**Multiple Levels of Social Disadvantage and its Links to Obesity Risk in Adolescence and Young Adulthood**

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The striking disparities in burden of illness and death experienced by racial and ethnic minorities, despite improvements in the overall health of the nation, are a serious public health concern facing our country (CDC 2006; DHHS 2006; NIH 2000). Growing racial/ethnic and socioeconomic differences in the prevalence of obesity and the morbidity and mortality due to obesity have become a major focus in eliminating health disparities. The highest rates of obesity occur among the most disadvantaged population groups, racial and ethnic minorities, (Flegal et al. 2002; Ogden et al. 2002) and those with the highest poverty rates and the least education (DHHS 2000; Drewnowski & Specter 2004; Schoenborn et al. 2002). Disparities in overweight/obesity trends between both racial and ethnic minorities and whites and the poor and non-poor, appear early in childhood and increase dramatically during adolescence and in the transition to adulthood (Gordon-Larsen et al. 2004a; Harris et al. 2006; McTigue et al. 2002; Ogden et al. 2002; Serdula et al. 1993). In addition, racial and ethnic minorities are disproportionately poor and low educated (Iceland 2003), compounding their disadvantage. Because adolescence is a critical period when lifestyle and health-related behaviors are established and because the transition period from adolescence to young adulthood is a time of high risk for the development of obesity (Gordon-Larsen et al. 2004a; McTigue et al. 2002), understanding the role social disadvantage plays in influencing obesity risk is critical to understanding racial/ethnic and socioeconomic health disparities in these outcomes.

The relationship between social disadvantage and health outcomes is complex because disadvantage operates at multiple levels of social context to affect health (Bravemen et al. 2005; Robert 1999; Sampson et al. 2002; Swinburn et al. 1999;Yen & Syme 1999). The life course (Elder et al. 1995; Elder et al. 1985) and ecological perspectives (Bronfrenbrenner and Morris 1998) both contain arguments that social disadvantage should be measured at multiple ecological levels, over time, and via different processes. Capturing the complex and dynamic nature of the social context of disadvantage is especially important when studying the transition to adulthood (Elder 1997; Shanahan 2000) as well as health development, including the development of chronic diseases such as obesity (Ben-Schlomo and Kuh 2000; Halfon and Hochstein 2002; Lynch and Smith 2005). A large amount of research exists that demonstrates the importance of neighborhood, school and family contexts in affecting health and health behaviors (Diez-Roux 2000; Goodman et al. 2003; Harding 2007; IOM 2001; Kawachi & Berkman 2003; Kirby & Kaneda 2005; Pickett & Pearl 2001; Stafford & Marmot 2003). There is also a growing amount of research linking family, neighborhood and school contexts to obesity and physical activity outcomes (Boardman et al. 2005; Cummins & Macintyre 2005; Dietz & Gortmaker 2001; Frumkin 2006; Gordon-Larsen et al. 2000; IOM 2005; Janssen et al. 2006; Lowry et al. 1996; Morenoff et al. 2006; Richmond et al. 2006; Robert & Reither 2004; Sallis et al. 2006; Wickrama et al. 2006). In general, the research shows that the more disadvantaged a family, community or school, the more likely an individual is to be obese or less physically active. The research also highlights the independent contextual effects of each level of the social

environment. Therefore, a better understanding of the relationship between socioeconomic disadvantage and obesity will entail capturing these multiple levels of disadvantage.

Although less studied in relationship to obesity and physical activity outcomes, peer context is also an important influence on health and health behaviors, especially in adolescence and the transition to young adulthood (Borsari & Carey 2001; Bronte-Tinkew 2005; Christakis and Fowler 2007; Giordano 2003; La Greca et al. 2001; Perry 2000; Prinstein et al. 2001; Sallis et al. 2000; Zakarian et al. 1994). During adolescence peer influences increase as peer groups become more autonomous and less neighborhood-based, (Brown 1990; Giordano 2003) and continue to strengthen during the lifecycle transition to adulthood (Bronte-Tinkew 2005). Peers function as credible sources of information, role models of new social behaviors, sources of reinforcement, and bridges to alternative lifestyles (Brown 1990). In addition, community influences can originate in neighborhoods, schools, or other organizations and can operate through adolescents' peer groups. Including peer group measures in analysis using school level measures helps to disentangle the larger context of school composition effects from smaller group context of peer relations in a school, an issue previous research in this area has not been able to address due to data set limitations. In addition, as individuals age, these multiple contexts broaden and deepen and serve to channel and reinforce influences into health trajectories (Halfon & Hochstein 2002; NRC 2004). Because multiple levels of disadvantage operate simultaneously, it is important to model all levels of social context to determine what levels of disadvantage are most salient in determining obesity risk in adolescence and young adulthood.

This paper investigates the relationship between multiple levels of social disadvantage in childhood and adolescence and obesity in adolescence and young adulthood using multilevel models (Raudenbush & Bryk 2002a; 2002b) and nationally representative data from the National Longitudinal Study of Adolescent Health (Add Health). Social disadvantage operates at different levels of social context (e.g. family, peers, school and neighborhood) and interdependently. Multilevel models can capture these multiple levels of social disadvantage simultaneously. Multilevel models can also explicitly recognize the clustering of individuals and adjust for the correlation among individuals who share the same context to correct for their lack of independence. These analyses will:

(1) Create measures of socioeconomic disadvantage at the individual, family, peer, school and neighborhood levels.

(2) Determine how contextual disadvantage varies by race/ethnicity, sex and poverty status.

(3) Investigate the bivariate relationships between each level of contextual disadvantage and risk of obesity.

(4) Investigate the unique influence of each level of disadvantage on the risk of obesity in adolescence and adulthood using multivariate multilevel modeling.

(5) Examine interactions between individual, peer and school levels of disadvantage to determine if higher levels of contextual poverty operate via peer influences to impact obesity risk in adolescence and adulthood.

This study of contextual disadvantage and its relationship to health is unique in that it attempts to model multiple levels of social context and its relationship to obesity; something previous research on environmental effects and health has not done. Multilevel models are used to account for the nesting of individuals in schools (the highest level of social context in this analysis) and peer and neighborhood level measures serve as controls.

**Conceptual Model**

The conceptual model for these analyses draws from the life course and ecological frameworks. The fundamental assumption of this model is that an individual's obesity risk is dynamic (changeable over time) and affected by multiple aspects of his/her social environment. In this model (See Figure 1), an individual's family, peers, school and neighborhood represent overlapping environments that influence individual obesity, both directly and in interaction with each other, over time, from adolescence and into young adulthood. Although these influences overlap in this conceptual model, they represent ever larger aspects of an individual's social world which all take place within the political, economic and cultural constraints of the nation. This model is derived from the Committee on Evaluation of Children's Health (NRC 2004) conceptualization of the dynamic process of multiple, interacting influences on the evolution of children's health.

**Data**

Data come from the National Longitudinal Study of Adolescent Health (Add Health), which is an ongoing nationally representative, school-based study of adolescents in grades 7 to 12 that began in 1994. It was designed to explore the causes of health-related behaviors, with an emphasis on the influence of social context. In 1994 Add Health administered an In-School Questionnaire to every student attending school from a nationally representative sample of schools. A sample of 80 high schools and 52 middle schools from the U.S. was selected using a stratified cluster design. A subsample of individuals in these schools participated in the In-Home Interview in 1995 (Wave I), given an average of eight months after the In-School Survey, and again in 1996 (Wave II). In Wave III (2001-02) Wave I respondents were re-interviewed.

A parent, generally the mother, was also interviewed in Wave I. In-home adolescent questionnaires were administered by computer-assisted personal interview (CAPI), as well as computer-assisted self-interview (CASI) for more sensitive questions. Ultimately, 20,745 in-home interviews were completed in Wave I; 17,713 parents answered child specific questions and 17,669 answered parent specific questions (more than one child was interviewed in some households). 14,738 in-home interviews were completed in Wave II (the seniors in Wave I were not followed-up). In Wave III 15,197 eligible original Wave I respondents completed the survey. In Wave I, the age of participants ranged from 12 to 19 years, in Wave II from 13 to 20 years and Wave III from 18 to 26 years.

Over 70% of the schools originally selected for the survey participated. Of the adolescents sub-sampled for the in-home questionnaires, 78.9% participated in Wave I. Parent interviews are available for 85% of these respondents. Of those eligible for participation in Wave II, 88.2%

completed in-home interviews. Of those eligible for participation in Wave II, 77.4% completed in-home interviews.

In the In-School Questionnaire students were asked to nominate up to 5 male and 5 female friends and to locate and record their student ids from the school roster. Because the in-school sample was a saturated sample, with nearly all children in the school interviewed, the identification numbers of nominated friends can be linked back to their own in-school questionnaire and characteristics of a respondent's peer group can be determined, such as its racial/ethnic makeup. In a similar fashion, school-level measures can be derived by aggregating the responses of the In-School Questionnaire for all students in their respective schools. In addition, contextual data containing information on the characteristics of the neighborhoods and communities in which Add Health sample members lived in Waves I and II have been linked to individual-level records.

The fact that the data set is longitudinal and nationally representative, with extensive measures of socioeconomic status, health, race and ethnicity among other factors and the ability to create measures at multiple levels of social context, makes it an ideal data set to investigate the relationship between poverty and obesity in adolescents. Harris et al. (2003) provides a more detailed description on the Add Health Study.

This study uses data from the Wave I In -Home and Parent Questionnaires as well as the follow-up Wave II and III surveys. This analysis is therefore limited to adolescents who participated in all three waves of the study, have completed Parent Questionnaires, school information, and have complete measured height and weight data. Exclusions included seriously disabled respondents and pregnant females. After applying these data constraints and deleting the few cases with missing data on covariates, the final study sample contains 7,562 (3,933 females and 3,629 males).

**Measures**

Table 1 provides means and standard errors of all measures used in this analysis for the sample by sex.

*Individual Level Measures and Controls*

**Race/Ethnicity:** Add Health allows for rich detail in measures of race and ethnicity. Race/ethnicity is self-reported at Wave I and is classified into five race and ethnic groups: non-Hispanic white (reference group), non-Hispanic black, Hispanic, Asian, or other racial/ethnic group. I control for race/ethnicity because of its possible confounding effects with socioeconomic status.

**Sex:** This measure is constructed from responses in the Wave I In-Home Questionnaire. This measure was crosschecked with WII and WIII responses. I divide the full sample by sex for this analysis.

**Age:** Age is a continuous measure of self-reported age at WI. Age ranges from 11 to 21 years of age.

**Parent Obese:** Using self-reports from the Parent In-Home Questionnaire, a respondent was coded as having an obese parent if either their biological mother and/or biological father were reported as being obese. Parental obesity is used as a control to account for the genetic predisposition for obesity. 21% of the sample has an obese parent.

*Socioeconomic Disadvantage*

The measures of socioeconomic disadvantage used in this analysis are measured at the family, peer, school and neighborhood level. Family level socioeconomic disadvantage is measured in two ways using welfare status and parent education. Family structure is used as a control. Peer and school disadvantage are measured using parent education. Neighborhood level disadvantage is measured by the education level of adults in the census tract. I will also control for racial heterogeneity at the neighborhood level. Because school and neighborhood contexts overlap considerably and may be highly correlated, I will explore whether there are distinct neighborhood social disadvantage effects in supplementary analysis that include both school and neighborhood or exchange these two measures.

Parent education is used as a measure of socioeconomic disadvantage for multiple reasons. There is a well-established and robust positive relationship between education and a variety of health outcomes (Antonovsky 1967; Crimmins and Saito 2001; Kitagwa and Hauser 1973; Ross and Wu 1995; Vargas, Ingrim and Gillum 2000). Education is a socioeconomic indicator that is particularly likely to capture aspects of behavior and lifestyle (Shavers 2007). Parental education, related to poverty and family structure, may also affect parental monitoring, with more educated parents doing a better job at monitoring their children (Lareau 2003), especially behaviors that directly relate to obesity such as physical activity and eating patterns. Further, the education of parents directly affects food and diet quality (Cade & Booth 1990). People with higher education levels have a greater awareness of health issues and are better able to make healthy food choices for their children. This is especially relevant during adolescence when lifestyle and health-related behaviors are established.

*Family Level Disadvantage and Controls*

**Welfare Status:** Welfare status is a dichotomous indicator of any welfare receipt before the age of 18. This measure is constructed from data on the family's receipt of public assistance or welfare from Waves I and II during adolescence in combination with a retrospective report at Wave III on the receipt of welfare and public assistance prior to the age of 18. This measure includes report of welfare usage at WII to account for any welfare receipt prior to the age of 18. This measure serves as a proxy for poverty status. I chose a welfare-based measure of poverty over an income-based measure due to the large proportion of missing data on income (≈ 20%). 22% of the total sample received welfare prior to the age of 18.

**Parental Education Less than High School:** Using data from the Wave I Parent Questionnaire, parents' education is measured as the higher of either mother's or father's education. A

respondent is considered disadvantaged of their highest educated parent has less than a high school degree or equivalent (i.e., GED). 9% of the sample has a parent with less than a high school degree.

**Family Structure:** There is rich detail on family of origin living arrangements. Adolescents are classified as those who live with two biological or adoptive parents (reference category), a stepfamily (biological mother and step father or a biological father and step mother), single mother, single father, and surrogate or foster parents (including grandparents, aunts and uncles, other adult relatives, or nonrelative adults). I control for family structure because of its possible confounding effects with socioeconomic status.

*Peer Level Disadvantage and Controls*

**Peer Parental Education Less than High School:** Continuous measures of percentage of students in a respondent's peer group (as nominated by the respondent) that come from a family where the highest educated parent received less than a high school degree or GED. An average of 7% of a respondent's peer group has a highest educated parent with less than a high school degree.

**No Peer Information:** This measure serves as a control measure for respondents who had no friendship info because they reported no friends or reported non-school friends. Missing friendship level measures are substituted using respondents' school level means.

*School Level Disadvantage*

**School Parental Education Less than High School:** Continuous measures of percentage of students in a respondent's school that come from a family where the highest educated parent has less than a high school degree or GED. An average of 8% of a respondent's school peers has a highest educated parent with less than a high school degree.

*Neighborhood Level Disadvantage and Controls*

**Neighborhood Adult Education Less than High School:** Continuous tract level measure of the proportion aged 25 years and over with no high school diploma or equivalency. An average of 27% of the adult individuals living in a respondent's census tract do not have a high school diploma or equivalent.

**Neighborhood Racial Heterogeneity:** Continuous tract level measure of dispersion in racial composition (using the racial categories of white/black/other), based on census definition.

I account for neighborhood racial dispersion due to links between neighborhood racial composition and obesity in previous research (Boardman et al. 2005; Wickrama et al. 2006).

**Urban Tract:** Categorical measure to designate if respondent lives in an urbanized area from Wave I context data. About half of the sample lives in an urbanized tract.

*Outcome Variable*

**Obesity at WII and WIII**

I use body mass index or BMI to measure obesity. BMI is a tool for indicating weight status in adults, computed by dividing an individual's body weight in kilograms by the square of his or her height in meters (i.e., weight/(height)$^2$). BMI is more highly correlated with body fat than any other indicator of height and weight (NRC 1989). For adults over 20 years old, BMI falls into one of four categories: underweight, normal, overweight and obese. Adults with a BMI of 25 to 29.9 are categorized as overweight. Adults with a BMI of 30 or more are considered obese (NHLBI 1998, WHO 2000).

BMI is defined differently for children and adults. Age- and sex-specific BMI percentiles are used as growth references during childhood and adolescence because BMI changes at different rates by age and sex during normal developmental growth. In the United States, the 85$^{th}$ and 95$^{th}$ percentiles, based on nationally representative data from the 2000 growth curves of the Centers for Disease Control and Prevention (CDC), have been recommended for use in classifying persons as being overweight or at risk of overweight (CDC 2004). However, definitions of overweight based on these percentiles are not directly comparable to the adult definitions of obesity using specified cut points (NHLBI 1998, WHO 2000).

The ability to generate comparable prevalence measures between adult and adolescent measures of obesity or to calculate obesity incidence over the transition period of adolescence to young adulthood is limited by discrepancies between adolescent and adult definitions. The International Obesity Task Force (IOTF) developed BMI curves, which link childhood and adolescent BMI centiles to adult cut off points of BMI of 25 and 30 kg/m$^2$, and thus, allow greater consistency in the youth versus adult definitions. The BMI curves provide good comparative reference data during this transitional period (Cole et al. 2000). Because I investigate the incidence of obesity in adolescence and young adulthood, I use the IOTF measures to determine obesity status among adolescents and young adults in this analysis.

Using the IOTF cutoffs, I define obesity at Waves II and III using BMI calculated from measured height and weight[4]. I identify individuals as obese if their BMI falls above the age- and sex-specific, IOTF 30 kg/m$^2$ cutpoint in adolescence at Wave II. For the young adults at Wave III, we consistently use the adult BMI cut point of 30 kg/m$^2$. At Wave 11% of the sample was obese and at Wave 23% of the sample was obesity, indicating a doubling in the prevalence of obesity in this sample in only 2 years.

**Analytical Design**

The analytical design is derived from the conceptual model (See Figure 1). Longitudinal data from three waves of Add Health are used to measure obesity in adolescence and young adulthood and to measure factors operating during adolescence that serve to influence these trajectories. Outcomes of interest include obesity at WII (adolescence) and WIII (young adulthood). Factors influencing obesity are measures of individual, family, peer, school and

neighborhood context at WI, in addition to ascribed social characteristics such as race/ethnicity and sex, also measured at WI. This design exploits the longitudinal data and incorporates the temporal order of effects (i.e. factors operating during adolescence prior to the transition to adulthood), which is a necessary first step in establishing a causal relationship. A longitudinal design also allows for the measurement of factors operating in adolescence and the influences this has on obesity outcomes in later adolescence and young adulthood. Although a longitudinal design also allows for measurement of change in obesity status from adolescence and into young adulthood, it is important to first investigate how multiple levels of disadvantage at WI operate to affect obesity risk at WII and WIII, separately. If significant relationships are found at both WII and WIII then future analyses will be employed to investigate the relationship between multiple levels of contextual risk and obesity trajectories from adolescence into young adulthood.

**Analytical Approach**

All analyses will use STATA survey procedures with sampling weights to adjust for the clustered sample design and unequal probability of selection to ensure the results are nationally representative and that bias in standard errors are reduced. The SAS GLIMMIX macro will be utilized for multilevel analysis. Because research suggests that disadvantage might operate differently in affecting obesity risk for males and females (Lee et al. 2005), analyses will also be run in samples stratified by sex.

Table 2 shows the percentage of respondents obese at WII and WIII by each of the measures of social disadvantage that will be used in these analyses. There is a stronger association between family level disadvantage for females compared to males, as has been evidenced in previous research (Lee et al. 2005). 34% of females with a (highest educated) parent who has less than a high school diploma or equivalent are obese at WIII compared to only 22% of females with a (highest educated) parent who has at least a high school diploma or equivalent. Among males, 25% of males with a parent with less than a high school education being obese at WIII compared to 22% of males with a parent with at least a high school education being obese at WIII. Similarly, the relationship between disadvantage and obesity is stronger for females at the peer, school and neighborhood level. However, the strength of this relationship becomes more comparable between males and females at the school and neighborhood level. The strong relationships evidenced between disadvantage and obesity at each level of social context highlight the importance of investigating multiple levels of disadvantage when investigating the relationship between poverty and obesity.

Analysis follows the five research aims listed at the outset of the paper. To explore variation in contextual disadvantage, the proportion of disadvantaged individuals at each level of social context will be calculated by individual poverty, race/ethnicity and sex. For example, the proportion of a respondent's peers with parentl education less than a high school diploma will be compared across racial/ethnic groups. Chi-square analyses will be performed to test for differences between subgroups. As a further step in the descriptive phase of this aim, bivariate logit models will be employed to investigate the relationship between each level of contextual disadvantage and the likelihood of being obese in adolescence and young adulthood.

Multilevel modeling (Raudenbush & Bryk 2002a; 2002b) will then be used to investigate the unique influence of each level of disadvantage on obesity risk in adolescence and young adulthood. Multilevel models explicitly recognize the clustering of individuals and adjust for the correlation among individuals who share the same context to correct for their lack of independence. This analysis will employ a two-level model, individuals serve as level 1 and schools serve as level 2. Peer context is associated with individuals (level 1) given that peer groups are nominated from respondents' nominations. Neighborhoods can be conceptualized as being nested within schools (level 2), given the school-based sampling design of Add Health and the fact that neighborhood level data are matched to individual respondents.

The SAS GLIMMIX macro is used to estimate multilevel generalized linear models with a logit link and a binary distribution. To illustrate the analytic techniques used in this analysis, assume a model with only two levels of observation: individual and school. The multilevel model for binary outcomes is conceptually similar to traditional logistic regression with the addition of a school-level error component ($u_j$). Error across schools is measured by this school level (level 2) residual term, which is assumed to be normally distributed with an expected value of 0 and an unknown variance of $\sigma^2_u$ (Little et al. 1996; McCulloch & Searle 2001). The following equation represents a multilevel equation for the probability of being obese, allowing obesity to vary across schools and including an individual level explanatory variable ($x_{ij}$).

$$\log\left[\frac{P_{ij}}{1-P_{ij}}\right] = \beta_0 + \beta_1 x_{ij} + u_j \quad \text{(Model 1: Combined Model)}$$

Model 1 is known as the combined model and can alternatively be represented by 2 models.

$$\log\left[\frac{P_{ij}}{1-P_{ij}}\right] = \beta_{0j} + \beta_1 x_{ij} \quad \text{(Model 2: Level 1)} \qquad \beta_{0j} = \beta_0 + u_j \quad \text{(Model 3: Level 2)}$$

Model 1 captures the probability ($P_{ij}$) that the *i*th individual in the *j*th school is obese. These models can then be reduced to an additive model in the form of a single equation represented by Model 1. The extent to which residual variation in the log-odds of obesity is situated within or between schools can be estimated by the variance of the level 2 residual ($\sigma^2_u$). The ratio of the level 2 residual variance to the overall residual variance ($\sigma^2_u + \sigma^2_e$) measures the intraclass correlation. The variance of the standard logistic regression ($\Pi^2/3$ ) has been suggested to estimate level 1 residual variance when modeling binary outcomes (Guo & Zhao 2000; Snijders & Bosker 1999). Model 4 represents a multilevel equation including individual ($x_{ij}$) and school level ($w_j$) explanatory variables. $\log\left[\frac{P_{ij}}{1-P_{ij}}\right] = \beta_0 + \beta_1 x_{ij} + \beta_2 w_j + u_j$ (Model 4)

For these analyses, models will also include measures at the peer and neighborhood level. Cross-level interaction effects between individual, peer, and school level disadvantage will be employed to determine if higher levels of contextual poverty operate via peer influences to impact obesity risk.

*Modeling Plan*

As discussed earlier, variables are grouped into individual and family-level variables, peer group-level, school-level and neighborhood-level variables. The most basic model (Model 1) for

analysis in this study only includes an intercept term (the null model), which is used to calculate the unadjusted intraclass correlation coefficient for obesity. Model 2 includes the individual and family-level variables for race/ethnicity, age, parental obesity status, family structure and socioeconomic disadvantage. Here, controlling for individual characteristics accounts for the aggregation effects of individual characteristics that are confounded with school-level measures (Manski, 1993). School level socioeconomic disadvantage is added in Model 3 as a second-level of the multilevel model. Neighborhood level variables are included in Model 4 mainly as controls. Peer group-level measures are added in Model 5. Variables that interact family-level disadvantage (measured in terms of parent education) with school-level disadvantage are added in Model 6. Variables that interact family-level disadvantage with peer group-level disadvantage are then added in Model 7. These series of models are run separately for obesity at WII and WIII.

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**TABLES AND FIGURES**

Figure 1. Conceptual Model

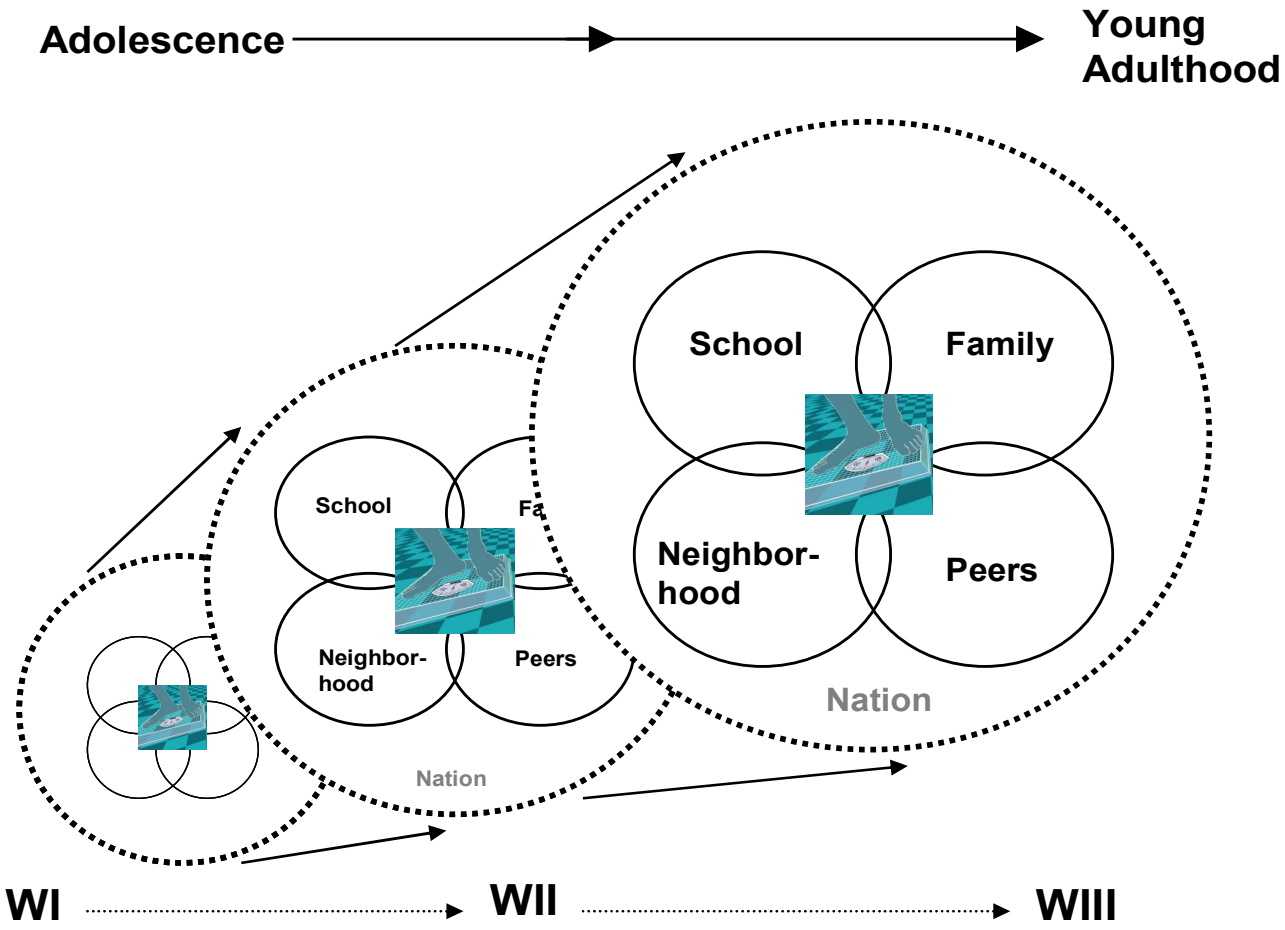

**Table 1. Variable Descriptions, Means and Standard Deviations by Sex**

| | | Female | | Male | |
|---|---|---|---|---|---|
| Variable | Description | Mean | SD | Mean | SD |
| ***Outcomes*** | | | | | |
| **Obesity** | | | | | |
| Obese at Wave II | Obese at Wave II | 0.10 | 0.007 | 0.12 | 0.008 |
| Obese at Wave III | Obese at Wave III | 0.23 | 0.012 | 0.22 | 0.010 |
| ***Individual Level Measures*** | | | | | |
| **Ethnic Minority Status** | | | | | |
| Non-Hispanic White (Reference Category) | Respondent reported white | 0.70 | 0.031 | 0.69 | 0.032 |
| Non-Hispanic Black | Respondent reported black | 0.16 | 0.024 | 0.14 | 0.022 |
| Hispanic | Respondent reported Hispanic | 0.10 | 0.015 | 0.10 | 0.016 |
| Asian | Respondent reported Asian | 0.04 | 0.008 | 0.05 | 0.011 |
| Other | Respondent reported other race. | 0.01 | 0.002 | 0.01 | 0.003 |
| **Age** | Self-reported age at WI. | 14.85 | 0.118 | 15.05 | 0.129 |
| **Parent Obese** | Report of mother or father being obese | 0.21 | 0.009 | 0.22 | 0.010 |
| ***Family Level Measures*** | | | | | |
| **Welfare Status** | Welfare receipt prior to the age of 18 | 0.23 | 0.014 | 0.22 | 0.014 |
| **Parent Education Less than High School** | Highest educated parent completed less than high school or GED | 0.10 | 0.010 | 0.09 | 0.010 |
| **Family Structure** | | | | | |
| 2 Biological Parents (Reference Category) | 2 Biological/Adoptive Parents | 0.60 | 0.015 | 0.61 | 0.016 |
| Step family | Step family | 0.16 | 0.008 | 0.16 | 0.007 |
| Single mother | Single mother | 0.19 | 0.011 | 0.17 | 0.012 |
| Single father | Single father | 0.02 | 0.004 | 0.03 | 0.003 |
| Other family structure | Other family structure | 0.03 | 0.004 | 0.03 | 0.005 |
| ***Peer Level Measures*** | | | | | |
| **Parent Education Less than High School** | Proportion of peers with highest educated parent completed less than high school or GED | 0.07 | 0.006 | 0.06 | 0.006 |
| ***School Level Measures*** | | | | | |
| **Parent Education Less than High School** | Proportion of school students with highest educated parent completed less than high school or GED | 0.08 | 0.005 | 0.08 | 0.005 |
| ***Neighborhood Level Risk*** | | | | | |
| **Adult Education Less than High School** | Proportion of individuals 25 years or older who completed less than high school or GED | 0.27 | 0.009 | 0.27 | 0.009 |
| **Racial Dispersion** | Continuous tract level measure of dispersion in racial composition | 0.25 | 0.020 | 0.24 | 0.020 |
| **Urban Tract** | Categorical measure to designate if respondent lives in an urbanized area | 0.47 | 0.045 | 0.46 | 0.045 |
| N | | 3,933 | | 3,629 | |

Data are weighted.

**Table 2. Associations Between Disadvantage Measures and Obesity Status at Waves II and III by Sex**

| | Female | | Male | |
|---|---|---|---|---|
| | **Obese Wave II** | **Obese Wave III** | **Obese Wave II** | **Obese Wave III** |
| ***Family Level Measures*** | | | | |
| **Welfare Status** | | | | |
| No | 0.09 | 0.21 | 0.12 | 0.21 |
| Yes | 0.13 | 0.31 | 0.13 | 0.25 |
| **Parent Education Less than High School** | | | | |
| No | 0.10 | 0.22 | 0.12 | 0.22 |
| Yes | 0.13 | 0.34 | 0.12 | 0.25 |
| ***Peer Level Measures*** | | | | |
| **Parent Education Less than High School** | | | | |
| Less than 12% | 0.08 | 0.21 | 0.11 | 0.22 |
| 12% or more | 0.15 | 0.30 | 0.15 | 0.23 |
| ***School Level Measures*** | | | | |
| **Parent Education Less than High School** | | | | |
| Less than 10% | 0.10 | 0.21 | 0.09 | 0.22 |
| 10% or more | 0.15 | 0.29 | 0.12 | 0.28 |
| ***Neighborhood Level Risk*** | | | | |
| **Adult Education Less than High School** | | | | |
| Less than 37% | 0.09 | 0.21 | 0.11 | 0.20 |
| 37% or more | 0.15 | 0.32 | 0.16 | 0.28 |
| **N** | 3,933 | 3,933 | 3,629 | 3,629 |

Data are weighted.