs (n = 10,860)

	Model 1-AA	Model 2-AA	Model 3-AA	Model 4-AA	Model 5-AA	Model 6-AA
Neighborhood poverty* school-level teacher education						-0.90 (0.80)
<i>Error Variance</i>						
Level-1	175.91* (2.46)	162.40* (2.26)	162.34* (2.25)	162.66* (2.26)	162.40* (2.25)	162.40* (2.25)
Intercept (Neighborhood)	10.37* (1.74)	2.86* (0.84)	1.80* (0.70)	2.60* (0.78)	1.64* (0.66)	1.62* (0.66)
Intercept (School)	24.64* (4.38)	11.65* (2.24)	5.72* (1.41)	3.33* (0.96)	3.30* (0.96)	3.23* (0.96)
<i>Model Fit</i>						
AIC	87529.9	86429.1	86340.1	86357.5	86309.6	86315.2
BIC	87521.9	86413.1	86316.1	86335.5	86279.6	86277.2

*Statistically significant--variance estimate and intercept, $p < .05$. For fixed effects tested in blocks, test for block of fixed effects $p < .05$ and test for individual fixed effect $p < .05$.

Values based on SAS Proc Mixed. Entries show parameter estimates with standard errors in parentheses.

Neighborhood ICC = .049

School ICC = .117

Neighborhood and school ICC = .166

In terms of individual neighborhood characteristics and adolescent academic achievement, three of the four neighborhood characteristics (affluence, racial composition, and urbanicity) were statistically significantly associated with adolescent academic achievement after controlling for individual and school characteristics (Model 5-AA, Table 12). The only neighborhood variable not associated with academic achievement was neighborhood poverty. More specifically, for every one standard deviation increase in neighborhood affluence, AHPVT scores were predicted to increase 0.07 standard deviations while controlling for other neighborhood variables and school and individual characteristics. Also, for every 10% increase in White residents in a

neighborhood, AHPVT scores were predicted to increase 0.03 standard deviations. Conversely, for every 10% increase in residents living in urban areas within a neighborhood, AHPVT scores were predicted to decrease 0.008 standard deviations.

In terms of school characteristics, both student body racial composition and school SES were statistically significantly associated with adolescent academic achievement, while controlling for individual and neighborhood characteristics (Model 5-AA, Table 12). For every 10% increase in White students at a school, AHPVT scores were predicted to increase 0.03 standard deviations. In addition, for every one standard deviation increase in school SES, AHPVT scores were predicted to increase 0.06 standard deviations. After controlling for individual and neighborhood characteristics, school-level teacher education was not statistically significantly related to adolescent academic achievement.

Next, regarding individual-level variables and adolescent academic achievement, the proportion of variance accounted for in academic achievement through the simultaneous inclusion of individual, neighborhood, and school variables was statistically significantly greater than the proportion of variance accounted for by individual characteristics alone (Model 5-AA to Model 2-AA in Table 11). Also, unlike neighborhoods and schools, all four individual control variables were statistically significant predictors of adolescent academic achievement after controlling for neighborhood and school contexts (Model 5-AA, Table 12). More specifically, AHPVT scores among traditionally underserved racial minority adolescents were predicted to be 0.26 standard deviations below non-Hispanic White and non-Hispanic Asian adolescents

and girls were predicted to achieve 0.10 standard deviations below boys. Also, for every year increase in age, adolescents were predicted to achieve 0.02 standard deviations less. Conversely, in terms of family SES, for every one standard deviation increase in SES, AHPVT scores were predicted to increase 0.32 standard deviations. Lastly, when examined alone, approximately 58% of the variability in adolescent academic achievement was accounted for by individual characteristics alone (Model 2-AA to Model 1-AA in Table 11).

Research Question 3. To what extent are neighborhood influences on U.S. middle and high school students' risk of obesity moderated by school environments?

Based on the results from the risk of obesity CCREMs, the data do not suggest a moderating relationship between these neighborhood and school characteristics in relation to U.S. middle and high school students' risk of obesity. As presented in Table 13, the change in pseudo- R^2 values between Model 6-RO and Model 5-RO was not statistically significant. Thus, inclusion of these interaction terms did not account for a greater proportion of variance in risk of obesity than individual, neighborhood, and school main effects. Given these results, Model 5-RO was used as the complete risk of obesity CCREM when interpreting the risk of obesity multivariate findings. See Table 13 for more details about each of the model pseudo- R^2 comparisons.

Table 13

Model Pseudo-R² Comparisons for Risk of Obesity CCREMs

	Model 6-RO to Model 5-RO	Model 5-RO to Model 4-RO	Model 5-RO to Model 3-RO	Model 5-RO to Model 2-RO	Model 2-RO to Model 1-RO
Δ pseudo- R^2	.063	.075*	.028	.275*	.494*
Δ -2 log likelihood (obtained χ^2)	6.5	24.0	7.1	52.4	210.8
Δ fixed effects (DF)	4	4	3	7	5
χ^2 critical value	9.49	9.49	7.82	14.07	11.07
* $p < .05$	Pseudo- R^2 Model 6-RO = .833 Pseudo- R^2 Model 4-RO = .694 Pseudo- R^2 Model 2-RO = .494	Pseudo- R^2 Model 5-RO = .770 Pseudo- R^2 Model 3-RO = .742 Pseudo- R^2 Model 1-RO = .000			

Note: Model 6-RO = Neighborhood, school, and interaction model
 Model 5-RO = Neighborhood and school main effects model
 Model 4-RO = School model
 Model 3-RO = Neighborhood model
 Model 2-RO = Level-1 control model
 Model 1-RO = Unconditional model

Research Question 4. What are the relative influences of neighborhood and school environments on U.S. middle and high school students' risk of obesity?

Understanding the relative influences of neighborhood and school environments on U.S. middle and high school students' risk of obesity was more challenging than it was for adolescent academic achievement. For example, when the pseudo- R^2 value from Model 5-RO was compared to the pseudo- R^2 for Model 4-RO, the proportion of variance accounted for by neighborhood and school characteristics together was statistically significantly greater than the proportion of variance accounted for by school characteristics alone (Table 13). However, when the pseudo- R^2 value from Model 5-RO

was compared to the pseudo- R^2 for Model 3-RO, the proportion of variance accounted for by neighborhood and school characteristics together was not statistically significantly greater than the proportion of variance accounted for by neighborhood characteristics alone (Table 13). Thus, these model comparisons suggest that after controlling for neighborhood and individual characteristics, school characteristics do not uniquely contribute to the proportion of variance accounted for in adolescent risk of obesity.

Based on the findings from the model comparisons, the selection of the best risk of obesity model for the interpretation of parameter estimates was less straightforward than model selection for academic achievement. However, in terms of the research questions investigated in this study, the parameter estimates from Model 5-RO (representing the relationships between risk of obesity and school factors after adjusting for neighborhood factors, and the relationships between risk of obesity and neighborhood factors after adjusting for school factors) best addressed the fourth research question. Furthermore, although the proportion of variance accounted for in Model 5-RO was not statistically significantly greater than was the proportion of variance accounted for in Model 3-RO, at $\alpha = .05$ level, Model 5-RO was a better fitting model in the sample than Model 3-RO ($BIC_{\text{Model 5-RO}} = 27,682.1$, $BIC_{\text{Model 3-RO}} = 27,689.2$; Table 14).

Table 14

Summary Table for Risk of Obesity CCREMs (n = 10,860)

	Model 1-RO	Model 2-RO	Model 3-RO	Model 4-RO	Model 5-RO	Model 6-RO
<i>Fixed Effects</i>						
Intercept	0.38* (0.02)	0.25* (0.02)	0.46* (0.06)	-0.008 (0.09)	0.22 (0.12)	-0.42 (0.37)
Age		-0.05* (0.006)	-0.05* (0.005)	-0.05* (0.005)	-0.05* (0.005)	-0.05* (0.005)
Biological sex		0.11* (0.02)	0.11* (0.02)	0.11* (0.02)	0.11* (0.02)	0.11* (0.02)
Race		0.15* (0.02)	0.12* (0.02)	0.14* (0.02)	0.13* (0.02)	0.12* (0.02)
Family SES		-0.05* (0.01)	-0.03* (0.01)	-0.04* (0.01)	-0.03* (0.01)	-0.03* (0.01)
Athletic participation		-0.004 (0.007)	-0.003 (0.007)	-0.001 (0.01)	-0.001 (0.01)	-0.001 (0.01)
Neighborhood affluence			-0.07* (0.01)		-0.06* (0.01)	0.02 (0.11)
Neighborhood poverty			-0.001 (0.01)		-0.001 (0.01)	0.21* (0.10)
Neighborhood racial composition			-0.07 (0.04)		-0.08* (0.04)	-0.08 (0.04)
Urbanicity			-0.01 (0.02)		-0.006 (0.02)	-0.0006 (0.02)
School SES				-0.08* (0.02)	-0.04 (0.02)	0.02 (0.06)
Weight education				0.36* (0.12)	0.29 (0.13)	1.09* (0.48)
School athletic participation				-0.008 (0.02)	-0.008 (0.03)	-0.009 (0.02)
Neighborhood affluence* school SES						-0.01 (0.01)
Neighborhood poverty* school SES						-0.02 (0.02)
Neighborhood affluence* weight education						-0.10 (0.14)
Neighborhood poverty* weight education						-0.27 (0.13)

Table 14

Summary Table for Risk of Obesity CCREMs (n = 10,860)

	Model 1-RO	Model 2-RO	Model 3-RO	Model 4-RO	Model 5-RO	Model 6-RO
<i>Error Variance</i>						
Level-1	0.76* (0.01)	0.74* (0.01)	0.74* (0.01)	0.74* (0.01)	0.74* (0.01)	0.74* (0.01)
Intercept (Neighborhood)	0.006* (0.002)	0.003 (0.002)	0.002 (0.002)	0.003 (0.002)	0.002 (0.002)	0.002 (0.002)
Intercept (School)	0.01* (0.003)	0.006* (0.002)	0.002* (0.002)	0.002 (0.002)	0.002 (0.002)	0.001 (0.001)
<i>Model Fit</i>						
AIC	27953.3	27752.5	27715.2	27730.1	27714.1	27715.6
BIC	27945.3	27734.5	27689.2	27706.1	27682.1	27675.6

*Statistically significant--variance estimate and intercept, $p < .05$. For fixed effects tested in blocks, test for block of fixed effects $p < .05$ and test for individual fixed effect $p < .05$.

Values based on SAS Proc Mixed. Entries show parameter estimates with standard errors in parentheses.

Neighborhood ICC = .008

School ICC = .014

Neighborhood and school ICC = .022

After controlling for individual variables and school factors, neighborhood affluence and racial composition were statistically significantly associated with adolescent risk of obesity and neighborhood poverty and urbanicity were not (Model 5-RO, Table 14). As with the academic achievement models, to ease the interpretation of variables scaled as proportions, parameter estimates were multiplied by .10, thus transforming a conceptual unit for these variables to equal 10 %. More specifically, for every one standard deviation increase in neighborhood affluence, adolescent BMI z -scores were predicted to decrease 0.06 standard deviations. Similarly, for every 10% increase in White residents in a neighborhood, adolescent BMI z -scores were predicted to decrease 0.008 standard deviations. Furthermore, after controlling for all individual,

neighborhood, and school predictors, the residual variation between neighborhoods ($\tau_{b00} = 0.002$) and between schools was close to zero ($\tau_{c00} = 0.002$). Thus, it appears that the variables included in Model 5-RO accounted for most of the neighborhood and school variability in adolescent BMI *z*-scores. In terms of school factors, after controlling for individual and neighborhood characteristics, the school factors examined do not appear to have a statistically significant relationship to U.S. middle and high school students' risk of obesity (Model 5-RO, Table 14).

Next, regarding individual-level variables and adolescent risk of obesity, the proportion of variance accounted for in risk of obesity through the simultaneous inclusion of individual, neighborhood, and school variables was statistically significantly greater than the proportion of variance accounted for by individual characteristics alone (Model 5-RO to Model 2-RO in Table 13). After adjusting for neighborhood and school factors, all individual-level variables were statistically significantly associated with adolescent risk of obesity except for adolescent athletic participation (Model 5-RO, Table 14). More specifically, standardized age-and-gender-adjusted BMI for a traditionally underserved racial minority adolescent was predicted to be 0.13 standard deviations above non-Hispanic White and non-Hispanic Asian adolescents, and boys were predicted to have standardized age-and-gender-adjusted BMI values 0.11 standard deviations above girls. Also, for every year increase in age, standardized age-and-gender-adjusted BMI was predicted to decrease 0.05 standard deviations. A similar relationship was observed for family SES; for every one standard deviation increase in SES, standardized age-and-gender-adjusted BMI was predicted to decrease 0.03 standard deviations. Lastly, when

examined alone, approximately 49% of the variability in adolescent risk of obesity was accounted for by individual characteristics alone (Model 2-RO to Model 1-RO in Table 13).

Summary of Findings

Adolescents included in the study sample did not appear to be substantially different from adolescents included in the original sampling frame. However, when sampling weights were used, the difference between the weighted and unweighted race frequencies was rather pronounced. Thus, all statistical analyses were unweighted and findings are not considered generalizable at the national level.

In terms of the relationships between neighborhood, school, and individual characteristics and adolescent academic achievement and risk of obesity, bivariate relationships among all of the variables included in the study were relatively weak. Similarly, albeit the data suggest several neighborhood and school characteristics were statistically significantly associated with adolescent academic achievement and risk of obesity, the magnitude of the relationships was small. Likewise, the data also do not suggest any moderating relationships between the neighborhood and school characteristics examined in this study.

Regarding the relative association between neighborhood factors and academic achievement, neighborhood affluence, racial composition, and urbanicity appeared to have statistically significant unique relationships with adolescent achievement after controlling for individual, school, and other neighborhood characteristics. Similarly, two school factors (student body racial composition and school SES) evidenced statistically

significant unique relationships with adolescent achievement after controlling for other factors. Conversely, when examining the relative associations between neighborhood and school factors, in relation to adolescent risk of obesity, neighborhood affluence and racial composition were the only characteristics that appeared to have statistically significant unique relationships with adolescent risk of obesity after controlling for individual, school, and other neighborhood characteristics.

However, results from this study need to be interpreted with caution. For example, given the systematic missingness of two of the variables included in the standardized family SES composite variable (household income and parental education), the relationships among family SES and adolescent academic achievement and risk of obesity need to be interpreted with caution. The same caution needs to be used when interpreting the relationships between neighborhood affluence and school SES and both criterion variables as these two predictor variables were correlated with family SES.

Lastly, there was little variation in adolescent academic achievement or risk of obesity across neighborhoods and schools; thus, even though Model 5-AA and Model 5-RO accounted for 86% and 77% of the variance in academic achievement and risk of obesity, respectively, it is important to remember that these pseudo- R^2 values represent the proportion of explainable variance, not total variance accounted for. For example, the pseudo- R^2 value for Model 5-AA (.86) does not represent the proportion of total variance accounted for in adolescent academic achievement. Instead, Model 5-AA accounts for 86% of explainable variance (35.01) in adolescent academic achievement.

Chapter Five

Discussion

Using data from the National Longitudinal Study of Adolescent Health (2005c) and the Adolescent Health and Academic Achievement study (n.d.), the purpose of the current study was to examine simultaneously neighborhood and school influences on academic achievement and adolescent risk of obesity and to examine the moderating effects of schools on these outcomes. To help fill the gap in social determinants literature related to adolescent academic achievement and risk of obesity, four specific research questions were investigated:

Research Question 1. To what extent are neighborhood influences on U.S. middle and high school students' academic achievement moderated by school environments?

Research Question 2. What are the relative influences of neighborhood and school environments on U.S. middle and high school students' academic achievement?

Research Question 3. To what extent are neighborhood influences on U.S. middle and high school students' risk of obesity moderated by school environments?

Research Question 4. What are the relative influences of neighborhood and school environments on U.S. middle and high school students' risk of obesity?

The following sections contain a summary of the findings, limitations of the study, implications for the field, directions for future research, and overall conclusions.

Summary of Findings

Neighborhoods, schools, and academic achievement. Results from the academic achievement CCREMs do not suggest a moderating relationship between the neighborhood and school environments examined in this study. In terms of each environment's relative relationship with middle and high school students' academic achievement, three neighborhood characteristics (neighborhood affluence, racial composition, urbanicity) and two school characteristics (student body racial composition, school SES) appear to have statistically significant unique relationships with adolescent achievement after controlling for individual and other neighborhood and school characteristics. In relation to the social determinants literature and previous findings related to neighborhoods, schools, and adolescent academic achievement, findings from the current study both complement and contradict findings from other published studies.

For example, the statistically significant positive relationship between neighborhood affluence and academic achievement and the statistically non-significant association between neighborhood poverty and achievement are consistent with other non-experimental research findings (Boyle et al., 2007; Brooks-Gunn et al., 1997a; Dornbusch et al., 1991; Halpern-Felsher et al., 1997; Leventhal & Brooks-Gunn, 2000). Yet, these associations also contradict findings from previous experimental and quasi-experimental studies that did not reveal statistically significant improvements in adolescent academic achievement based on higher neighborhood socioeconomic levels (Kling & Liebman, 2004; Leventhal et al., 2005; Rosenbaum, 1995). Similarly, the statistically significant positive association found between neighborhood racial

composition (i.e., proportion of White residents) and academic achievement in the current study contradicts Blau et al.'s (2001) statistically non-significant findings between neighborhood diversity and social studies achievement.

Another contradiction with the literature is the magnitude of the neighborhood ICC for academic achievement from the current study. Unlike Boardman and Saint Onge (2005) who reported a relatively large neighborhood ICC based on Add Health data (.25), the neighborhood ICC for academic achievement in the current study was minuscule (.049). Differences in model specifications and the sample used to calculate the ICCs are plausible explanations for the variation in ICC values. For example, not only did Boardman and Saint Onge (2005) use a traditional two-level hierarchical model to generate ICC values whereas the current study used a cross-classified two-level model, but the ICC values they report were not derived from an unconditional model as was undertaken in the current study. Instead, the ICC values were generated from models that statistically controlled for a host of level-1 factors such as race, age, gender, family structure, and maternal education (Boardman & Saint Onge, 2005).

In terms of school sociodemographic characteristics and adolescent academic achievement, findings from the current study are more consistent with Coleman et al.'s (1966) findings than with findings from more recent studies (i.e., Caldas & Bankston, III, 1997; Everson & Millsap, 2004; Lee & Croninger, 1994). For example, even though the current study revealed statistically significant associations between school SES and student body racial composition and adolescent academic achievement, the magnitude of these associations was negligible, thus lending support to Coleman et al.'s (1966)

conclusion that after accounting for family background characteristics and general social context, school sociodemographic characteristics have little relationship with academic achievement. The lack of a statistically significant association between teacher education and academic achievement in the current study also lends support to Coleman et al.'s (1966) findings and contradicts findings from more recent studies (i.e., Darling-Hammond, 1999; Greenwald et al., 1996).

Neighborhoods, schools, and risk of obesity. Results from the risk of obesity CCREMs do not suggest a moderating relationship between the neighborhood and school environments examined in this study. In terms of each environment's relative relationship with risk of obesity, two neighborhood characteristics (neighborhood affluence, racial composition) appear to have statistically significant unique relationships with adolescent risk of obesity after controlling for individual, school, and other neighborhood characteristics. After controlling for individual and neighborhood characteristics, none of the three school factors examined in this study had statistically significant unique relationships with adolescent risk of obesity. In relation to the social determinants literature and previous findings related to neighborhoods, schools, and adolescent risk of obesity, findings from the current study are not directly comparable to other published studies. More specifically, because most the neighborhood and school factors examined in the current study are different than those included in other studies, a direct comparison of findings cannot be made. Nonetheless, some general, common elements among studies can be discussed.

For example, the statistically significant negative association between neighborhood affluence and adolescent risk of obesity in the current study both supports and contradicts Chen and Paterson's (2006) findings on neighborhood SES and high school students' BMI. The statistically significant negative association found between neighborhood affluence and age-and-gender-adjusted BMI *z*-scores supports Chen and Paterson's (2006) results of neighborhood education and employment as statistically significant negative predictors of adolescent BMI; however, it contradicts their findings that neighborhood income and assets were not statistically significant predictors of BMI. The relationship between neighborhood affluence and adolescent risk of obesity in the current study also contradicts Kling and Liebman's (2004) results of no statistically significant differences in adolescent obesity status between Moving to Opportunity adolescents whose families moved to low-poverty neighborhoods and those who remained in impoverished urban housing projects.

As with academic achievement, the magnitude of the neighborhood ICC for adolescent risk of obesity also is much smaller than the neighborhood ICC for risk of being overweight reported by Boardman and Saint Onge's (.008 vs. .05, respectively; 2005). Similarly, as with the academic achievement models, differences in model specifications and the sample used to calculate the ICCs are probable explanations for the observed differences. Differences in how risk of obesity was operationalized also could be related to the different neighborhood ICC values.

The lack of a statistically significant association between urbanicity and age-and-gender-adjusted BMI *z*-scores in the current study also can be viewed as supporting and

contradicting previous research findings. For example, the lack of a statistically significant relationship between urbanicity and age-and-gender-adjusted BMI z-scores contradicts Ewing et al.'s (2006) cross-sectional findings regarding urban sprawl and adolescent weight status. However, the findings from the current study support their longitudinal findings regarding urban sprawl and adolescent weight status.

As with most of the neighborhood and risk of obesity literature, results related to school characteristics and adolescent risk of obesity both support and contradict previous findings. More specifically, the lack of any statistically significant school characteristic and age-and-gender-adjusted BMI z-scores from the current study contradicts O'Malley et al.'s (2007) findings on school SES and adolescent BMI. However, the magnitude in school ICC for adolescent risk of obesity in the current study is not considerably smaller than the school ICC for risk of obesity reported by O'Malley et al. (.014 vs. .03, respectively; 2007).

Limitations of the Study

As with all secondary data analyses, this study has several methodological limitations. First and foremost is the issue of variable selection and model misspecification. Not only were limited variables available related to adolescent risk of obesity, but the quality of some of the variables that were available was poor. For example, the variable that was used to assess adolescent participation in physical education classes was only asked of students who completed their In-Home Interview during the active academic year; thus, this variable had more legitimate skips than completed responses. Therefore, even though this information is possibly an important

factor in understanding adolescent risk of obesity, the large amount of missing data precluded its inclusion in the study. Although it is unclear why the Add Health researchers only asked the physical education class question to students interviewed during the academic year, the overall lack of variables related to adolescent risk of obesity could be related to the age of the data, which is another limitation of the study.

Wave I Add Health data were collected more than 10 years ago (1994-1995). Since that time, not only have neighborhoods and schools likely changed, but the questionnaire and interview items were likely related to the pressing health issues of the early 1990's, which are not the same as the pressing issues of today. For instance, the current childhood and adolescent obesity epidemic was just beginning to be noticed in the 1990's. Thus, because obesity was not a public health priority when Add Health was designed and initially implemented, it is not surprising that the data contain little information that can be used to assess factors associated with obesity. If Add Health were conducted today, the focus of the questions would likely be very different (e.g., the recently funded National Children's Study focus on understanding social and biological factors associated with obesity; The National Children's Study, 2007). Possible areas of interest that might be examined today include detailed questions related to average caloric intake (e.g., keeping a 2-week food journal), adolescent perceptions about the weight status of their friends, family, and students at their schools, and attitudes and beliefs towards weight and body image issues.

Furthermore, because cross-classified random effects models can only be used with continuous criterion variables, adolescent risk of obesity had to be operationalized

differently in this study compared to other studies (i.e., age-and-gender-adjusted BMI z -scores were used instead of a more traditional dichotomous risk/no-risk variable based on age-and-gender-adjusted BMI percentiles). In this manner, although the risk of obesity results from the current study are not directly comparable to findings from studies in which the risk of obesity was operationalized as falling above or below a specific BMI percentile, they are not completely disparate either. Variables included in the current study had similar bivariate correlations with risk of obesity operationalized as age-and-gender-adjusted BMI z -scores ($r1$) and with risk of obesity operationalized as age-and-gender specific BMI \geq 85th percentile ($r2$; Table 15).

After applying the Fisher z transformation, all of the effect sizes for the differences between $r1$ and $r2$ were well below Cohen's (1988) guidelines for a small effect size when comparing correlation coefficients ($q = .10$; Table 15). In addition, the correlation between age-and-gender-adjusted BMI z -scores and the dichotomous risk of obesity measure was .74. Therefore, although the difference in how risk of obesity was operationalized in the current study should be noted, the results from the current study need not be considered in complete isolation from other studies that operationalize adolescent risk of obesity as age-and-gender specific BMI \geq 85th percentile.

Table 15

*Correlation Coefficient Comparisons for Different Adolescent Risk of Obesity Measures
(n = 10,860)*

	BMI z-score (<i>r1</i>)	BMI \geq 85th percentile (<i>r2</i>)	Cohen's <i>q</i>
AHPVT	-.012	-.016	0.004
Affluence	-.092	-.082	-0.010
Poverty	.054	.045	0.009
Neighbor racial comp	-.066	-.061	-0.005
Urbanicity	-.006	-.009	0.004
Teacher education	-.028	-.018	-0.010
School racial comp	-.042	-.043	0.001
School SES	-.090	-.085	-0.005
Age	-.086	-.048	-0.039
Family SES	-.066	-.071	0.005
Biological sex	.056	.060	-0.003
Race	.088	.062	0.026
Athlete	.006	-.040	0.047
School athletics	.003	-.039	0.042
Weight education	-.022	-.038	0.015

Add Health data also only contain two measures of academic achievement—GPA calculated from self-reported grades in English, mathematics, science, and social studies and AHPVT scores, both of which have their own limitations. For example, because the lack of standardization in school grades was a serious limitation in using them as a single measure of academic achievement, AHPVT scores were used as a measure of adolescent academic achievement in the current study. However, although this variable is a standardized measure of academic achievement, no reliability or validity studies on this version of the PPVT are available from Add Health researchers. Furthermore, it too, is a single measure of achievement at one point in time.

An additional limitation of the study is the use of census tracts to operationalize neighborhoods. In doing so, neighborhood measures included in the study were very

broad and likely did not contain data related to the significant areas of an adolescent's neighborhood that shape his or her daily experiences. Therefore, even though the findings from the study help advance our understanding of neighborhoods' unique influences on adolescent academic achievement and risk of obesity, findings are still limited to administratively defined neighborhoods. Thus, the study does not contribute to our understanding of how smaller, more immediate neighborhood environments might influence adolescent well-being and whether schools moderate these influences.

The relatively low correlation among variables included in the neighborhood poverty composite also is a limitation of the current study. Although the selection of variables used to create the neighborhood poverty composite variable was informed by poverty composites used in previous research (i.e., Duncan & Aber, 1997; Leventhal & Brooks-Gunn, 2003), in this study, these three variables did not appear to represent the underlying poverty construct well. More specifically, the proportion of female-headed households in a neighborhood was not highly correlated with the proportion of families living below the federal poverty level or with the proportion of unemployed adults. Thus, even though historically researchers have often conceptualized female-headed households as an indicator of poverty, for these data, the proportion of female-headed households does not appear to be an accurate component of neighborhood poverty.

A further limitation of the study pertains to the small neighborhood ICC values and the proportion of singletons (i.e., a neighborhood unit containing only one adolescent) included in the study. The neighborhood ICCs for both academic achievement and risk of obesity were very small (.049 and .008); however, it is unknown

if the variance in adolescent academic achievement and risk of obesity across neighborhoods is truly that small, or if the proportion of singleton neighborhoods (.45) might be diminishing these values. More specifically, with singletons, there is no clustering at the neighborhood level, therefore, there is no neighborhood variance for these adolescents, which, in turn, could be suppressing the neighborhood ICCs. Furthermore, just as we do not know the impact of having high proportions of singleton neighborhoods, the structure of the Add Health data does not allow for an examination of the degree to which schools are or are not nested in neighborhoods. Theoretically, we would expect some students to attend school in their neighborhoods, whereas other students attend schools not in their neighborhoods. However, the data do not provide information about which schools are in which neighborhoods; thus, it is not possible to determine how many students attended school outside their neighborhoods.

The generalizability of findings is another limitation of this study. Not only could sampling weights not be used in the multivariate analyses, thus prohibiting the results to be generalized to a national level, but, even if sampling weights could have been used, Add Health data do not contain weights at the neighborhood level. Thus, even though the Add Health schools and sample of adolescents were selected to be nationally representative, the neighborhoods were not selected to be nationally representative. Therefore, any findings at the neighborhood level cannot be generalized beyond the sample of adolescents included in the study and their corresponding neighborhoods. The age of the data also requires caution in the generalizability of findings. For example, the neighborhood and school influences examined in the current study do not necessarily

relate to today's neighborhoods and schools. Instead, they relate to neighborhood conditions in 1990 and school conditions in 1994-1995.

Lastly, even with its many limitations, to date, Add Health data are still the best source for researchers interested in examining the relationships between social contexts and adolescent well-being. Although there are many secondary data sources that contain information related to adolescent development and well-being, none include the vast array of individual and contextual data available from Add Health. Thus, albeit not perfect, Add Health's large sample size and focus on multiple social contexts allows researchers to apply advanced analytic techniques that other data sources cannot support.

Implications for the Field

The most notable implication of the current study is its addition to the social determinants literature. By examining simultaneously neighborhood and school environments in relation to adolescent academic achievement and risk of obesity, findings from the current study are likely less biased than are previous findings because the CCREMs used in the current study allowed for the examination of the unique contributions of each environment. However, even though the current study contributes to our understanding of each environment's unique relationship with achievement and risk of obesity, given the correlational design of the current study, results from the current study cannot be used to guide policies or programs related to adolescent development. Instead, the strongest implications for the field of social and behavioral science are best discussed in terms of future research.

Directions for Future Research

Although the findings from the current study have made an important contribution to the social determinants literature, there is still much work to be undertaken in furthering our understanding of neighborhood and school influences on adolescent development and well-being. For example, the criterion variables examined in the current study (academic achievement and risk of obesity) were two of many developmental outcomes that might be influenced by various neighborhood and school factors. Thus, future research needs to utilize CCREMs to investigate other important social, physical, intellectual, and emotional outcomes. Similarly, just as the criterion variables included in the current study were two of many possible outcomes to be examined, the neighborhood and school factors included in the current study also represent a small proportion of neighborhood and school characteristics that could have been examined. Consequently, as future research uses CCREMs to investigate different developmental outcomes, it should also investigate different neighborhood and school characteristics in relation to these other outcomes.

Other neighborhood and school variables that should be examined include those that are more perceptual in nature versus administratively measured variables taken from the census. For example, at the neighborhood level, potential variables to be investigated in future research include social capital, social norms regarding health and education, residents' perceived neighborhood quality/dilapidation, researchers' observed neighborhood quality/dilapidation, and an index of perceived vs. observed neighborhood quality/dilapidation. At the school level, potential variables to examine in future studies

include perceived weight status of close friends and of students at school, perceived racism, time spent on instruction, school connectedness, and overall academic climate of the school.

Future research also is needed to begin to investigate and understand possible mechanisms behind the relationships among neighborhood affluence, adolescent academic achievement, and risk of obesity. Although the relationship between neighborhood affluence and age-and-gender-adjusted BMI *z*-scores had not been previously examined, the association between adolescent academic achievement and neighborhood affluence is consistent, albeit weaker, with findings from other social determinants research. Therefore, it seems appropriate for future research to further our understanding of these complex social processes by examining the mechanisms behind these relationships. Qualitative research would be especially useful in this area. For example, future researcher could take a phenomenological approach to understanding the mechanisms behind neighborhood affluence and adolescent well-being. In doing so, future researchers would be able to capture the meaning of the lived experience of adolescents in their neighborhoods (Creswell, 1998).

From a methodological perspective, future research should focus on several areas. First, given the weak correlations among the variables used to operationalize neighborhood poverty, future research should investigate a better composite variable for neighborhood poverty. Second, future research should investigate how much impact using CCREMs had, using Add Health data, compared to the traditional misspecified two-level model with adolescents only nested in schools. Given the large proportion of

singletons and low neighborhood ICCs found in the current study, accounting for the theoretical cross-classification of the data might have had little impact on the relationships examined. Third, future large-scale studies need to be designed using a better sampling design such that the data are nationally representative of both neighborhoods and schools. These better designed large-scale studies also need to provide links between neighborhoods and schools, thereby allowing researchers to evaluate the extent to which youth are cross-classified between neighborhoods and schools. In addition, to allow future researchers to be able to conduct mixed methods research using secondary data, future large-scale studies need to include more than the typical close-ended quantitative items; they need to include qualitative, open-ended items that can be used in conjunction with the more traditional quantitative items.

Conclusions

Bronfenbrenner's (1979) Ecological Systems Theory posits that human development is influenced by the interrelations among settings in which a person actively participates (e.g., family, school, neighborhoods, religious institutions); thus, to study human development effectively, we need to look beyond a single environment and analyze the interactions among multiple environments. Although this study did not discover any statistically significant interactions among neighborhood and school characteristics, it was the first to investigate school and neighborhood influences simultaneously using national data and cross-classified random effects hierarchical models. Thus, findings from the current study are important contributions to the social determinants literature as they are the first to present neighborhood associations with

adolescent academic achievement and risk of obesity while statistically controlling for school characteristics and vice versa. However, given the relatively small magnitude of many of the relationships found in the current study, it is imperative for social and behavioral scientist to continue to explore the complex relationships between various social environments and adolescent development and well-being, while employing proper statistical techniques.

Lastly, given the limitations of the current study, the findings do not completely answer the research questions. More specifically, the correlational design and model misspecification of the current study prohibit findings from being interpreted as “relative influences.” Instead, the findings should be viewed as adding another piece to the social determinants research puzzle. In this fashion, findings from the current study can be used in conjunction with previous research findings to help advance our knowledge of social determinants of adolescent development and well-being along the causality continuum. For example, the consistency with findings related to neighborhood affluence underscores the importance of this social construct in the development of achievement and health. Therefore, as more researchers use findings from the current study to guide new investigations of these complex relationships, policymakers and community leaders will be better informed as they continue to work towards eliminating education inequity and health disparities.

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Appendix A: Summary Tables of Previous Neighborhood and School Research

Table A-1

Summary of Neighborhood Influences on Adolescent Academic Achievement Research Studies

Authors	Sample	Analytic Technique	Academic Achievement Operationalization	Neighborhood Operationalization	Neighborhood-Level Variables	Individual-Level Variables	Other Variables
Halpern-Felsher et al. (1997)	11- to 16-year old African American youth in Atlanta	OLS regression	National percentile ranking from the Iowa Test of Basic Skills	1980 census tracts	Low SES, high SES, male joblessness, family concentration, and ethnic diversity	Family income, family structure, and mother's education, grade in school	
Halpern-Felsher et al. (1997)	12- to 15-year old White and African American students in an upstate New York urban school district	OLS regression	Educational risk behavior composite variable that included information on attendance, standardized achievement tests, suspensions, old for grade or recommendation for retention, and two or more core courses were failed in the previous academic year	1980 census tracts	Low SES, high SES, male joblessness, family concentration, and ethnic diversity	Eligible for reduced price/free lunch	

Table A-1

Summary of Neighborhood Influences on Adolescent Academic Achievement Research Studies

Authors	Sample	Analytic Technique	Academic Achievement Operationalization	Neighborhood Operationalization	Neighborhood-Level Variables	Individual-Level Variables	Other Variables
Halpern-Felsher et al. (1997)	15- to 20-year old White and African American students in an upstate New York urban school district	OLS regression	Educational risk behavior composite variable that included information on attendance, standardized achievement tests, suspensions, old for grade or recommendation for retention, and two or more core courses were failed in the previous academic year	1980 census tracts	Low SES, high SES, male joblessness, family concentration, and ethnic diversity	Eligible for reduced price/free lunch	
Dornbusch et al. (1991)	High school students in six San Francisco Bay Area schools	OLS regression	Adjusted self-reported grades in school on a 4- point scale	U.S. census tracts (year not specified)	Community socioeconomic status and community ethnic composition	Parental education, family structure, ethnicity, and gender	Family process variables: style, parental involvement, decision making, and parental reactions to grades

Table A-1

Summary of Neighborhood Influences on Adolescent Academic Achievement Research Studies

Authors	Sample	Analytic Technique	Academic Achievement Operationalization	Neighborhood Operationalization	Neighborhood-Level Variables	Individual-Level Variables	Other Variables
Halpern-Felsher et al. (1997)	10- to 16-year old White and African American youth in New York City, Baltimore, and Washington, D.C.	OLS regression	Combined reading and math standardized test scores	1980 census tracts	Low SES, high SES, male joblessness, family concentration, and ethnic diversity	Family poverty, no father in the home	
Rosenbaum (1995)	High school youth whose families participated in the Gautreaux Program	Not stated – was more of an evaluation report	High school GPA	Not specified – was a comparison between “suburban movers” and “city movers” Suburban movers were families who moved out of the inner city housing projects and into one of 115 suburbs in the six-county area surrounding Chicago City movers were families who moved out of the inner city housing projects and	Neighborhood type – urban or suburban	Not sure, nothing included in the report	

Table A-1

Summary of Neighborhood Influences on Adolescent Academic Achievement Research Studies

Authors	Sample	Analytic Technique	Academic Achievement Operationalization	Neighborhood Operationalization	Neighborhood-Level Variables	Individual-Level Variables	Other Variables
				into “revitalized” low-income Black neighborhoods within the city limits			
Kling & Liebman (2004)	Teenage youth (aged 15-20) whose families participated in the MTO program in Baltimore, Boston, Chicago, Los Angeles, and New York City	OLS regression	Woodcock-Johnson reading and mathematics test performance	Not clearly stated. Only provided general information on the different treatment and control groups Experimental group could only move to census tracts with a 1990 poverty rate less than 10 % Section 8 group could move to any neighborhood Control group was not allowed to live in Section 8 housing – they remained in the housing projects	Poverty level	Gender and baseline characteristics (race, gifted classes, special education classes, behavior problems, health problems, school discipline experiences)	
Leventhal et al. (2005)	Youth aged 14-19 whose families	OLS regression	Self-reported grades in school on a 5-point scale	Experimental group status – low-poverty group, traditional voucher group, and	Fraction poor, fraction rental units, fraction Black, fraction	Age, gender, parental characteristics including age,	

Table A-1

Summary of Neighborhood Influences on Adolescent Academic Achievement Research Studies

Authors	Sample	Analytic Technique	Academic Achievement Operationalization	Neighborhood Operationalization	Neighborhood-Level Variables	Individual-Level Variables	Other Variables
	participated in the New York City MTO program			control group	Latino, fraction White	race, education, employment status, marital status, and number of children in the household	
Baker et al. (2001)	8th-grade students in the state of Virginia	Structural equation modeling	Aggregated mean scores on three subtests (reading, language, and mathematics) of the Stanford 9	School district boundaries	Economic condition, social organization, and children's environment		
Bowen et al. (2002)	Nationally representative sample of middle and high school students	Structural equation modeling	Self-reported grades in school	Not defined administratively – youths' subjective view of their neighborhood	Perceived neighborhood support, perceptions of pro-social behaviors of neighborhood peers, and perceptions of neighborhood crime and violence	Race/ethnicity and family poverty	Supportive parenting and parental educational support
Eamon (2005)	Latino adolescents aged 10 to 14 whose mothers participated in	Hierarchical OLS regression	Peabody Individual Achievement Test reading comprehension and mathematics scores	Not defined administratively – mothers' subjective view of their neighborhoods.	Overall neighborhood quality	Latino origin, gender, age, LEP, maternal characteristics (age when had first child, years of education)	Youth's ratings of school environment and parenting processes

Table A-1

Summary of Neighborhood Influences on Adolescent Academic Achievement Research Studies

Authors	Sample	Analytic Technique	Academic Achievement Operationalization	Neighborhood Operationalization	Neighborhood-Level Variables	Individual-Level Variables	Other Variables
	the National Longitudinal Survey of Youth					completed, percentile score on Armed Forces Qualification Test, LEP, and U.S. born), and family characteristics (average adult-to-child ratio and poverty status)	(cognitive stimulation, parent-youth conflict, and academic involvement)
Plybon et al. (2003)	Urban, African American girls aged 11 to 14 living in a southeastern city	Hierarchical OLS regression	Self-reported grades in school on a 5-point scale	Not defined administratively - adolescents' subjective view of their neighborhoods	Bruckner's Neighborhood Cohesion Scale	Maternal education	
Bowen & Bowen (1999)	National probability sample of middle and high school students from the National	Hierarchical OLS regression	Composite grade index that included grades and perceptions of grades relative to other students	Not defined administratively - adolescents' subjective view of their neighborhoods	Negative neighborhood peer culture and neighborhood personal threats	Gender, race/ethnicity, school level, free/reduced lunch status, and urbanicity	School crime and violence and school personal threats

Table A-1

Summary of Neighborhood Influences on Adolescent Academic Achievement Research Studies

Authors	Sample	Analytic Technique	Academic Achievement Operationalization	Neighborhood Operationalization	Neighborhood-Level Variables	Individual-Level Variables	Other Variables
	School Success Profile data						
Williams et al. (2002)	African American 9th-grade students in a large, metropolitan area in the Midwest	Hierarchical OLS regression	Official 4-point GPA from students' records	Not defined administratively - adolescents' subjective view of their neighborhoods	Perceived neighborhood deterioration and perceived neighborhood resources	Gender, family structure, religiosity, and exposure to academic success	
Blau et al. (2001)	Public high school students from the High School Effectiveness Study	Hierarchical linear modeling	Two-year gains in social studies standardized test scores between 10th and 12th grade	Zip codes according to 1990 census data	Neighborhood diversity and inequality of socioeconomic resources	Gender, traditional educational advantage status, SES, previous mathematics and reading performance, family structure, locus of control, educational expectations, and academic motivation	School socio-demographic composite variable

Table A-1

Summary of Neighborhood Influences on Adolescent Academic Achievement Research Studies

Authors	Sample	Analytic Technique	Academic Achievement Operationalization	Neighborhood Operationalization	Neighborhood-Level Variables	Individual-Level Variables	Other Variables
Boardman & Saint Onge (2005)	Middle and high school youth from the Add Health data	Hierarchical linear modeling	Self-reported grades and performance on the Add Health Picture Vocabulary Test	1990 census tracts	Do not know – not clearly stated in the paper	Race/ethnicity, age, gender, mother's marital status and level of education, and use of public assistance	

Table A-2

Summary of Neighborhood Influences on Adolescent Risk of Obesity Research Studies

Authors	Sample	Analytic Technique	Risk of Obesity Operationalization	Neighborhood Operationalization	Neighborhood-Level Variables	Individual-Level Variables	Other Variables
Nelson et al. (2006)	Adolescents from the Add Health data	Cluster analysis and Poisson regression	BMI > 95th percentile	3-km buffer around each adolescent's residential location	Income/wealth, race/ethnicity, SES and environment, crime, road type, street connectivity/walkability, and recreation facilities	Race/ethnicity, parental education, and family income	
Chen & Paterson (2006)	Public high school students aged 14 to 19 in the St. Louis, MO area	Simultaneous regression	BMI (no mention of a specific cut point in the article)	Census block groups	Education, employment, income, and assets	Age, gender, family education, family occupational status, family income, and family assets	
Kling & Liebman (2004)	Teenage youth (aged 15-20) whose families participated in the MTO program in Baltimore, Boston, Chicago, Los Angeles,	OLS regression	BMI > 95th percentile	Not clearly stated. Only provided general information on the different treatment and control groups Experimental group could only move to census tracts with a 1990 poverty rate less than 10 %	Poverty level	Gender and baseline characteristics (race, gifted classes, special education classes, behavior problems, health problems, school	

Table A-2

Summary of Neighborhood Influences on Adolescent Risk of Obesity Research Studies

Authors	Sample	Analytic Technique	Risk of Obesity Operationalization	Neighborhood Operationalization	Neighborhood-Level Variables	Individual-Level Variables	Other Variables
	and New York City			Section 8 group could move to any neighborhood Control group was not allowed to live in Section 8 housing – they remained in the housing projects		discipline experiences)	
Wickrama et al. (2006)	Adolescents from Add Health data	Hierarchical linear modeling	BMI \geq 95th percentile	1990 census tracts	Community poverty	Race/ethnicity, gender, and family poverty	
Norman et al. (2006)	Adolescents aged 11 to 15 in San Diego County	Pearson Product Moment Correlation	BMI-for-age percentile	1-mile radius around adolescent's home address	Number of private recreation facilities, number of schools, number of parks, residential density, intersection density, retail floor area ratio, land use mix factor, walkability index		
Gordon-Larsen et al. (2006)	Adolescents from Add Health data	Relative odds	Age and gender adjusted BMI \geq 95th percentile	1990 census block groups	Population density		

Table A-2

Summary of Neighborhood Influences on Adolescent Risk of Obesity Research Studies

Authors	Sample	Analytic Technique	Risk of Obesity Operationalization	Neighborhood Operationalization	Neighborhood-Level Variables	Individual-Level Variables	Other Variables
Boardman & Saint Onge (2005)	Adolescents from Add Health data	Hierarchical linear modeling	Age and gender adjusted BMI \geq 85th percentile	1990 census tracts	Do not know – not clearly stated in the paper	Race/ethnicity, age, gender, mother's marital status and level of education, and use of public assistance	
Ewing et al. (2006)	Adolescents (12 to 17 years old) from the 1997 National Longitudinal Survey of Youth	Hierarchical linear modeling	Age and gender adjusted BMI \geq 85th percentile	County of residence	County sprawl index	Age, gender, race/ethnicity, cigarette use, hours worked, household income, and household education level	
Powell et al. (2007)	8th- and 10th- grade students from the 1997 to 2003 MTF data	OLS regression	BMI	School zip-code	Per capita income, number of chain supermarkets, number of non-chain supermarkets, number of grocery stores, number of convenience stores, number of full service restaurants,	Gender*age, grade, race/ethnicity, fathers' education, mothers' education, family composition, urbanicity, students' weekly income,	

Table A-2

Summary of Neighborhood Influences on Adolescent Risk of Obesity Research Studies

Authors	Sample	Analytic Technique	Risk of Obesity Operationalization	Neighborhood Operationalization	Neighborhood-Level Variables	Individual-Level Variables	Other Variables
Cohen et al. (2006)	Adolescents aged 12 to 17 residing in Los Angeles County	Hierarchical linear modeling and hierarchical generalized linear modeling	BMI-for-age and age and gender adjusted BMI >95th percentile	1990 census tracts in Los Angeles County	number of fast food restaurants, fast food prices, fruit and vegetable prices Collective efficacy, neighborhood disadvantage	hours worked by students, maternal employment, year Age, sex, race/ethnicity, nativity, extracurricular activities, hours of TV watched per day, family structure, parental education, family income, employment status, health insurance status, mother's BMI	

Table A-3

Summary of School Influences on Adolescent Academic Achievement Research Studies

Authors	Sample	Analytic Technique	Academic Achievement Operationalization	School Operationalization	School-Level Variables	Individual-Level Variables	Other Variables
Coleman et al. (1966)	U.S. 6th-, 9th-, and 12th-grade students.	OLS regression	Verbal standardized test scores developed from the ETS Sequential Tests of Educational Progress series	Elementary and secondary school buildings	Student body characteristics, school resource, and teacher characteristics	Family structure and size, poverty status, parental education, urbanism, and educational support	
Everson & Millsap (2004)	1995 U.S. high school graduates	Multilevel structural equation modeling	Composite achievement measure based on overall high school GPA, class rank, and subject specific GPA	High school buildings	SES, size, locale, and racial and ethnic composition	Gender, race and ethnicity, parental education, household income, and extra curricular activity participation	Race, poverty status, social class status, gender, LEP, homework hours, reading hours, TV hours, work hours, and school activity hours
Caldas & Bankston III (1997)	Louisiana 10th-grade public school students	OLS Regression	Louisiana Graduation Exit Examination composite score of mathematics, language arts, and written composition	High school buildings	Peer family poverty, peer family social status		

Table A-3

Summary of School Influences on Adolescent Academic Achievement Research Studies

Authors	Sample	Analytic Technique	Academic Achievement Operationalization	School Operationalization	School-Level Variables	Individual-Level Variables	Other Variables
Lee & Croninger (1994)	Middle school students included in NELS:88 base year data	Hierarchical linear modeling	Reading standardized test scores	Middle school buildings	School composition, environment and organization, and policies and practices	Academic background, race and ethnicity, non-native English speaker, poverty status, parental education, mother's educational expectations, literacy resources in the home, and family communication about school issues	
Crosnoe (2004)	Middle and high school students from Add Health Wave I and II	Hierarchical linear modeling	Self-reported grades in school on a 4-point scale	Middle and high school buildings	Student-teacher bonding, parent-adolescent relations, and parent educational attainment School-level controls: sector, level, and average academic achievement	Gender, age, race and ethnicity, parent education, family structure, parents' educational expectations, and Wave I academic achievement	Parent-adolescent emotional distance

Table A-3

Summary of School Influences on Adolescent Academic Achievement Research Studies

Authors	Sample	Analytic Technique	Academic Achievement Operationalization	School Operationalization	School-Level Variables	Individual-Level Variables	Other Variables
Blau et al. (2001)	Public high school students from the High School Effectiveness Study	Hierarchical linear modeling	Two year gains in social studies standardized test scores between 10th and 12th grade	High school buildings	Socio-demographic composite variable	Gender, traditional educational advantage status, SES, previous mathematics and reading performance, family structure, locus of control, educational expectations, and academic motivation	Neighborhood diversity and inequality of socioeconomic resources
Baker et al. (2001)	8th-grade students in the state of Virginia	Structural equation modeling	Aggregated mean scores on three subtests (reading, language, and mathematics) of the Stanford 9	Middle school buildings	Economic condition, social organization, and children's environment		
Greenwald et al. (1996)	60 studies that examined school resources effects on student achievement	Meta-analysis – combined significance testing and effect magnitude estimation	Standardized achievement tests	U.S. school districts or smaller (i.e., schools or classrooms)	Per-pupil expenditure, teacher ability, teacher education, teacher experience, teacher salary,	Studies included in the review had to control for socioeconomic characteristics in their models	

Table A-3

Summary of School Influences on Adolescent Academic Achievement Research Studies

Authors	Sample	Analytic Technique	Academic Achievement Operationalization	School Operationalization	School-Level Variables	Individual-Level Variables	Other Variables
	ment				teacher/pupil ratio, and school size		
Jeynes (2002)	15 studies that examined effects of religious schools or religious commitment and academic achievement of Black and/or Hispanic students	Meta-analysis – Hedge’s <i>g</i> measure of effect size	Overall academic achievement and achievement tests—neither one clearly defined	Middle and high school buildings	Religious affiliation	Race/ethnicity	
Darling-Hammond (1999)	8th-grade U.S. public middle school students included in the 1996 NAEP data	OLS regression	Mathematics standardized test scores	Middle school buildings	% well-qualified teachers, % of out-of-field teachers, % of fully certified teachers, % of less than fully certified teachers, % of uncertified new entrants, % of	Student poverty	

Table A-3

Summary of School Influences on Adolescent Academic Achievement Research Studies

Authors	Sample	Analytic Technique	Academic Achievement Operationalization	School Operationalization	School-Level Variables	Individual-Level Variables	Other Variables
					uncertified newly hired teachers, PPE, pupil: teacher ratio, and average class size		
Wentzel (2002)	Suburban 6th graders in a mid-Atlantic state	Hierarchical OLS regression	Official end-of-year grades for the subject taught by the teacher students assessed	Middle school buildings	Teaching practices: fairness, teacher motivation, rule setting, negative feedback, and high expectations	Gender and race/ethnicity	
Sweetland & Hoy (2000)	8th graders in 86 New Jersey public middle schools	OLS regression	Reading and mathematics standardized test scores from New Jersey's Eighth Grade Early Warning Test	Middle school buildings	SES and teacher empowerment	None	
Crosnoe & Muller (2004)	Middle and high school students from Add Health Wave I and	Hierarchical linear modeling	Self-reported grades in school on a 4-point scale	Middle and high school buildings	Rate of athletic participation, mean student romantic activity, mean student peer involvement,	Risk of obesity, gender, age, race/ethnicity, family structure, parental education, athletic status,	

Table A-3

Summary of School Influences on Adolescent Academic Achievement Research Studies

Authors	Sample	Analytic Technique	Academic Achievement Operationalization	School Operationalization	School-Level Variables	Individual-Level Variables	Other Variables
	II				and mean BMI School-level controls: SES, racial and ethnic composition, and school level	and Wave I achievement	
Eamon (2005)	Latino adolescents aged 10 to 14 whose mothers participated in the National Longitudinal Survey of Youth	Hierarchical OLS regression	Peabody Individual Achievement Test reading comprehension and mathematics scores	School buildings	Overall school quality	Latino origin, gender, age, LEP, maternal characteristics (age when had first child, years of education completed, percentile score on Armed Forces Qualification Test, LEP, and U.S. born), and family characteristics (average adult-to-child ratio and poverty status)	Overall neighborhood quality and parenting processes (cognitive stimulation, parent-youth conflict, and academic involvement)

Table A-3

Summary of School Influences on Adolescent Academic Achievement Research Studies

Authors	Sample	Analytic Technique	Academic Achievement Operationalization	School Operationalization	School-Level Variables	Individual-Level Variables	Other Variables
Bowen & Bowen. (1999)	National probability sample of middle and high school students from the National School Success Profile data	Hierarchical OLS regression	Composite grade index that included grades and perceptions of grades relative to other students	Middle and high school buildings	Perceived school crime and violence and school personal threats	Gender, race/ethnicity, school level, free/reduced lunch status, and urbanicity	Negative neighborhood peer culture and neighborhood personal threats
Zand & Thomson (2005)	11-to-14 year old African American adolescents living in a large Mid-western city	Path analysis	Self-reported grades in school on a 5-point scale	School buildings	School bonding	Global self-worth	
Sanders (1998)	African American 8th-grade students in a South-eastern city	OLS Regression	Self-reported grades in school on a 4-point scale	Middle school buildings	Teacher support	Age, gender, poverty status, household structure, school behavior, academic self-concept, and	Parental support and church involvement

Table A-3

Summary of School Influences on Adolescent Academic Achievement Research Studies

Authors	Sample	Analytic Technique	Academic Achievement Operationalization	School Operationalization	School-Level Variables	Individual-Level Variables	Other Variables
Hoy & Hannum (1997)	8th graders in 86 New Jersey public middle schools	OLS Regression	New Jersey's Eighth Grade Early Warning Test reading, writing, and mathematics test scores	Middle school buildings	SES, academic emphasis, teacher affiliation, collegial leadership, resource support, principal influence, and institutional integrity	achievement ideology	None
Henderson et al. (2005)	10 Tennessee middle schools	Pearson Product Moment Correlation	Median national percentile scores in reading, language, mathematics, science, and social studies	Middle school buildings	Academic emphasis, teacher affiliation, collegial leadership, resource support, principal influence, institutional integrity, and overall org. health index score		None

Table A-3

Summary of School Influences on Adolescent Academic Achievement Research Studies

Authors	Sample	Analytic Technique	Academic Achievement Operationalization	School Operationalization	School-Level Variables	Individual-Level Variables	Other Variables
Lee et al. (1997)	First three waves of NELS:88 data	Growth - curve analysis	Gains in science and mathematics test scores	High school buildings	Structural practices, social organization, academic organization, and demographics	Math and science courses taken in high school, race/ethnicity, gender, SES, 8th-grade ability, and 8th-grade engagement	
Gill et al. (2004)	8th-grade students include in NELS:88 base year data	Hierarchical linear modeling	Mathematics standardized test scores	Middle school buildings	Student perceived school responsiveness, principal perceived demandingness and responsiveness, and mean SES	Gender, minority status, SES, and prior grades	

Table A-4

Summary of School Influences on Adolescent Risk of Obesity Research Studies

Authors	Sample	Analytic Technique	Risk of Obesity Operationalization	School Operationalization	School-Level Variables	Individual-Level Variables	Other Variables
O'Malley et al. (2007)	1991 to 2004 MTF data	Hierarchical linear modeling OLS regression	BMI	Middle school buildings and high school buildings	School type, school size, school SES, racial/ethnic composition	Grade, SES, race/ethnicity	Region and population density
Gortmaker et al. (1999)	6th-and-7th grade Boston area students	Generalized estimating equation method	Age-and-gender-adjusted composite indicator based on both BMI and a triceps skinfold measure \geq 85th percentile	Middle school classrooms	School-based intervention focused on reducing TV viewing, increasing physical activity, decreasing high-fat foods, and increasing fruit and vegetables	Age, gender, race/ethnicity, self-reported weight-loss behaviors, and baseline obesity status	
Neumark-Sztainer et al. (2003)	High school girls in the Twin Cities area who were	Mixed-model repeated-measures with schools as random	BMI	High school PE classes	School-based intervention focused on improving physical activity and	Baseline BMI, race/ethnicity, and grade level	

Table A-4

Summary of School Influences on Adolescent Risk of Obesity Research Studies

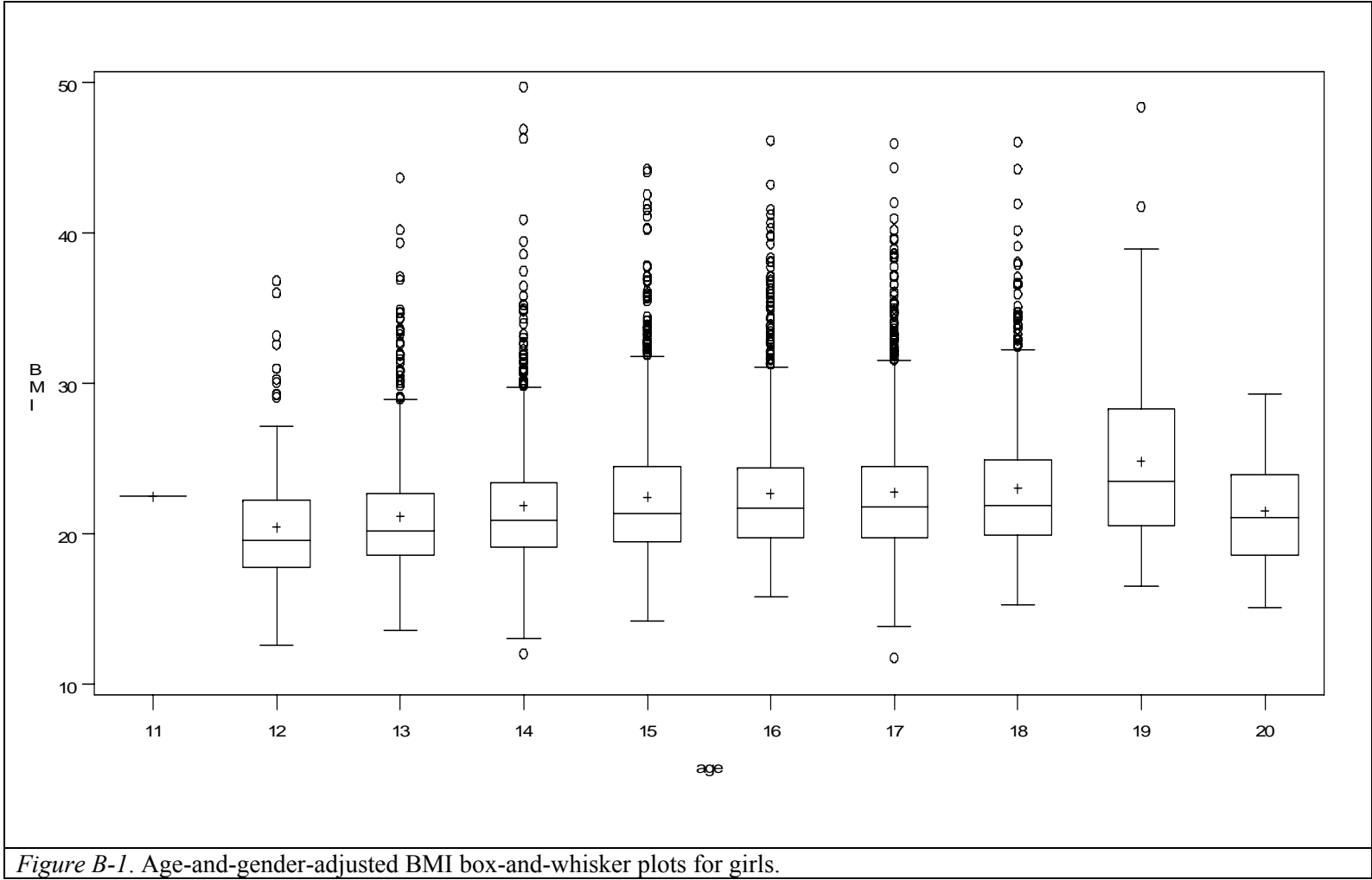
Authors	Sample	Analytic Technique	Risk of Obesity Operationalization	School Operationalization	School-Level Variables	Individual-Level Variables	Other Variables
	overweight or at-risk of being overweight	effects			eating behaviors and helping overweight girls feel good about themselves		
Sallis et al. (2003)	Students at 24 San Diego County middle schools	Randomized regression models	BMI	Middle school buildings	An environmental and policy focused school-based intervention aimed at increasing the availability of low-fat food choices and physical activity opportunities to promote healthful choices	Gender	
Scott et al. (2007)	6th-grade girls in 6 U.S. cities	Hierarchical linear modeling	BMI	School buildings located within a half-mile radius of participants home	School accessibility and amenities and percent of	Race and SES	Population density, SES index, and median

Table A-4

Summary of School Influences on Adolescent Risk of Obesity Research Studies

Authors	Sample	Analytic Technique	Risk of Obesity Operationalization	School Operationalization	School-Level Variables	Individual-Level Variables	Other Variables
				addresses in 6 U.S. cities	students on free or reduced lunch		year construction for each girl's block group Also, number of parks within study area and presence of one or more schools in each girl's area

Appendix B: BMI Box-and-Whisker Plots



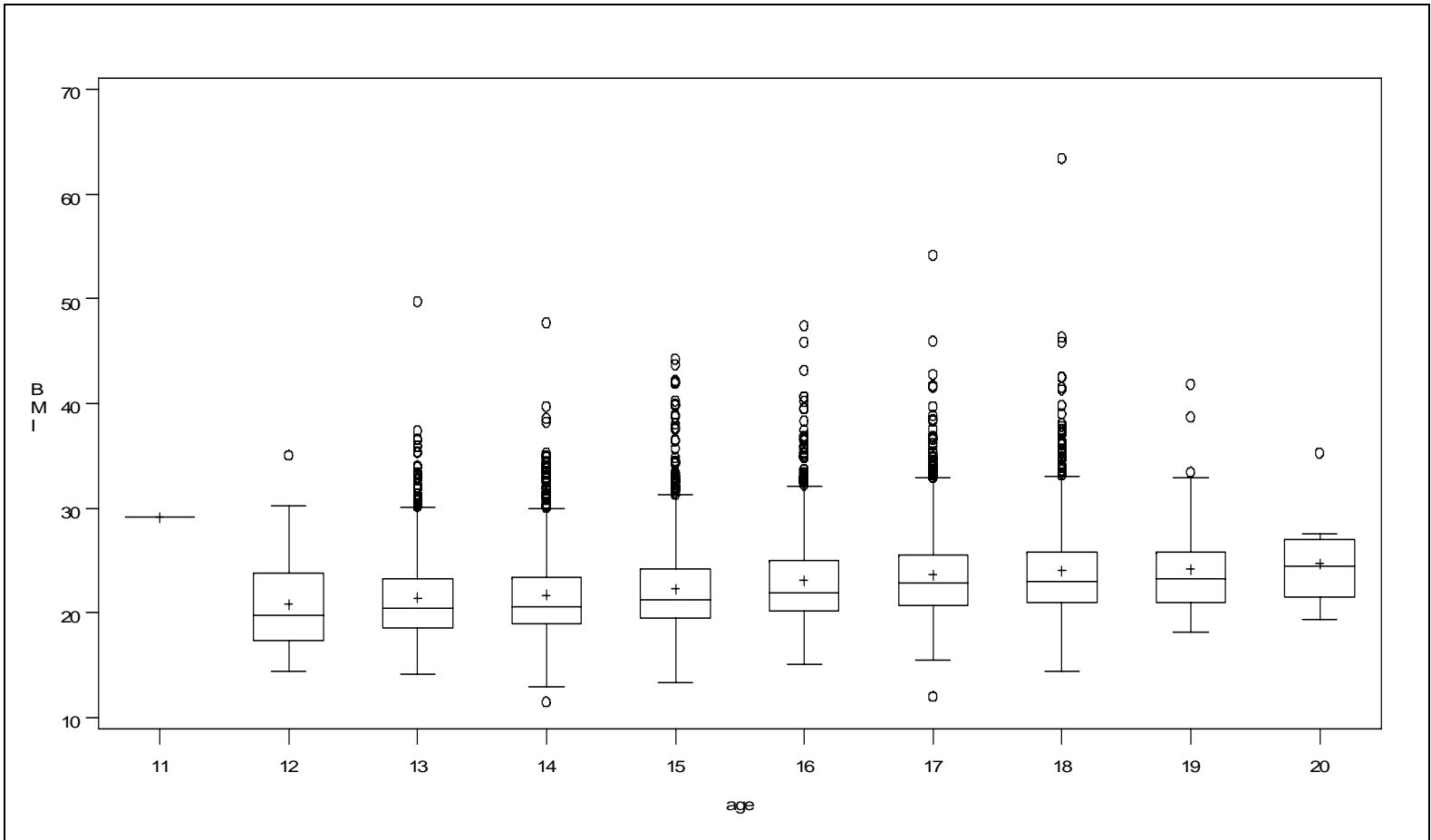


Figure B-2. Age-and-gender-adjusted BMI box-and-whisker plots for boys.

Appendix C: Analysis of Missing Data

Table C-1

Frequency of Missing Variables Across Observations in the Original Sample (n = 11,841)

Number of missing variables	Frequency	%
13	1	0.01
11	2	0.02
9	3	0.03
7	4	0.03
6	1	0.01
5	11	0.09
4	42	0.35
3	383	3.23
2	1500	12.67
1	2051	17.33
0	7842	66.23

Table C-2

Frequency of Missing Variables Across Observations after Deleting Cases Missing Household Income Data
(n = 9,919)

Number of missing variables	Frequency	%
9	3	0.03
8	1	0.01
7	1	0.01
6	1	0.01
5	6	0.06
4	2	0.02
3	36	0.36
2	427	4.30
1	2371	23.90
0	7071	71.29

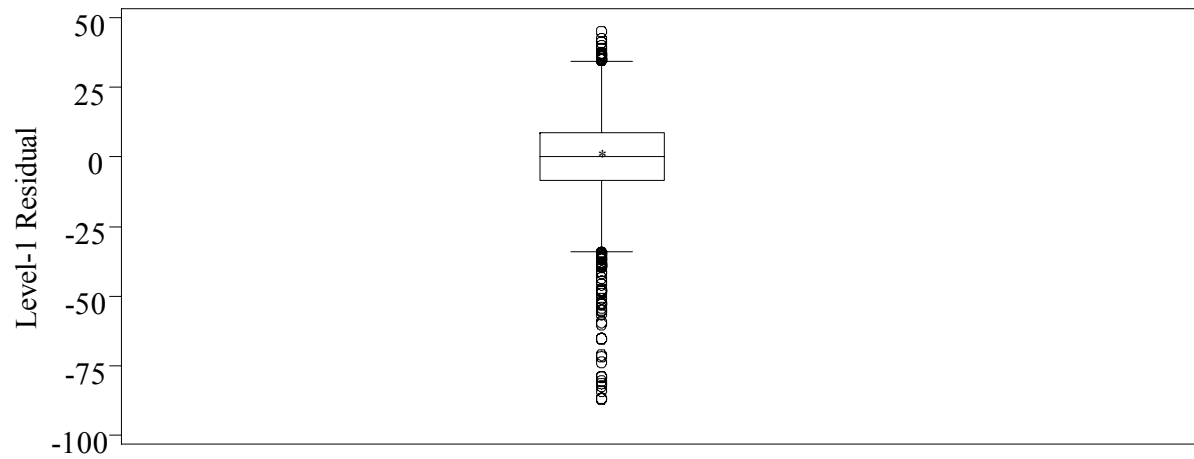
Note: For this analysis, adolescents who were missing household income were removed and adolescents whose parent refused to provide household income were marked as missing.

Appendix D: Investigation of Model Assumptions

Table D-1

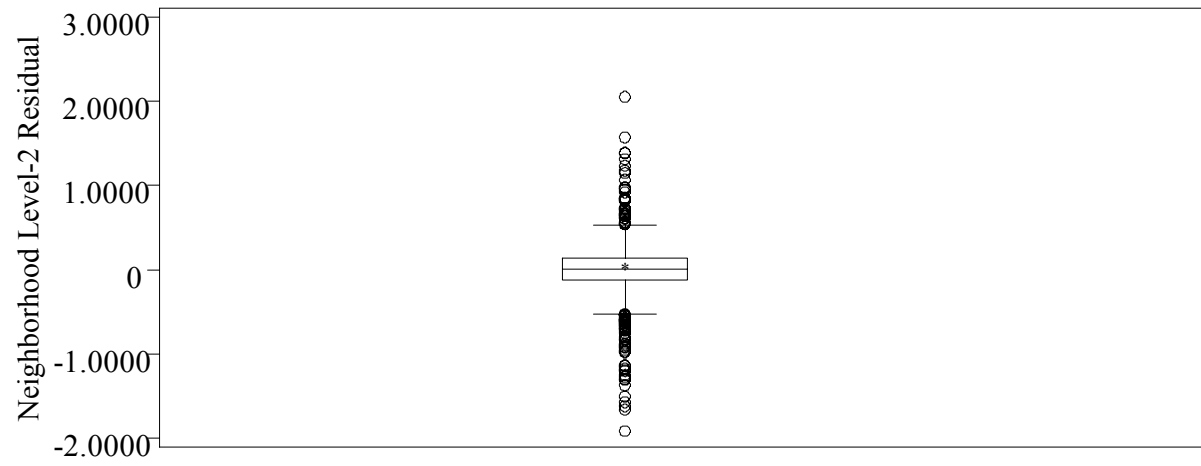
Tolerance Values for Each Variable Included in Academic Achievement CCREMs

Variable	Tolerance value
<i>Level-1 Model</i>	
Age	.99
Biological sex	.99
Race	.93
Family SES	.92
<i>Neighborhood Level-2 Model</i>	
Neighborhood affluence	.75
Neighborhood poverty	.77
Neighborhood racial composition	.91
Urbanicity	.89
<i>School Level-2 Model</i>	
School SES	.86
Teacher education	.83
Student body racial composition	.73
<i>Neighborhood & School Level-2 Model</i>	
Neighborhood affluence	.48
Neighborhood poverty	.72
Neighborhood racial composition	.38
Urbanicity	.76
School SES	.49
Teacher education	.78
Student body racial composition	.28



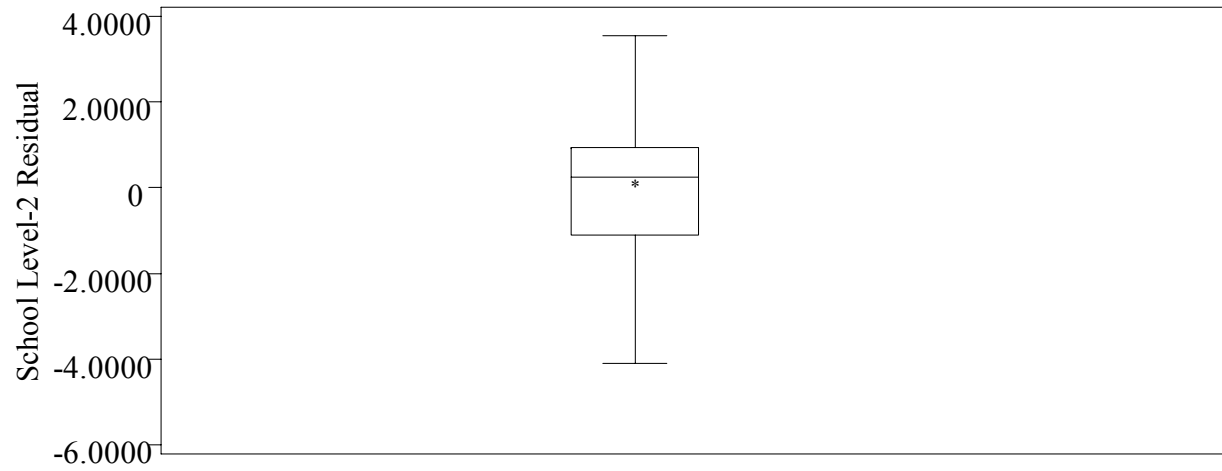
(sk = -0.37 , ku = 1.72)

Figure D-1. Box-and-whisker plot for Level-1 residuals (academic achievement).



(sk = -0.44, ku = 7.83)

Figure D-2. Box-and-whisker plot for Level-2 neighborhood residuals (academic achievement).



(sk = -0.21, ku = -0.06)

Figure D-3. Box-and-whisker plot for Level-2 school residuals (academic achievement).

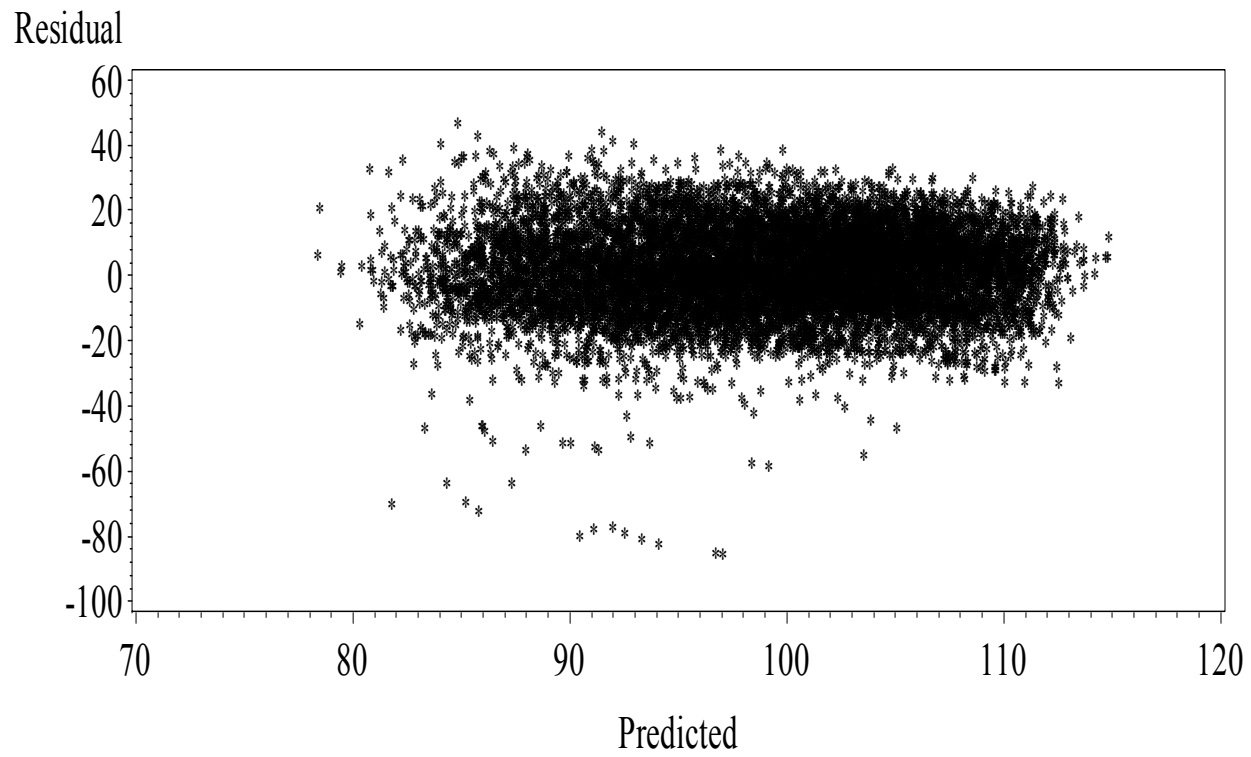


Figure D-4. Level-1 residuals*predicted academic achievement.

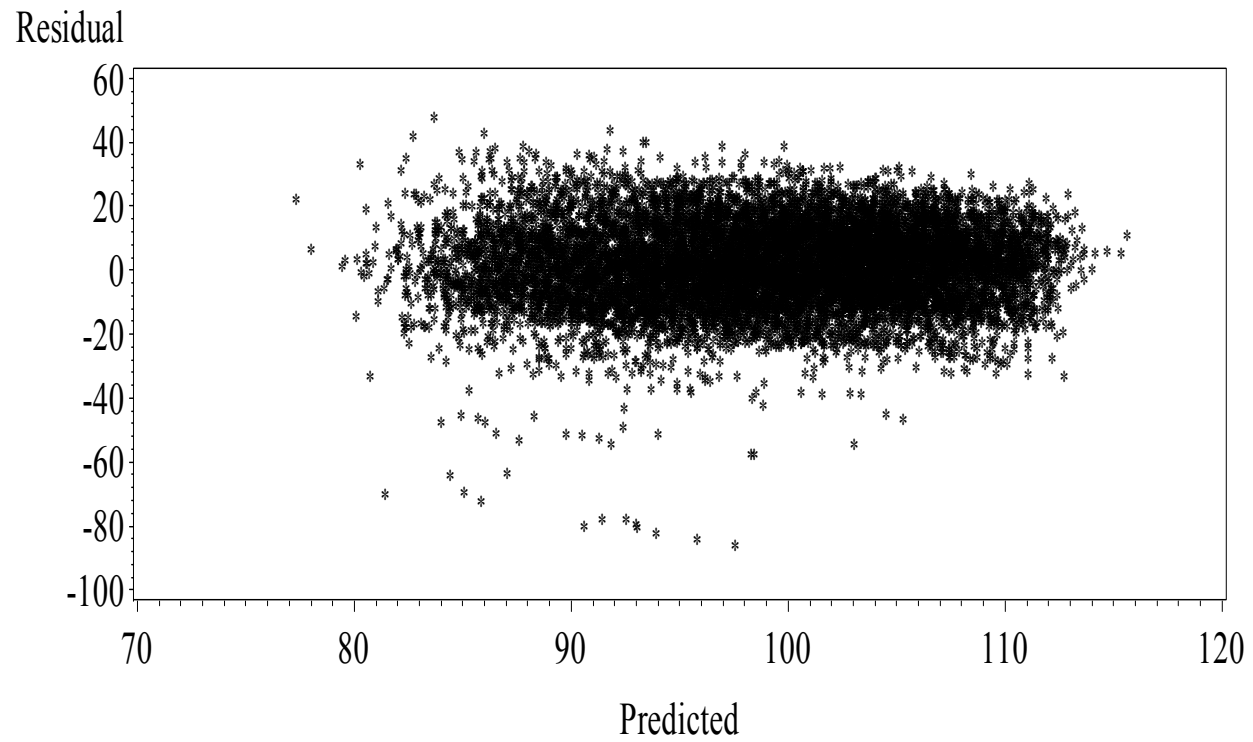


Figure D-5. Level-2 neighborhood residuals*predicted academic achievement.

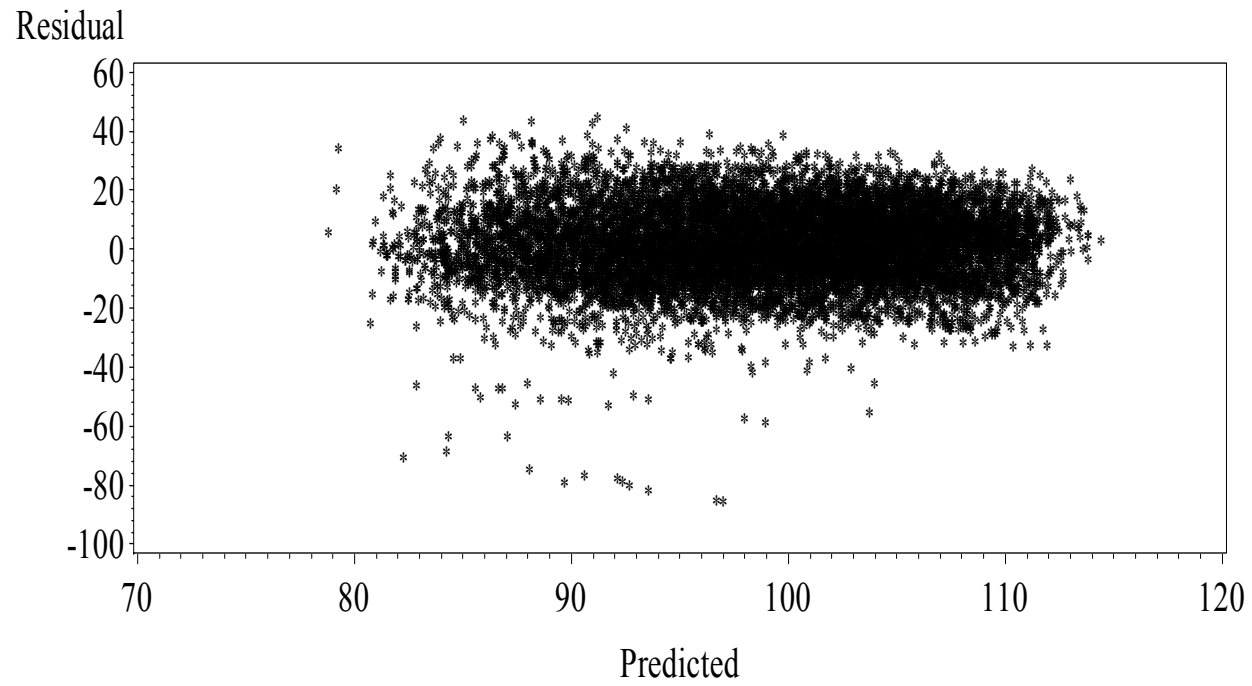
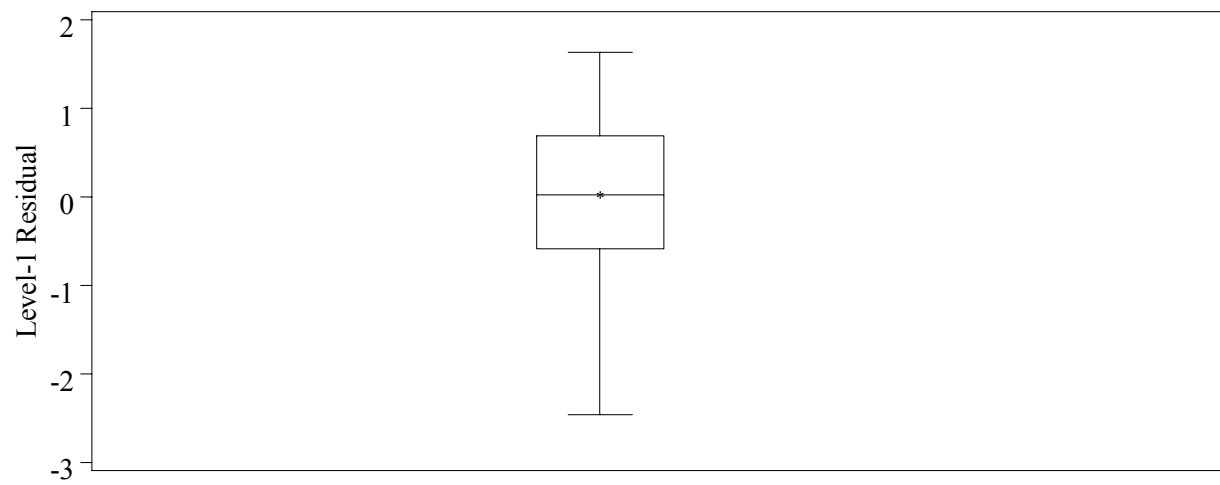


Figure D-6. Level-2 school residuals*predicted academic achievement.

Table D-2

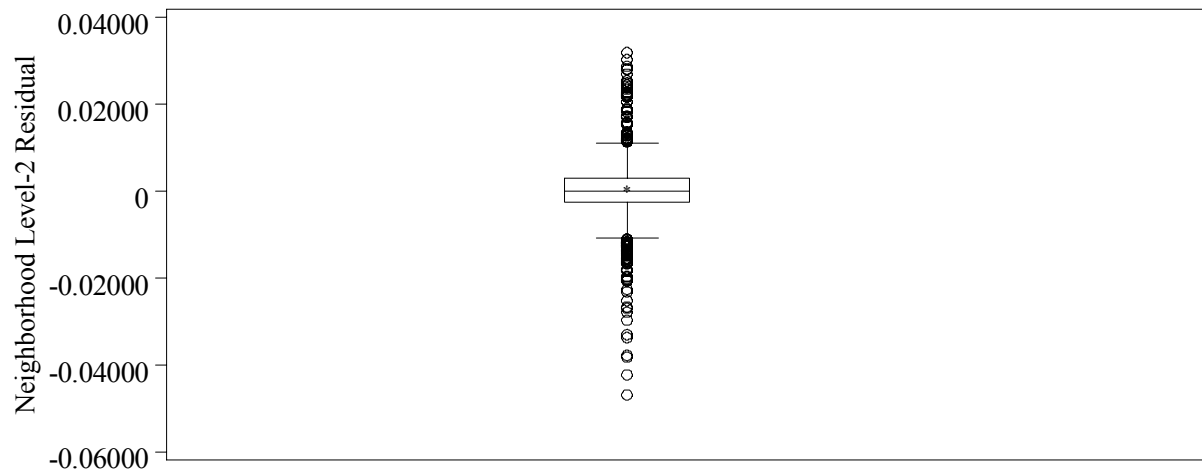
Tolerance Values for Each Variable Included in Risk of Obesity CCREMs

Variable	Tolerance value
<i>Level-1 Model</i>	
Age	.96
Biological sex	.99
Race	.93
Family SES	.92
Athletic participation	.95
<i>Neighborhood Level-2 Model</i>	
Neighborhood affluence	.75
Neighborhood poverty	.77
Neighborhood racial composition	.91
Urbanicity	.89
<i>School Level-2 Model</i>	
School SES	.90
Weight education	.90
School athletic participation	.99
<i>Neighborhood & School Level-2 Model</i>	
Neighborhood affluence	.49
Neighborhood poverty	.77
Neighborhood racial composition	.83
Urbanicity	.86
School SES	.54
Weight education	.79
School athletic participation	.99



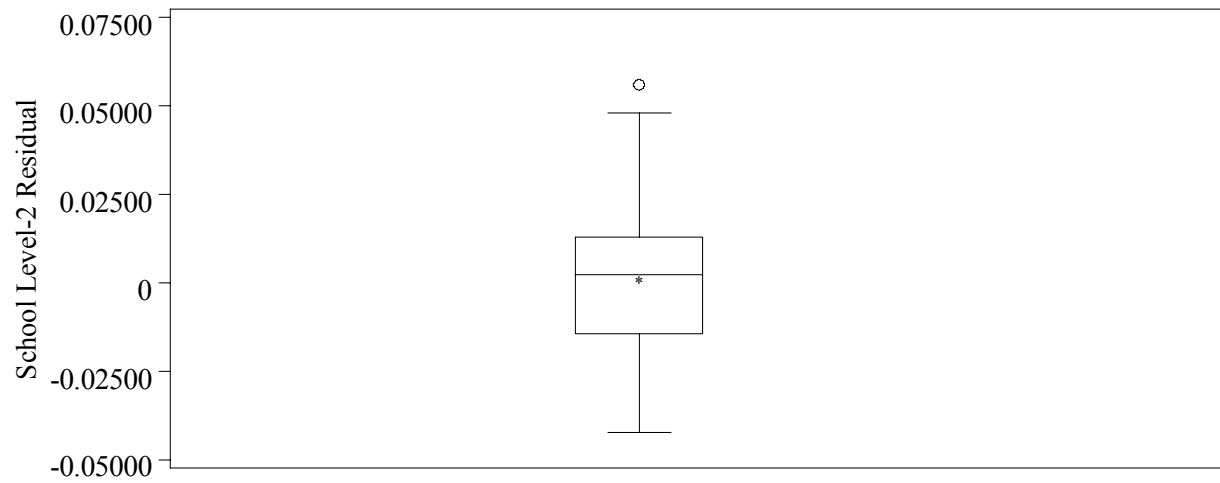
(sk = -0.32, ku = -0.58)

Figure D-7. Box-and-whisker plot for Level-1 residuals (risk of obesity).



(sk = -0.49, ku = 7.69)

Figure D-8. Box-and-whisker plot for Level-2 neighborhood residuals (risk of obesity).



(sk = 0.12 , ku = 0.28)

Figure D-9. Box-and-whisker plot for Level-2 school residuals (risk of obesity).

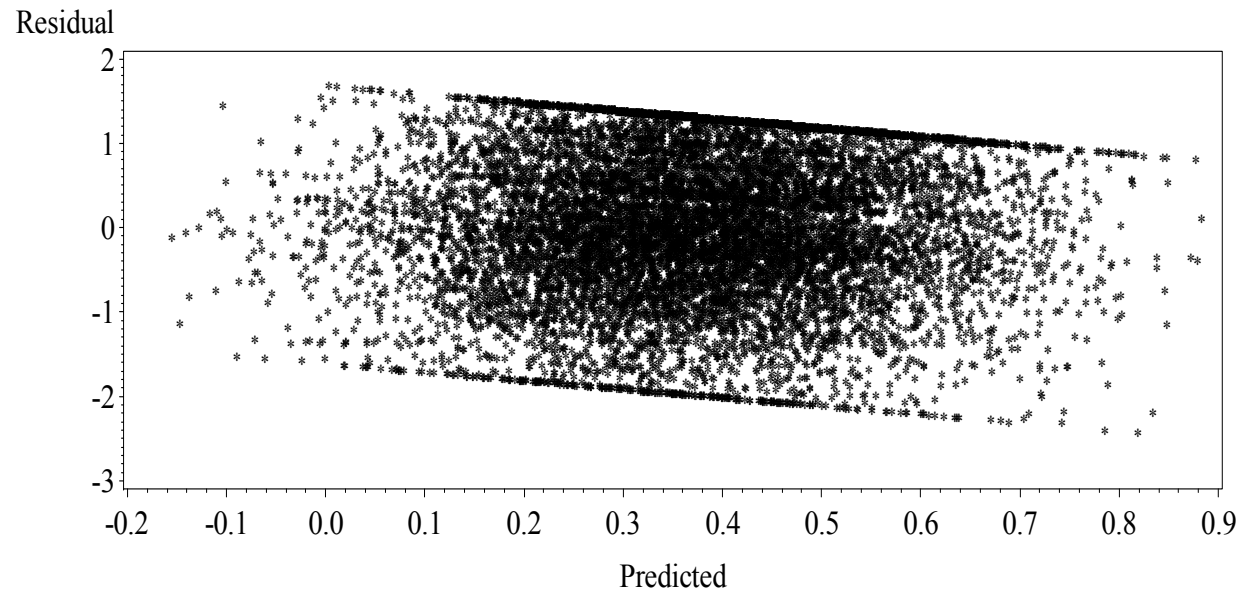


Figure D-10. Level-1 residuals*predicted risk of obesity.

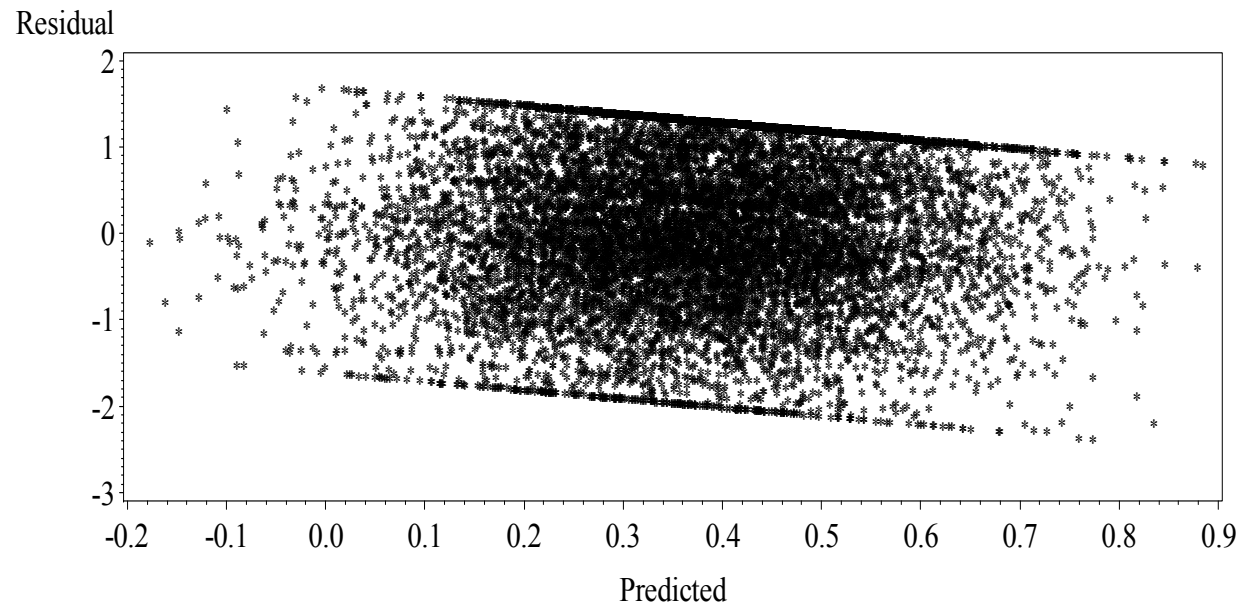


Figure D-11. Level-2 neighborhood residuals*predicted risk of obesity.

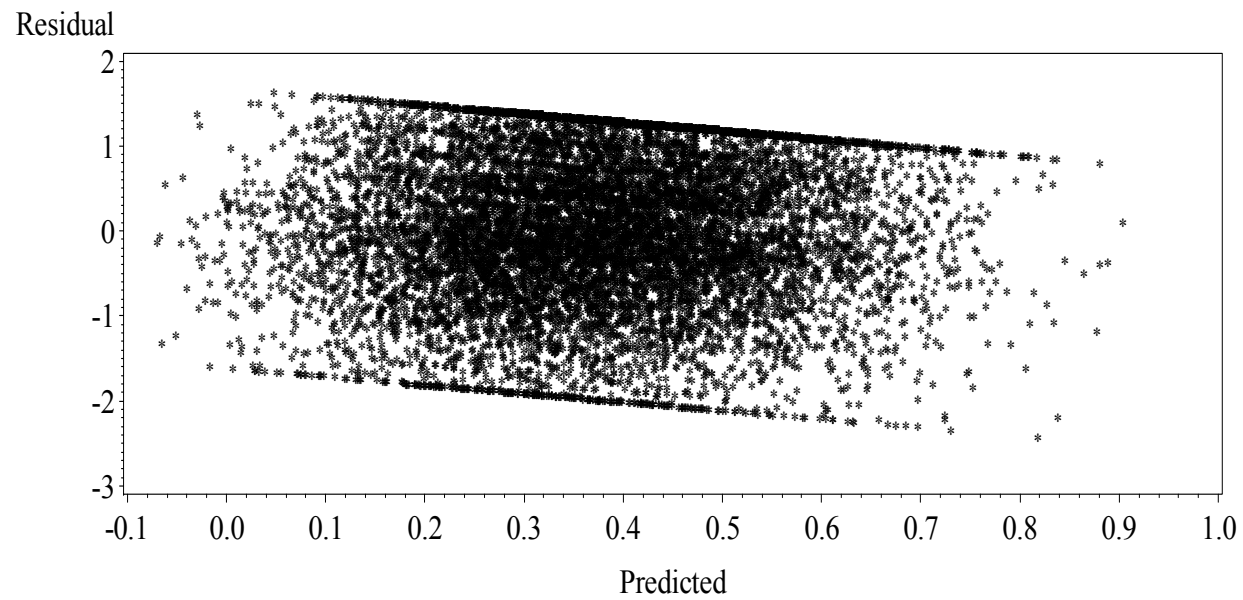


Figure D-12. Level-2 school residuals*predicted risk of obesity.

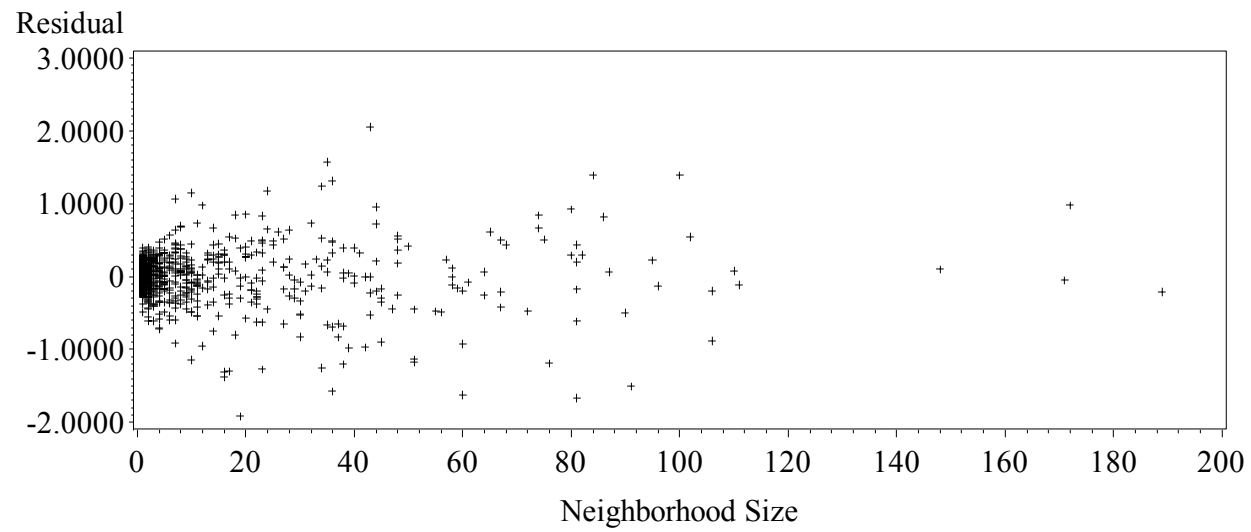


Figure D-13. Academic achievement neighborhood Level-2 residuals*neighborhood size.

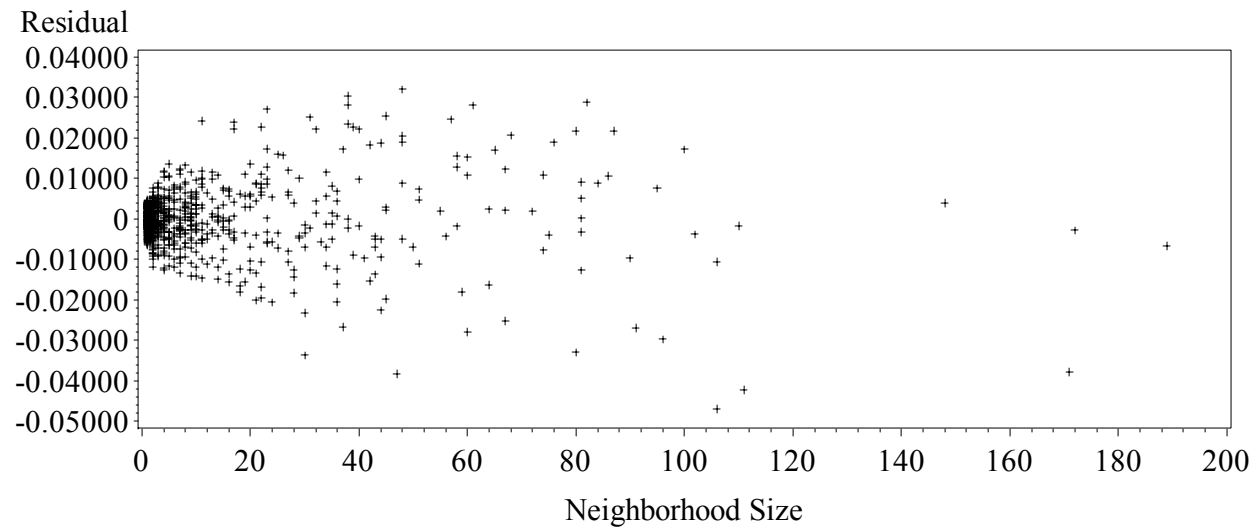


Figure D-14. Risk of obesity neighborhood Level-2 residuals*neighborhood size.

About the Author

Bethany A. Bell-Ellison received a Bachelor's Degree in Sociology from Mary Washington College in 1997. After working for AmeriCorps for two years and establishing the Oklahoma Caring Vans program, she attended graduate school at the University of Oklahoma Health Sciences Center where she received her MPH in 2002. Following the completion of her MPH, she began her Ph.D. program at the University of South Florida where her program of study focused on educational research methods and statistics and community and family health. Her applied research addresses issues related to educational equity, health disparities, and social determinants of child and adolescent development and her methodological research focuses on hierarchical linear modeling and complex sample data. Upon graduation, Ms. Bell-Ellison will be employed as an Assistant Professor of Educational Assessment, Research Methodology, and Statistics in the College of Education at the University of South Carolina.