**Race, Ethnicity, & Gender Disparities in the Embedding and Accumulation of Childhood Poverty on Young Adult BMI**

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## Abstract

**Purpose:** A disproportionate number of race/ethnic minorities are both impoverished and overweight compared to white populations. Experiencing poverty during childhood is positively correlated with being obese in adulthood, especially for females. However, it is unclear whether it is the *embedding* of childhood poverty (i.e. timing of childhood poverty in relation to children's stage of development) or the *accumulation* (i.e. duration) of the exposure to childhood poverty which contributes to the race and gender disparities in young adult body mass index (BMI).

**Method:** Data from the 1979 National Longitudinal Study of Youth and the Children and Young Adult file were used to explore the relationship between the exposure to childhood poverty from prenatal year to age 18 and weight status in young adulthood (N = 3,517). Models were stratified by race/ethnicity and logistic regression models were used to assess the embedding and accumulation of childhood poverty on body mass index in young adulthood. The final models included a term interacting poverty and gender and a number of child, mother, and household covariates, including indicators for the intergenerational transmission of body weight and poverty.

**Results:** The findings indicated that both the embedding and accumulation of childhood poverty contributes to race, ethnic, and gender disparities in young adult weight status. Findings indicates that the embedding of childhood poverty (during early adolescence) and the accumulation of childhood poverty lowers the odds that white males will be overweight as young adults. In contrast, experiencing poverty during infancy places black males at risk for being overweight as young adults. The weight status of young adult white, black and Hispanic females was negatively influenced by the accumulation of childhood poverty. Neither the embedding model, nor the accumulation model, of childhood poverty significantly predicted the overweight status of Hispanic males in young adulthood.

**Conclusions:** Helping impoverished families out of poverty may not only improve the immediate economic circumstances of families, but also improve the long-term health status of their children as young adults.

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**Introduction**

One of the most significant health concerns the U.S. is facing is the sky-rocketing increase in obesity over the past several decades. For instance, five percent of U.S. children between the ages of 2 and 19 were classified as obese between 1971-1974 compared to 17% in 2007-2008 (Ogden & Carroll, 2010). Among adults, the prevalence of obesity has increased from 13% to 32% between 1960 and 2004 (Wang & Beydoun, 2007). Obesity in adulthood has been associated with negative health consequences such as Type 2 diabetes, cardiovascular disease, hypertension, and high cholesterol (Deckelbaum & Williams, 2001; Mokdad et al., 2003); however, a number of obesity-related complications are beginning to be observed in obese children and adolescents (Daniels, 2009). Obesity and obesity-related complications follow a socio-economic gradient with the highest prevalence rates among individuals with the highest poverty rates and among individuals with the lowest education (Drewnowski & Specter, 2004; Paeratakul, Lovejoy, Ryan, & Bray, 2002). Consequently, a disproportionate number of individuals that are low-income and have lower levels of education compared to white populations are race and ethnic minorities, specifically blacks or African Americans and Hispanics (Simms, Fortuny, & Henderson, 2009).

In the US, experiencing poverty or low socioeconomic status during childhood is positively correlated with overweight status during childhood and adolescence (Goodman, 1999; Haas et al., 2003; Miech et al., 2006; Strauss & Knight, 1999; Wang, 2001; Wang & Zhang, 2006), as well as during adulthood (Goldblatt, Moore, & Stunkard, 1965; Langenberg, Hardy, Kuh, Brunner, & Wadsworth, 2003; Olson, Bove, & Miller, 2007; Power, Manor, & Matthews, 2003; Scharoun-Lee, Kaufman, Popkin, & Gordon-Larsen, 2009). Most studies that have

examined that effect of childhood poverty on young adult weigh status have measured poverty at one point in time. There is a dearth of US-based studies that have used a child lifespan approach to capture multiple measures of poverty throughout childhood (Ziol-Guest, Duncan, & Kalil, 2009) or for some amount of childhood (Wells, Evans, Beavis, & Ong, 2010). Although previous research has suggested that low socio-economic status is a contributing factor to the race and ethnic disparities in obesity (Gordon-Larsen, Adair, & Popkin, 2003; Powell, Wada, Krauss, & Wang, 2012; Scharoun-Lee, Adair, Kaufman, & Gordon-Larsen, 2009; Scharoun-Lee, Kaufman, et al., 2009; Trotter, Bowen, & Beresford, 2010; Wang & Beydoun, 2007; Zhang & Wang, 2004a), and that poverty is a contributing factor to the gender disparities in obesity (Laaksonen, Sarlio-Lahteenkorva, & Lahelma, 2004; Lee, Harris, & Gordon-Larsen, 2009), it is unclear whether it is the *embedding* of childhood poverty (i.e. timing of childhood poverty in relation to children's stage of development) or the *accumulation* (i.e. duration) of the exposure to childhood poverty which contributes to the race, ethnic, and gender disparities in young adult body mass index (BMI). In the current study, we explore the embedding and accumulating effects of childhood poverty on BMI in young adulthood paying close attention to race and ethnicity and gender differences.

*Race, ethnic and gender differences*

Although the association between socio-economic status and obesity has weaken in the past four decades as the prevalence of obesity has increased (Zhang & Wang, 2004b), we continue to observe a disproportionate number of minorities (except Asian Americans) and low-income individuals who are overweight (Schiller, Lucas, Ward, & Peregoy, 2012; Wang & Beydoun, 2007). A closer examination between the poverty-obesity relationship displays that the prevalent race/ethnicity differences are more pronounced among females. While low-income

non-Hispanic white, Hispanic, and African American adolescent males have similar overweight prevalence rates, low-income African American adolescent females have a higher overweight prevalence rate compared to low-income non-Hispanic white adolescent females (Gordon-Larsen, et al., 2003). Several of studies have observed the inverse relationship between poverty or low socioeconomic status and obesity among non-Hispanic white females (Gordon-Larsen, et al., 2003; McLaren, 2007; Wang & Zhang, 2006), while the prevalence of overweight status for African American females remains high after increases in socio-economic status (Gordon-Larsen, et al., 2003).

Further, the transition period from adolescence into young adulthood has been observed to be a risk period for weight gain among females and blacks, and particular black females (Gordon-Larsen, Adair, Nelson, & Popkin, 2004; Harris, Perreira, & Lee, 2009; Lee, Lee, Guo, & Harris, 2011). Because of this, a small group of studies have focused on the effect of poverty on obesity during the transition from adolescence into young adulthood. The research suggests that poverty and multidimensional measures of socioeconomic status have a positive effect on obesity of adolescent females, but not males, during the transition to adulthood (Lee, et al., 2009; Scharoun-Lee, Adair, et al., 2009). For instance, greater levels of "social advantage" are inversely associated with obesity for white and Hispanic females; however, greater levels of "economic hardship" are positively associated with obesity for white and Asian females (Scharoun-Lee, Adair, et al., 2009). In addition, adolescent females exposed to persist economic adversity are at greater risk for obesity in adulthood (Scharoun-Lee, Kaufman, et al., 2009). There has not been a significant amount of research that has investigated race, ethnic and gender differences at other developmental periods in relation to the poverty-obesity association.

*Theoretical framework*

The life course perspective (Elder, 1998; Shanahan, 2000) provides a framework to understanding the race, ethnic, and gender differences in the embedding and accumulating effects of childhood poverty on BMI. One of the central tenants of the life course perspective focuses on how the *embedding* and *accumulation* of events can influence a developmental outcome, such as obesity. For instance, research in epidemiology proposes that the timing of events is critical to understanding their effects on children rather than the duration of an event (Elder, 1998). Specifically, the fetal origins hypothesis suggests that the programming that occurs in utero and during infancy has a long-term effect on adult health (Barker, 1990). Early childhood is seen as a critical period during which adversity can become *embedded* or *programmed* into an individual's biological system. The embedded adversity then persists across the lifespan and heightens the probability for poor health to develop.  For example, Barker proposed that fetal undernutrition in middle and late gestation is associated with disproportionate fetal growth which programs the body for later disease (Barker, 1995). Research has demonstrated that experiencing early childhood poverty (Wells, et al., 2010), especially poverty during the prenatal and birth years (Ziol-Guest, Duncan, & Kalil, 2009), is detrimental to adult BMI.  A limitation of embedding models is that they typically focus on stressors that occur early in development, as a result there is a limited amount of research that has consider stressors that occur later on (e.g., Ziol-Guest et al 2009). Further, studies that have found the association between early childhood poverty and increased levels of BMI in adulthood have not included measures of poverty at the time the outcome of interest is assessed. Controlling for poverty at the time that the outcome is assessed is necessary to demonstrate that early childhood is particular important developmental period for which poverty influences BMI. Further, race and ethnic and

gender disparities has not been closely investigated in the assessment of when poverty occurs in relation to developmental time periods and young adult obesity.

Life course perspective also emphasis that the accumulation of adversity can lead to poor health. The risk literature postulates that children who reside in poverty for long periods face greater adverse development compared to children who reside in poverty for shorter periods or do not experience poverty at all (Duncan, Brooks-Gunn, & Klebanov, 1994; McLeod & Nonnemaker, 2000; McLeod & Shanahan, 1993). Several studies have found that the number of years spent in poverty is related to various negative health outcomes for children and adults (Evans & Kim, 2007; McDonough & Berglund, 2003; Seguin, Nikiema, Gauvin, Zunzunegui, & Xu, 2007), but more research is needed regarding the association between duration of childhood poverty from prenatal to age 18 (i.e. child lifespan) and race, ethnic, and gender disparities in young adult BMI.

*Current Study*

By taking a life course perspective (Elder, 1998; Shanahan, 2000), we explore the embedding and accumulating effects of childhood poverty on BMI in young adulthood controlling for factors that predict both poverty and weight status. Specifically, the current study (1) examines the embedding of poverty by focusing the stage(s) of development at which children are exposed to childhood poverty and overweight status in young adulthood and (2) examines the association between the accumulation of childhood poverty from prenatal to age 18 and overweight status in young adulthood. To capture the race and ethnic and gender disparities, all models are stratified by race and ethnicity and the final models will include a term interacting poverty and gender.

The following study contributes to the literature and has the potential to influence obesity intervention programs. The longitudinal, multi-generational nature of the data provides an opportunity to include maternal and household covariates that may be related to young adult's weight status at age 20 but are often unavailable in large survey data. For instance the intergenerational transmission of poverty and (maternal) obesity is pertinent to the research question but often times unavailable in data. Further, the focus on the timing of poverty exposure and the accumulation of poverty may have important implications for interventions. For example, the findings may indicate that a particular developmental stage predicts childhood overweight status for particular race, ethnic, and gender groups. In other words, the findings may indicate that a particular race/ethnic and gender group is vulnerable to the effects of poverty on young adult BMI at a particular developmental time point, signaling a target population in need of intervention services. On the other hand, if the findings indicate that poverty has an accumulating effect on obesity for particular race, ethnic, and gender groups, then all the children of the particular race, ethnic, and gender group who experiences one or more exposure to childhood poverty may be at risk for being overweight in young adulthood and would benefit from intervention services.

**Methods**

*Data*

Data for this study come from the National Longitudinal Survey of Youth 1979 (NLSY79) and the linked Children and Young Adults file (CNLSY). NLSY data are sponsored by the U.S. Department of Labor and have been compiled through the Ohio State University Center for Human Resource Research.  The original NLSY79 data includes a nationally representative sample of 12,686 men and women followed from 1979-2010. The CNLSY has

surveyed the biological children of these women every two years since 1986 and represents over 90 percent of all the children born to this cohort.

*Analytic Sample*

A total of 11,491 children were born to 4,928 NLSY79 mothers between 1970 and 2010. The child sample was restricted to young adults who were at least 20 years old by 2010 (2961 children were excluded because they were too young), had valid BMI data (2770 cases excluded), and were not pregnant during the BMI assessment (864 cases excluded). Because we were interested in capturing measures of poverty during the prenatal period, cases that had incomplete data on measures used to calculate poverty (i.e. income) or measures highly correlated to poverty were excluded. For instance, young adults were excluded from the sample if they had incomplete data on household income from the prenatal year to age 18 (696 cases) or young adults whose mothers were not pregnant with them during the course of the study (this was necessary to calculate prenatal poverty, 239 cases). Last, children were included if information on their mother's relationship status prior to the child's birth as single mother households correlate to higher rates of poverty (excluded 444 cases). The final analytic sample consisted of 3,517 young adults who were born between 1980-1990 (mean = 1985).

*Measures*

*Body Mass Index*

Direct assessment of young adults' height (feet and inches) and weight (pounds) was collected biennially starting in 1994 in the CNLSY. BMI was then calculated based on the first valid survey year in which young adults were 20 years of age or older. The continuous BMI measurements were categorized into the reference criteria for adults outlined by the Center for Disease Control [i.e. underweight (BMI < $18.5$ kg/m$^2$), normal weight (BMI = $18.5$-$24.9$ kg/m$^2$),

overweight (BMI = 25.0-29.9 kg/m$^2$), and obese (BMI >=30.0 kg/m$^2$)].(Center for Disease

Control and Prevention, 2011)  The BMI categories were then used to create three dichotomous

dependent variables where the primary focus was to predict the higher BMI category, where

BMI was at least 25 kg/m$^2$ or higher: (1) obese versus overweight; (2) overweight versus normal

weight; (3) obese/overweight versus normal weight. Thus, not all young adults in the analytic

sample are included in each of the three dependent variables.

*Duration and developmental timing of childhood poverty*

Measures of poverty in the NLSY79 were created by the Center for Human Resource

Research, based on annual household income, family size, and the yearly poverty guidelines

from the U.S. Department of Health and Human Services. Poverty data is available annually

from 1979 – 1994 and biennially from 1996 - 2008. As with most data sets, numerous NLSY79

women did not report their annual household income, which resulted in missing data for the

poverty measure (range from 5% to 20% across the waves). However, the NLSY79 also gauged

women's participation in different public assistance programs; the information regarding

maternal receipt of public assistance programs was used to impute missing household poverty

data wherever possible. Mirroring methods employed by McLeod and Shanahan (1996) and

Mossakowski (2008), young adults were categorized as "experiencing poverty" if their mothers

reported receipt of Aid to Families with Dependent Children (AFDC) or food stamps (FS) for

each wave missing valid information on household poverty status. Similarly, young adults were

categorized as "not experiencing poverty" if their mothers reported they did not receive public

assistance for the wave in which household poverty status was missing. This reduced the overall

level of missing cases for the household poverty measure (<1% across the waves). While this

imputation method does present bias, mothers who were living poverty at any given wave were

11 to 80 times more likely to receive AFDC or food stamps than mothers not living in poverty (mean = 46).

Because children born earlier during the survey (i.e. children born in the late 1970's and early 1980's) have more available poverty data compared to children born later during the survey (mid 1980's and onward), the duration of poverty measure was calculated based on the number of *survey waves* (rather than the number of years) the income of the household was below 100% of the Federal Poverty Line (FPL). We based childhood poverty from the year before the child was born (the prenatal year) to the year in which the child turned 18. For each young adult, the number of survey waves he/she experienced poverty as a child was summed and then divided by the total number of available survey waves of poverty data. Therefore, the duration of poverty measure represents the percentage of waves a young adult experienced poverty from the year before their birth to the end of their childhood (when they turned 18).

Further, to explore if the relationships between poverty and young adult BMI depended on the developmental timing of which household poverty occurred, several variables were created which capture experiences with poverty at *specific stages* of child development. These variables were broken into the following stages of child development: the year prior to birth to the child's first birthday (infancy); from age 2 to 5 years (early childhood); from age 6 to age 10 years (middle childhood); from age 11 to age 14 years (early adolescence); and from age 15 to age 18 years (late adolescence). These categories are not mutually exclusive, and capture the time at which poverty occurred according to stages of child development; thus all categories were included in regression models.

*Gender and Race/ethnicity*

Young adults' gender was reported by their mothers at time of birth (1=female; 0 = male). Young adults' race/ethnicity is based on their mothers' response to the question in the1979 survey wave [White (reference), Hispanic, Black].

*Child, Mother, and Household Characteristics*

A set of child, mother, and household characteristics were incorporated as covariates in the models to reflect selection factors that could influence both childhood poverty as well as overweight status in young adulthood. Child characteristics: young adults age at BMI assessment (in years), elevated depressive symptoms [1994 Center for Epidemiological Studies Depression Scale (CES-D); 1 = $\geq 75^{th}$ percentile; 0 = < $75^{th}$ percentile; (Radloff, 1991)], positive self-esteem [1994 Rosenberg Self-esteem Scale (RSE); (Rosenberg, 1965)], and low birth weight (1 = low birth weight; 0 = not low birth weight). Mother characteristics: age at child's birth (in years), relationship status at child's birth (1 = partnered; 0 = single), highest education completed at age 23 (years of schooling), employment status at child's birth (1 = employed; 0 = not employed), and maternal BMI at age 20 (Strauss & Knight, 1999; Gordon-Larsen, Adair, Suchindran, 2007). Household characteristics include number of siblings (in reference to the child) and family poverty status at year of BMI assessment.

*Statistical Analysis*

Weighted descriptive analyses were conducted on non-imputed data; while regression models were conducted on imputed data using STATA version 11.0 statistical software (StataCorp LP, College Station, Texas). Mean differences were conducted using analysis of variance for continuous variables and chi-square tests for dichotomous variables. Prior to conducting multivariate OLS and logistic regression models, multiple imputation techniques were used to impute missing data. Specifically, missing values on two covariates (< 1.0 % of the

values) were imputed using switching regression, an interactive multivariable regression imputation technique. The multiple imputation technique created five imputed data sets. A strength of multiple imputation is that all relevant cases are kept in the analyses for accurate parameter estimates and the standard errors are corrected for the amount of missing information. This is in comparison to listwise deletion, which results in a sample that no longer represents the population (Graham, 2009; Graham & Schafer, 1999).

Multivariate logistic regression models were conducted on the imputed data to predict clinical cutoffs for categorizing adults as overweight or obese. The odds ratio coefficients in the final models represent the estimates of the five pooled data sets. Separate regression models stratified by race and ethnicity were conducted on (a) the duration of childhood poverty and (b) the developmental timing of poverty. In each model, the dependent variable was regressed on poverty, gender, a term interacting gender and poverty, and the covariates. In all regression models, the standard errors were adjusted using the Huber-White sandwich estimator to account for the lack of independence of observations based on siblings born to the same mother (Rogers, 1993; Williams, 2000).

**Results**

The average BMI of our sample during young adulthood was 25.27 (**Table 1**). Over half of our sample (54.3%) had a BMI in the normal weight range, while still 42.2% were considered overweight or obese. Approximately one-third (29.4%) of young adult white females were overweight (i.e. BMI $\geq$ 25), compared to 61.7% of black females and 40.4% of Hispanic females. For young adult males, 46.5% of white males, 47.0% of black males, and 56.1% of Hispanic males were overweight (i.e. BMI $\geq$ 25) in young adulthood. Compared to white females, white males were more likely to be overweight (30.8% vs. 17.5%) or obese (15.7% vs.

11.9%). Black females compared to black males were more likely to be overweight (31.3% vs. 28.0%) or obese (30.4% vs. 19.0%). Last, Hispanic males (40.1%) were more likely to be overweight compared to Hispanic females (20.4%).

On average, young adults in our sample lived in households below 100% of the FPL (i.e. in poverty) for approximately one-fifth of their childhoods (from pre-natal to age 18) (**Table 2**). However, the duration of childhood poverty varied by race/ethnicity. Black and Hispanic young adults experienced poverty 48% and 41% of their childhood compared to 13% of white young adults. The developmental time period by which young adults experienced childhood poverty also varied by race/ethnicity. For example, the developmental periods which were more prominent for white young adults to experience poverty were during early and middle childhood (i.e. ages 2 - 10), where approximately 23% of white young adults experienced poverty. This is in contrast to black and Hispanic young adults. At least 50% of the black young adults experienced poverty in all the developmental periods from infancy to early adolescence (i.e. prenatal to age 14), and at least 50% of Hispanic young adults experienced poverty in all the developmental periods from infancy to middle childhood (i.e. prenatal to age 10).

The vast majority of young adults were white and in their early twenties (21.0). At the time of the child's birth, mothers were approximately 25 years of age, partnered (85.1%), had slightly more than a high school education, and not employed at the time of birth (57.6%). On average, mothers had a BMI score of 22.40 (i.e. normal weight) when they were 20 years of age, which is lower than their young adult children's BMI score at time of the study's assessment (BMI = 25.27; average age = 21.0). The proportion of young adults living in poverty at time of BMI assessment varied by race and ethnicity with 9% of white young adults living in poverty compared to 30% of black young adults and 35% of Hispanic young adults.

*Multivariate Regression Models*

Multivariate regression models indicate that the developmental timing of childhood poverty exposure (i.e. embedding of childhood poverty) contributes to race, ethnic, and gender disparities in overweight status in young adulthood (**Table 3**). Specifically, the developmental timing of exposure to childhood poverty does not significantly influence white, black, nor Hispanic females, but the timing of childhood poverty exposure does significantly influence white and black males in contrasting ways. Panel A suggest that white males who experienced poverty during early adolescence were 54% at lower odds of being overweight or obese during young adulthood. However, Panel B suggests that black males who experienced poverty during infancy were at higher odds of being overweight as young adults. Black males who experienced poverty during infancy were over two times at higher odds of being overweight versus normal weight and 72% at higher odds of being obese or overweight versus normal weight. The developmental timing of childhood poverty does not significant influence the weight status Hispanic males (Panel C).

Not being exposed to poverty during childhood has a positive effect on the weight status of white and Hispanic females. Panel A suggests that white females who did not experience poverty were 59% at lower odds of being overweight vs. normal weight and were 59% at lower odds of being obese or overweight versus normal weight. Further, Hispanic females who are never exposed to childhood poverty are 73% lower odds of being overweight versus normal weight and 69% lower odds of being obese or overweight versus normal weight. A lack of childhood exposure of poverty did not significant influence the weight status of black females.

Multivariate results also indicate that the accumulation of childhood poverty contributes to race, ethnic, and gender disparities in overweight status in young adulthood (**Table 4**). In

Panel A, findings indicate that the accumulation of childhood poverty influences white males and white females differently. White males who experienced longer durations of childhood poverty were 65% at lower odds of being overweight versus normal weight and 64% at lower odds of being obese or overweight versus normal weight as young adults. In contrasts, white females who experienced longer durations of poverty during childhood were over seven times at greater odds of being obese versus overweight as young adults. In addition, white females who experienced longer durations of childhood poverty were approximately six times at greater odds of being obese or overweight versus normal weight as young adults.

Further, accumulation of childhood poverty influenced black and Hispanic females but not black and Hispanic males. Panel B suggests that the black females who experienced longer durations of childhood poverty were 74% higher odds of being obese versus overweight and over two times at greater odds of being obese or overweight versus normal weight as young adults. Panel C indicates that Hispanic females that experienced longer durations of childhood poverty were three times at greater odds of being overweight versus normal weight and three times at greater odds of being obese or overweight versus normal weight as young adults.

Similar to the embedding models, the accumulation models suggest that white and Hispanic females who did not experience multiple exposures to poverty during childhood were at lower of being overweight in young adulthood. White females who did experience multiple exposures of childhood poverty were 58% lower odds of being overweight versus normal weight and 60% lower odds of being obese or overweight versus normal weight as young adults (Panel A). Hispanic females who did not experience multiple exposures of childhood poverty were 70% lower odds of being overweight versus normal weight and 66% lower odds of being obese or overweight versus normal weight as young adults (Panel C).

**Discussion**

The goal of the current study was to investigate whether the embedding of childhood poverty or the accumulation of childhood poverty contributed to the race, ethnic and gender disparities in young adult weights status. The findings indicated that both the embedding and accumulation of childhood poverty contributes to race, ethnic, and gender disparities in young adult weight status. Results suggest that the weight status of young adult white, black, and Hispanic females were not influenced by the embedding of childhood poverty; instead, the weight status of young adult white, black and Hispanic females was negatively influenced by the accumulation of childhood poverty. Further, the research indicates that the embedding of childhood poverty (during early adolescence) and the accumulation of childhood poverty lowers the odds that white males will be overweight as young adults. In contrast, experiencing poverty during infancy places black males at risk for being overweight as young adults. The findings also suggested that not experiencing childhood poverty to be associated with lowering the odds of being overweight in young adulthood for white and Hispanic females. Neither the embedding model, nor the accumulation model, of childhood poverty significantly predicted the overweight status of Hispanic males in young adulthood. Below we discuss the findings in relation how the embedding of childhood poverty and the accumulation of childhood poverty may be contributing to race, ethnic, and gender disparities in young adult weights status. The limitations along with the important implications for health interventions and social policies focusing on adult obesity and health related consequences of obesity are also discussed.

*Embedding of childhood poverty*

The embedding model suggest that early negative experiences, such as economic deprivation, produces biological changes that can set up individuals to be at risk for poor health,

or in this case be at risk of being overweight. For black males experiencing economic deprivation in the prenatal year and postnatal year increases their risk of being overweight in young adulthood. This finding maps onto previous research that has suggested prenatal and birth years represent a critical period in which poverty exposure places individuals at risk for obesity. (Ziol-Guest, Duncan, & Kalil, 2009). Our finding contributes to the literature by highlighting that black males are vulnerable during this particular developmental period.

Poverty is associated with consuming less fruits and vegetables and being at risk for experiencing food insecurity. Animal models have demonstrated that nutritional imbalance during utero place animals for illnesses (Gluckman and Hanson, 2006). The nutritional imbalance during utero and the first year postnatal may "program" individuals for later overconsumption of energy-dense, high caloric foods, which is a precursor to overweight status.

Our findings also suggest that experiencing poverty during early adolescence lowers the risk for white males to be overweight in young adulthood. As males enter adolescence their body begins to produce greater amounts of lean tissue. The poor living conditions experienced by white males during early adolescence may interact with biological changes, programming their biological system in a way that slows down the development of adipose tissue (or body fat).

*Accumulation of childhood poverty*

The results of the accumulation models suggest that the reoccurring exposure to economic deprivation, rather the exposure at a particular developmental time period, is what places white, black, and Hispanic females at risk for being overweight as young adults. In other words, repeated exposures of poverty places white, black, and Hispanic females on a path towards obesity and perhaps obesity-related diseases. Although it is unclear the behavioral mechanisms by which the accumulation of childhood poverty influences young adult female

weight status, previous research that has found a similar association has suggested the mediating effects of physical inactivity, inadequate sleep, skipping breakfast and certain forms of parental monitoring could be at play (Lee, Harris, Gorden-Larsen, 2009). Biologically, it has been suggested that chronic stress activates the hypothalamic-pituitary-adrenal (HPA) axis, which is associated with releasing cortisol. High levels of cortisol have been associated with overeating.

Compared to white females, the accumulation of poverty has the opposite effect on weight status for white males. Repeated exposures of poverty lowers the risk that white males will be overweight as young adults. Previous research has indicated that children become aware of economic hardship, such as early as middle childhood. The awareness for some children results in them eating less to ensure that the rest of the family has enough to eat. Entering the labor market during adolescence and performing manual labor jobs is typical of adolescents whose families face economic uncertainty. The combination of control appetite and the physical activity involved in manual labor may act as a "protective factor" for obesity among young adult white males who experience repeated exposures of poverty during childhood.

Helping impoverished families out of poverty may not only improve the immediate economic circumstances of families, but also improve the long-term health status of their children as young adults.

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Table 1 Weighted Descriptives of Body Mass Index in Young Adulthood for the Full Analytic Sample and by Race/Ethnicity, Stratified by Gender

| BMI in Young Adulthood | Full Analytic Sample | White | | Black | | Hispanic | |
|---|---|---|---|---|---|---|---|
| | | Females | Males | Females | Males | Females | Males |
| Continuous BMI, mean (SD) | 25.27 (5.49) | 24.08 (5.47) | 25.41 (4.96)** | 27.99 (6.65) | 26.25 (6.05)* | 25.19 (5.68) | 26.21 (4.98)*** |
| Obese, % | 15.8 | 11.9 | 15.7* | 30.4 | 19.0** | 20.4 | 15.1 |
| Overweight, % | 26.4 | 17.5 | 30.8*** | 31.3 | 28.0** | 20.4 | 41.0*** |
| Normal BMI, % | 54.3 | 64.2 | 52.1*** | 35.3 | 51.4* | 50.9 | 41.4*** |
| Underweight, % | 3.5 | 6.5 | 1.5*** | 3.1 | 1.6 | 8.3 | 2.4* |
| Unweighted n | 3517 | 703 | 906 | 466 | 640 | 312 | 490 |

*Note*. Significant differences between female and males within each race/ethnic group: *** $p < .001$; **$p < .01$; *$p < .05$

Table 2. Weighted Descriptives of the Independent Variables and Covariates for the Full Analytic Sample by Race/Ethnicity

| Characteristics | Full Sample | White | Black | Hispanic |
|---|---|---|---|---|
| Independent Variables | | | | |
| Poverty | | | | |
| Duration of Childhood Poverty, mean (SD) | 0.21 (0.30) | 0.13 (0.22) | 0.48 (0.35)[a] | 0.41 (0.37)[a,b] |
| Developmental Timing of Childhood Poverty | | | | |
| Infancy, % | 25.7 | 15.1 | 61.1[a] | 50.6 [a, b] |
| Early Childhood, % | 34.1 | 23.7 | 70.0[a] | 56.7 [a,b] |
| Middle Childhood, % | 31.6 | 22.8 | 60.1[a] | 53.2 [a,b] |
| Early Adolescence, % | 22.6 | 14.8 | 50.0[a] | 38.8 [a,b] |
| Late Adolescence, % | 18.2 | 11.7 | 38.1[a] | 38.1 [a,b] |
| Child Characteristics | | | | |
| Gender, % | | | | |
| Female | 42.7 | 44.5 | 41.2 | 28.8 [a] |
| Race/ethnicity, % | | | | |
| White | 75.2 | 100 | -- | -- |
| Black | 16.7 | -- | 100 | -- |
| Hispanic | 8.1 | -- | -- | 100 |
| Age at BMI assessment, mean (SD) | 21.07 (1.02) | 21.08 (1.06) | 20.99 (0.84) | 21.12 (0.96) |
| Elevated Depression Symptoms, % | 22.8 | 21.3 | 29.0[a] | 23.0 |
| Positive Self-esteem, mean (SD) | 1.80 (0.39) | 1.79 (0.38) | 1.80 (0.43) [a] | 1.87 (0.43)[a,b] |
| Low birth-weight status | 6.0 | 6.0 | 8.0[a] | 8.0[b] |
| Mother Characteristics | | | | |
| Age at child's birth, mean (SD) | 24.70 (3.38) | 25.01 (3.33) | 23.64 (3.23) [a] | 24.05 (3.63)[a,b] |
| Partnered at child's birth, % | 85.1 | 92.8 | 53.3[a] | 79.1 [a,b] |
| Education, mean (SD) | 12.43 (1.93) | 12.68 (1.82) | 12.09 (1.73) [a] | 10.79 (2.41)[a,b] |
| Employed at child's birth, % | 42.4 | 45.5 | 35.1[a] | 29.3[a] |
| BMI at age 20, mean (SD) | 22.40 (3.71) | 22.01 (3.53) | 23.78 (3.97) [a] | 23.30 (3.96)[a,b] |
| Household Characteristics | | | | |
| Number of Siblings | 1.86 (1.28) | 1.74 (1.14) | 2.15 (1.46)[a] | 2.34 (1.75)[a] |
| HH inc. <= 100% FPL (age 20) | 15.0 | 9.0 | 30.0[a] | 35.0[a,b] |
| Unweighted n | 3517 | 1609 | 1106 | 802 |

*Note*. Abbreviation: BMI, body mass index; FPL, federal poverty line; Descriptives based on non-imputed data.
[a] Significantly different from white (p < .05). [b] Significantly different from black (p < .05).

Table 3. Adjusted Odds Ratios (95% CI) Predicting the Association between the Embedding of Childhood Poverty and Overweight by Race/Ethnicity[a]

| | Panel A: Whites | | | | | |
|---|---|---|---|---|---|---|
| | Obese vs. Overweight (n = 634) | | Overweight vs. Normal BMI (n = 1328) | | Obese/Overweight vs. Normal BMI (n = 1552) | |
| Childhood Poverty | | | | | | |
| Infancy | 1.52 | (0.54, 4.34) | 1.46 | (0.76, 2.80) | 1.64 | (0.89, 3.03) |
| Early Childhood | 0.48 | (0.17, 1.34) | 0.82 | (0.42, 1.59) | 0.65 | (0.35, 1.22) |
| Middle Childhood | 1.22 | (0.40, 3.75) | 0.52 | (0.22, 1.25) | 0.55 | (0.25, 1.20) |
| Early Adolescence | 1.04 | (0.37, 2.89) | 0.46 | (0.21, 1.03) | 0.46 | (0.23, 0.93)* |
| Late Adolescence | 1.53 | (0.50, 4.62) | 0.88 | (0.41, 1.93) | 1.11 | (0.55, 2.23) |
| Gender | | | | | | |
| Female | 0.96 | (0.62, 1.50) | 0.41 | (0.30, 0.56)*** | 0.41 | (0.31, 0.53)*** |
| Childhood Poverty x Gender | | | | | | |
| Infancy x Female | 0.41 | (0.09, 1.81) | 1.34 | (0.51, 3.51) | 0.91 | (0.39, 2.14) |
| Early Childhood x Female | 3.13 | (0.73, 13.50) | 1.55 | (0.53, 4.49) | 2.08 | (0.85, 5.08) |
| Middle Childhood x Female | 1.38 | (0.16, 11.83) | 1.53 | (0.34, 6.87) | 2.23 | (0.67, 7.45) |
| Early Adolescence x Female | 3.50 | (0.60, 20.54) | 1.01 | (0.24, 4.21) | 2.03 | (0.69, 6.01) |
| Late Adolescence x Female | 1.24 | (0.21, 7.38) | 0.71 | (0.18, 2.69) | 0.70 | (0.23, 2.15) |
| | Panel B: Blacks | | | | | |
| | Obese vs. Overweight (n = 575) | | Overweight vs. Normal BMI (n = 814) | | Obese/Overweight vs. Normal BMI (n = 1566) | |
| Childhood Poverty | | | | | | |
| Infancy | 0.49 | (0.23, 1.03) | 2.23 | (1.28, 3.88)** | 1.72 | (1.06, 2.79)* |
| Early Childhood | 1.60 | (0.62, 4.17) | 0.83 | (0.43, 1.58) | 0.96 | (0.54, 1.72) |
| Middle Childhood | 0.69 | (0.25, 1.91) | 1.02 | (0.50, 2.10) | 0.90 | (0.49, 1.66) |
| Early Adolescence | 0.88 | (0.36, 2.17) | 0.69 | (0.35, 1.34) | 0.65 | (0.36, 1.18) |
| Late Adolescence | 1.40 | (0.58, 3.38) | 1.11 | (0.60, 2.04) | 1.31 | (0.75, 2.26) |
| Gender | | | | | | |
| Female | 1.11 | (0.64, 1.94) | 0.97 | (0.60, 1.59) | 1.03 | (0.68, 1.55) |
| Childhood Poverty x Gender | | | | | | |
| Infancy x Female | 1.99 | (0.70, 5.65) | 0.47 | (0.20, 1.14) | 0.61 | (0.29, 1.32) |
| Early Childhood x Female | 0.53 | (0.15, 1.90) | 1.61 | (0.59, 4.38) | 1.27 | (0.54, 3.01) |
| Middle Childhood x Female | 1.85 | (0.45, 7.65) | 1.95 | (0.60, 6.28) | 2.19 | (0.82, 5.81) |
| Early Adolescence x Female | 1.66 | (0.45, 6.19) | 1.76 | (0.53, 5.87) | 2.32 | (0.83, 6.50) |
| Late Adolescence x Female | 0.76 | (0.22, 2.67) | 0.60 | (0.22, 1.69) | 0.57 | (0.24, 1.38) |

| | Obese vs. Overweight (n = 417) | | Overweight vs. Normal BMI (n = 634) | | Obese/Overweight vs. Normal BMI (n = 1566) | |
|---|---|---|---|---|---|---|
| | | | Panel C: Hispanics | | | |
| Childhood Poverty | | | | | | |
| Infancy | 1.46 | (0.63, 3.38) | 0.66 | (0.35, 1.26) | 0.74 | (0.41, 1.34) |
| Early Childhood | 1.63 | (0.60, 3.43) | 0.78 | (0.39, 1.58) | 0.88 | (0.47, 1.64) |
| Middle Childhood | 0.73 | (0.21, 2.63) | 0.91 | (0.39, 2.17) | 0.81 | (0.37, 1.78) |
| Early Adolescence | 0.97 | (0.34, 2.79) | 0.88 | (0.37, 2.08) | 0.86 | (0.38, 1.95) |
| Late Adolescence | 0.85 | (0.31, 2.33) | 1.31 | (0.55, 3.17) | 1.21 | (0.55, 2.69) |
| Gender | | | | | | |
| Female | 1.61 | (0.86, 3.02) | 0.27 | (0.17, 0.43)*** | 0.31 | (0.20, 0.47)*** |
| Poverty x Female | | | | | | |
| Infancy  x  Female | 0.56 | (0.12, 2.50) | 3.07 | (0.95, 9.95) | 2.60 | (0.98, 6.91) |
| Early Childhood  x  Female | 0.21 | (0.04, 1.16) | 1.24 | (0.34, 4.49) | 0.81 | (0.28, 2.31) |
| Middle Childhood  x  Female | 2.81 | (0.28, 27.90) | 1.81 | (0.36, 9.07) | 2.73 | (0.67, 11.19) |
| Early Adolescence  x  Female | 2.17 | (0.36, 12.99) | 0.86 | (0.23, 3.27) | 1.14 | (0.34, 3.79) |
| Late Adolescence  x  Female | 2.08 | (0.35, 12.31) | 0.66 | (0.16, 2.67) | 0.76 | (0.23, 2.51) |

[a] Models were conducted on imputed data and child, mother, and household covariates listed in Table 2 were included in all models.

***$p < .001$; ** $p < .01$; *$p < .05$.

Table 4. Adjusted Odds Ratios (95% CI) Predicting the Association between the Accumulation of Childhood Poverty and Overweight by Race/Ethnicity[a]

| | Panel A: Whites | | |
| --- | --- | --- | --- |
| | Obese vs. Overweight (n = 634) | Overweight vs. Normal BMI (n = 1328) | Obese/Overweight vs. Normal BMI (n = 1552) |
| **Childhood Poverty** | | | |
| Accumulation of Childhood Poverty | 1.09 (0.40, 2.99) | 0.35 (0.17, 0.73)** | 0.36 (0.18, 0.73)** |
| **Gender** | | | |
| Female | 0.91 (0.58, 1.41) | 0.42 (0.31, 0.56)*** | 0.40 (0.31, 0.52)*** |
| **Childhood Poverty x Gender** | | | |
| Accumulation of Poverty x Female | 7.27 (1.56, 33.92)* | 2.59 (0.86, 7.85) | 5.96 (2.35, 15.10)*** |
| | Panel B: Blacks | | |
| | Obese vs. Overweight (n = 575) | Overweight vs. Normal BMI (n = 814) | Obese/Overweight vs. Normal BMI (n = 1076) |
| **Childhood Poverty** | | | |
| Accumulation of Childhood Poverty | 0.67 (0.28, 1.63) | 1.45 (0.70, 2.99) | 1.34 (0.71, 2.51) |
| **Gender** | | | |
| Female | 1.16 (0.67, 1.99) | 0.85 (0.54, 1.36) | 0.93 (0.62, 1.38) |
| **Childhood Poverty x Gender** | | | |
| Accumulation of Poverty x Female | 1.74 (0.67, 4.51) | 1.87 (0.81, 4.33) | 2.32 (1.10, 4.88)* |

| | Obese vs. Overweight (n = 417) | | Overweight vs. Normal BMI (n = 634) | | Obese/Overweight vs. Normal BMI (n = 1566) | |
|---|---|---|---|---|---|---|
| | | Panel C: Hispanics | | | | |
| **Childhood Poverty** | | | | | | |
| Accumulation of Childhood Poverty | 1.43 | (0.51, 4.05) | 0.63 | (0.27, 1.47) | 0.64 | (0.29, 1.37) |
| **Gender** | | | | | | |
| Female | 1.52 | (0.82, 2.82) | 0.30 | (0.19, 0.47)*** | 0.34 | (0.22, 0.51)*** |
| **Childhood Poverty x Gender** | | | | | | |
| Accumulation of Poverty x Female | 0.69 | (0.19, 2.51) | 3.07 | (1.11, 8.50)* | 3.09 | (1.24, 7.72)* |

[a] Models were conducted on imputed data and child, mother, and household covariates listed in Table 2 were included in all models.
***$p < .001$; ** $p < .01$; *$p < .05$.