Relative Obesity and the Formation of Non-cognitive Abilities During Adolescence*

Wei Huang[1], Elaine M. Liu[2], and C. Andrew Zuppann[3]

[1]University of International Business and Economics
[2]University of Houston, Department of Economics and NBER
[3]Vega Economics

June 3, 2020

Abstract

We study the role of relative childhood and adolescent obesity in the development of non-cognitive abilities. We employ a novel identification strategy, utilizing the fact that one's body size is a relative concept and there are large variations in body sizes across MSAs. We focus on children who move between MSAs. Controlling for origin-destination state pair fixed effects, we find that a 10 percentile point increase in relative body size would increase behavioral problems by 2 percentile points. This effect is of a similar magnitude to a two-year reduction in maternal education.

*This paper has benefitted from comments from Aimee Chin, Sandy Black, Chinhui Juhn, Nick Papageorge and conference participants at Economic Demography Workshop, ASHE, Stata Texas Empirical Microeconomics Conference and SEA. All errors are our own. *Keywords: obesity, non-cognitive skills, behavioral problems, reference groups, neighborhoods, mobility. JEL codes: I1,I12,J3,J31*

1 Introduction

In the past decade, childhood obesity has become a pandemic. According to the World Health Organization (WHO), nearly one in five children world-wide is considered obese or overweight. In addition to known negative impacts on health, childhood obesity may also negatively affect a child's psychological development through worsened self-esteem and increased behavioral problems. A recent paper by Lumeng et al. (2010) finds that obese children are 65% more likely to be bullied than their normal-weight counterparts. In a book by child psychologist Sylvia Rimm (2004), she surveyed thousands of children and reports that children "who considered themselves very overweight not only were bullied, but ... indicated more loneliness ... and saw themselves as sad, fearful, and wimpy." While these findings are hardly surprising, the impact and magnitude of childhood obesity on these socio-emotional traits is a point of policy concern. Recent economic studies by Heckman and Rubinstein (2001), Heckman et al. (2006), Carneiro et al. (2007), and Heckman et al. (2013) suggest that non-cognitive traits—such as behavioral problems and self-esteem—during childhood are malleable and important determinants of education outcomes, labor market outcomes, criminal activities, and health behaviors.

The extent to which obesity leads to behavioral problems and self-esteem has been discussed widely by economists, sociologists, and psychologists. Many papers have found a negative correlation between obesity and self-esteem (see Strauss (2000), Biro et al. (2006), Viner and Cole (2005), Harrist et al. (2016), and Hesketh et al. (2004), among others), but these may suffer from issues with reverse causality and omitted third factors in establishing a causal link. For example, children with low self-esteem (or more behavioral problems) may find solace in food and end up obese. The difficulty of finding exogenous variation in obesity that is orthogonal to self-esteem was discussed extensively in Mocan and Tekin (2011).

In this paper, we investigate the causal relationship between childhood and adolescent obesity and non-cognitive traits by focusing on a relatively unexplored but important avenue: the fact that perception of body size is, to an extent, a relative concept. How a child feels about her weight depends on who she is comparing herself to. The idea that reference groups affect ideal body size has been well-established in psychological studies and some economic studies (for examples, see

Kernper et al. (1994), Hebl and Heatherton (1998), Burke and Heiland (2007), and Welch et al. (2004)).

The benefit of focusing on relative body size—despite it being a more narrow focus than the overall role of obesity on child development—is that we are able to estimate a causal link by utilizing the fact that there is large variation in average body sizes across Metropolitan Statistical Areas (MSAs). For example, what is considered heavyset in Los Angeles could be the weight of an average person in Houston. If reference groups are based on residence then there will be variation in relative body size based on location. Further, we focus attention on children whose parents move between MSAs during childhood and are thus exposed to changes in their reference group of peers that are plausibly exogenous to family and child factors.

To examine the role relative weight plays in child development, we use the sample of National Longitudinal Survey of Youth 1979 Children and Young Adults (NLSY79-CYA)—a panel survey that has information on childhood body size, adult and adolescent self-esteem, and childhood and adolescent behavioral issues. We estimate a youth's relative weight based on the distribution of body sizes within a local reference group of MSA, race, and gender. Since the cell size of reference groups (MSA/race/gender) is small if we only utilize NLSY79-CYA data, we incorporate data from the National Longitudinal Survey of Youth 1997 (NLSY97) to improve the precision of our estimation of reference group weight distributions. Our construction of relative weight is described in detail in Section 2. As we define reference groups at the MSA level instead of at the level of schools or friends, standard concerns of endogenous sorting or reflection problems that appear in the peer effect literature are less of a concern.

Simply including relative weight alongside absolute weight in a regression does not fully resolve endogeneity issues. Relative weight measures likely still suffer from reverse causality. Children may have both large absolute weight and large relative weight due to low self-esteem.

Therefore, our preferred approach restricts analysis to children who move across MSAs. We utilize the fact that when a child's parents move to a new city, the child may gain or lose weight in relative terms due solely to changing reference groups. Clearly, movers are different from non-movers in a variety of dimensions, so we restrict our attention exclusively to movers. We compare the non-cognitive outcomes of moving children who gain weight in relative terms to moving children who lose it, holding their own weight constant. In this approach, changes in relative weight are thus driven only by exogenous changes in a child's reference group.

Some may worry that the destination or type of move (such as moving from the South to the Northeast) may be correlated with child or family characteristics. We address this by including a set of origin and destination state pair fixed effects. We further test this threat to identification and find that conditional on our origin and destination state pair fixed effects, the family and individual characteristics of children who lose weight in relative terms and those who gain it are similar. Our findings are also robust to a variety of other specifications such as including origin and destination MSA fixed effects. We discuss these in more detail in Section 4.[1]

We further hypothesize that the effect of an increase in relative obesity could be heterogeneous for children of different body sizes. For instance, for children who are already overweight or obese, emotional well-being will be more affected by their relative standing than their skinnier counterparts. Children who are of a healthy weight could be relatively less affected since they are unlikely to be exposed to teasing or bullying in the first place.

Controlling for origin-destination state fixed effects, we find that among children who are already overweight or obese, increasing a child's relative weight by 10 percentile points causes an increase in measured behavioral problems index (BPI) by 2 percentile points. The BPI-relative weight elasticity is 0.164 evaluated at the mean. However, an increase in relative weight does not have a significant impact on non-overweight children. In order to understand the magnitude of the relative weight, we can compare this to the impact of maternal education. The effect of increasing relative weight by 10 percentile points is similar to the impact of decreasing of maternal education by two years. The BPI-maternal education elasticity is 0.209 evaluated at the mean.

We find that relative weight gains have a negative impact on behavioral problems for both overweight boys and girls. We also find that they are more likely to exhibit externalizing behavioral

[1]This methodology can also be used to examine the causal relationship between adult obesity and self-esteem. However, we worry that an adult's decision to move and the location she moves to may be endogenous to self-esteem compared to the decision for a child's move. Thus, in this paper we focus on child obesity. In addition, we also examine whether the location of the move is orthogonal to a child's body weight and non-cognitive abilities prior to the move.

problems, but there is no significant impact on internalizing problems.

We examine whether relative weight gains are experienced differently from relative weight losses. When comparing the impact of weight loss and weight gain in absolute terms, we discover that overweight children who experience a significant relative weight loss have large behavioral changes compared to overweight children experiencing a relative weight gain. However, we fail to reject the null hypothesis that relative gain and relative weight loss have the same impact in absolute terms.

Our paper contributes to several literatures. First, this paper makes a methodological contribution to the literature on body size. An extensive literature suggests that obesity could lead to low self-esteem (Strauss, 2000, Biro et al., 2006, Viner and Cole, 2005, Hesketh et al., 2004, Chen, 2012), but as French et al. (1995) and as Mocan and Tekin (2011) point out, much of this work finds associations without causal links. This is true even for studies that utilize longitudinal features of data by including individual fixed effects. While these control for time-invariant characteristics, it is still unclear whether becoming obese is indeed exogenous to low self-esteem. The novel identification strategy of utilizing the importance of relative body size could be adopted by other researchers in this line of research. Our work also contributes to the literature on the importance of ranking, reference points, and relative status. This literature includes work examining the importance of relative income compared to neighbors', wages compared to other colleagues', academic performance (Murphy and Weinhardt, 2014, Brown et al., 2008, Card et al., 2012, Luttmer, 2005); our work highlights another dimension along which ordinal rank matters.

Third, our findings provide evidence that child and adolescent body size play an important role in determining non-cognitive skills, as measured by behavioral problems. This paper also relates to the finding in a set of papers that examine the importance of body size, body shape, and beauty on labor market outcomes and even criminal behaviors (Persico et al., 2004, Mocan and Tekin, 2010, Mobius and Rosenblat, 2006, Han et al., 2009, Baum and Ford, 2004, Brunello and dŠHombres, 2007, Cawley, 2004, Morris, 2007, Conley and Glauber, 2007).

Lastly, our findings that movement between MSAs impacts childhood development and can possibly impact adult labor market outcomes echoes recent findings by Chetty and Hendren (2015). In Chetty and Hendren (2015), the authors also focus only on movers and find that child movement from relatively rich countries to relatively poor countries leads to permanent negative impacts on adult earnings. Our paper provides a potential channel through which neighborhoods could affect children's behaviors.

The paper proceeds as follows. Sections 2 and 3 describe our empirical methodology and the construction of the matched mother-children data from the NLSY. Section 4 presents results on the effect of changing relative weights on non-cognitive characteristics, and Section 5 concludes.

2 Empirical methodology

In the existing economic literature on weight, researchers typically examine the relationship between BMI (body weight) and various behavioral or emotional outcomes (Strauss, 2000, Biro et al., 2006, Viner and Cole, 2005, Hesketh et al., 2004). We depart from this literature by examining not only a child's absolute weight but also their weight relative to a local reference group. More specifically, we estimate the following regression:

For each child i whose reference group is j at time t,

$$\begin{aligned} Y_{i,j,t} = \; & \alpha + \beta_1 \text{BMI Z-score}_{i,t} \\ & + \beta_2 \left(\text{BMI Percentile}_{i,j,t}\right) + \lambda_j + \gamma X_{i,t} + \varepsilon_{i,j,t} \end{aligned} \tag{1}$$

$Y_{i,j,t}$ are outcomes including self-esteem and behavioral problems. [2] If our subjects were adults, we would include their BMI directly to control for absolute weight. However, since BMI varies drastically across age and gender during childhood, we instead standardize BMI by constructing a child's BMI Z-score. BMI Z-scores are calculated by comparing one's BMI to the BMI distribution of children who are of the same age (in months) and the same gender, as provided by the Centers for Disease Control (CDC).[3] Thus, BMI Z-score represents the number of standard deviation units above or below the median BMI compared to those of the same age and gender groups. BMI Percentile$_{i,j,t}$ is a child i's body size percentile rank in a given reference group j at time t.

[2] These variables are percentile scores provided by NLSY79-CYA. More details about what these composite indices represent and how they are imputed are discussed in Section 3 and the Appendix.

[3] This standardization follows the recommendations of the CDC to "facilitate comparisons across ages" and "describe the relative status of children at the extremes of the distributions" (Kuczmarski et al., 2002).

$X_{i,t}$ includes individual child characteristics such as gender, age, and race, as well as various household characteristics such as mother's education and mother's age at birth, and λ_j is a fixed effect for reference group (MSA by race by gender). β_1 captures how a child's own weight—as measured by her BMI Z-score—affects her outcome $Y_{i,j,t}$. β_2 reflects how a child's BMI Z-score percentile rank within a reference group j affects her outcomes. If β_2 is statistically significant, it suggests that relative weight matters.[4] In fact, many papers in this literature suggest that perception of appropriate body weight is influenced by societal and cultural norms (Kernper et al., 1994, Hebl and Heatherton, 1998). For example, Welch et al. (2004) find that children of different races or geographic locations have different views of ideal body size. However, to the best of our knowledge, our paper is the first to explore how relative weight can affect one's emotional well-being and behavioral outcomes.[5]

Since we do not know who precisely is in the reference group j that a child i compares herself to, there are many possible choices of j for our empirical analysis. A child's reference group may be as narrowly defined as his classmates, or as broadly defined as other children residing in the same state or even country as the child. There are trade-offs between choosing a narrow versus broad reference group. Choosing a narrow definition of reference group—such as classmates or siblings—will lead to endogeneity problems in estimating the effect of these peers on any individual child's outcomes due to well-known issues in peer effect estimations such as reflection problems and endogeneity of peer networks. On the other hand, a broader definition of a reference group may not accurately reflect the peers that a child is comparing her weight to. Additionally, there are data trade-offs in using broad versus narrow reference groups. The narrower the reference group, the harder it can be to precisely estimate a child's relative weight as the number of observations in the reference group shrinks. In order to mitigate problems with small reference groups and imprecise estimates when constructing relative body size, we augment our data to include data from the NLSY97.[6] These

[4] This type of comparison is often used in the literature of subjective well-being and relative income, where one's subjective well-being is influenced by neighbors' income. See Clark et al. (2008) for a review.

[5] While we do not set up a formal model, one can adopt the model from Fortin and Boucher (2015), where individual utility function form depends not only on one's own characteristics, but also on the reference group constructs. A paper by Burke and Heiland (2007) also employs a model where there is a disutility if one's own weight deviates from the reference weight (the weight of their social group) in the utility function.

[6] In the robustness checks, we also augment our data to include Behavioral Risk Factor Surveillance System (BRFSS) samples.

NLSY97 respondents are used only to increase the precision of our relative weight measure and are not included in our main estimation sample.

Our choice of reference groups is at the MSA/race/gender level. Race is broadly divided between black and non-black.[7] We use all individuals age 22 and under within the same MSA/race/gender to reflect local variation in child/adolescent obesity that could affect how a child perceives her weight relative to people she sees on a day-to-day basis. We have included race and gender in our reference group definition based on evidence from the child psychology literature that suggests adolescent body images are most influenced by those of the same race and gender (Kernper et al., 1994, Hebl and Heatherton, 1998, Welch et al., 2004).

Ideally, we could use a finer level of geography such as neighborhood or Census block, but the lowest level of geographic disaggregation available in the NLSY is the county where the mother and child live. However, defining reference groups using county/race/gender cells does not give us enough observations to precisely identify the rank of a child's BMI Z-score within many reference group cells. For instance, if we define a reference group using county/race/gender cells, roughly 35% of individuals reside in cells with fewer than 15 observations in their reference groups. When we use MSA/race/gender cells to define reference groups, less than 15% of respondents reside in such small cells. To ensure the precision of estimation of our reference group distributions, we omit all reference group cells that have fewer than 15 unique respondents. The resulting sample of NLSY79-CYA has 269 MSAs and 417 unique reference groups.[8]

Variation across reference groups Given that we are holding a child's own absolute weight constant in this specification, variation in relative weight is due to differences in the distribution of BMI across reference groups. A natural question is whether there is enough variation across reference groups at the MSA/race/gender level in the distribution of BMIs.

Figure 1 plots the 25th, 50th, and 75th percentiles of the BMI Z-score distribution across reference groups (MSA/race/gender). We see a considerable amount of variation across reference

[7] The definition of MSAs changes over the course of the NLSY survey. We standardize our definition of the MSA by using county of residence in each wave and aggregating those to MSAs using a 2004 crosswalk provided by the Department of Labor.

[8] As a robustness check, we also use county/race/gender or state/race/gender as alternative reference groups.

groups. A child with a BMI Z-score of 0.5 could rank anywhere from the 25th percentile to the 50th or even 75th percentile within their reference group distribution depending on their MSA, race, and gender.

Heterogeneous effects We examine whether the impact of relative weight has a heterogeneous impact. We hypothesize that for children who are already overweight or obese, emotional well-being will be more affected by their relative standing than those who are healthy weight. Children who are not overweight should be relatively unaffected by the change in percentile rank as they are unlikely to be exposed to teasing or bullying in the first place, whereas children who are heavier are more likely to be victims of mocking and teasing and so changes in their relative standing are likely to impact their emotional and behavioral outcomes to a greater degree.

To test this hypothesis we estimate the following specification: For each individual i with reference group j at time t,

$$\begin{aligned} Y_{i,j,t} = \; & \alpha + \beta_1 \text{BMI Z-score}_{i,t} \\ & + \beta_2 \left(\text{BMI Percentile}_{i,t}\right) \cdot I\{\text{Not Overweight}\}_{i,t} \\ & + \beta_3 \left(\text{BMI Percentile}_{i,t}\right) \cdot I\{\text{Overweight}\}_{i,t} \\ & + \beta_4 I\{\text{Overweight}\}_{i,t} + \lambda_j + \gamma X_{i,t} + \varepsilon_{i,j,t} \end{aligned} \tag{2}$$

where $I\{\text{Not Overweight}\}_{i,t}$ and $I\{\text{Overweight}\}_{i,t}$ are indicator variables for whether a child's BMI Z-score does or does not meet the CDC definition of overweight or obese. $X_{i,t}$ includes race, gender, age, mother's age at first birth, and mother's highest grade completed. The main coefficients of interest are β_2 and β_3. β_2 captures how much a normal weight/underweight child is affected by her BMI percentile rank and β_3 reflects how much an overweight or obese child is affected by her BMI percentile rank.[9]

A potential problem with the above estimation approach is a plausible reverse causality relationship between non-cognitive outcomes and weight. Heavyset children may be heavier due to

[9]To simplify the interpretation of β_4, we demean BMI percentile in all regressions. This does not change the estimation or interpretation of β_2 or β_3.

underlying individual unobservable characteristics, such as poor body image or low self-esteem. When we compare them to individuals in the same reference group with lower weight, we could incorrectly conclude that weight is driving self-esteem. To account for this possibility, we focus on children who are exposed to changing reference groups as their parents move between MSAs. By focusing on this subsample, we are utilizing changes in relative weight that are exclusively driven by changes in the reference group that a child finds herself in.

As an example of the variation in relative weight in the NLSY79-CYA, Figure 2 plots the estimated *cdf*s of BMI Z-scores for reference groups in Houston and Chicago. We see that even though Houston has higher child and adolescent obesity rates than Chicago (25% as opposed to 15%), Houston's weight distribution does not first-order stochastically dominate Chicago's. Therefore, whether a child gains or loses relative weight upon moving from Houston to Chicago depends on their BMI Z-score as well as their race and gender.

For instance, consider a black girl with a BMI Z-score of 1. If she moved from Houston to Chicago she would be exposed to a skinnier reference group and her relative BMI would increase by 10 percentile points. In contrast, a black girl with a BMI Z-score of -0.5 who moved from Houston to Chicago would experience a 5 percentile point decrease in relative BMI percentile. This suggests that it is hard for parents to predict whether their child will gain or lose relative weight as a result of moving.

Our specification to estimate the effect for children who experience changes in relative BMI due to moving between MSAs is as follows: For each child i who moves MSAs between survey waves $t-1$ and t:

$$
\begin{aligned}
Y_{i,t} = \; & \alpha + \beta_1 \text{BMI Z-score}_{i,t-1} \\
& + \beta_2 \Delta\text{BMI percentile}_{i,t} \cdot I\{\text{Not Overweight}\}_{i,t-1} \\
& + \beta_3 \Delta\text{BMI percentile}_{i,t} \cdot I\{\text{Overweight}\}_{i,t-1} \\
& + \beta_4 I\{\text{Overweight}\}_{i,t-1} + \gamma X_{i,t} + \omega Y_{i,j,t-1} + \varepsilon_{i,t}
\end{aligned} \tag{3}
$$

where ΔBMI percentile$_{i,t}$ is the change in a child's BMI percentile between survey waves t and $t-1$. In other words, it is the difference between BMI percentile in wave t in destination MSA and BMI percentile in wave $t-1$ in origin MSA. $X_{i,t}$ includes race, gender, age, mother's age at first birth, mother's highest grade completed, mother's marital status, and a set of dummies for the origin and destination state pair of the moves. We include these dummy variables to capture any inherent differences in child outcomes across geographic locations and the time-invariant characteristics of the types of families that move between each state pair. $Y_{i,j,t-1}$ is the outcome in the previous survey wave. The main coefficients of interest are still β_2 and β_3. β_2 captures how much a healthy-weight/underweight child is affected by the change in her BMI percentile rank as a result of moving. β_3 reflects the effect of changing BMI percentile rank on outcomes for overweight or obese children.

Using moving children instead of the entire cross-section removes many of the endogeneity concerns in the above specification. Holding one's absolute weight constant, the change in relative weight for moving children is driven entirely by the changes in her reference group's weight distribution. As this is a byproduct of the move (and we include origin-destination state pair dummies), it will not be driven by reverse causality nor omitted variables influencing both weight changes and child development. We further examine whether relative weight gains are experienced differently from relative weight losses for those who are overweight. Our specification is as follows: For each individual i who moves MSAs between survey waves $t-1$ and t,

$$\begin{aligned}
Y_{i,t} = \ & \alpha + \lambda_1 \text{BMI Z-score}_{i,t-1} + \lambda_2 I\{\text{Overweight}\}_{i,t-1} \\
& + \lambda_3 I\{\Delta\text{BMI Percentile} \leq 0\}_{i,t} + \lambda_4 I\{\Delta\text{BMI Percentile} \leq 0\}_{i,t} \cdot I\{\text{Overweight}\}_{i,t-1} \\
& + \theta_1 I\{\text{Not Overweight}\}_{i,t-1} \cdot |\Delta\text{BMI Percentile}_{i,t}| \cdot I\{\Delta\text{BMI Percentile} \geq 0\}_{i,t} \\
& + \theta_2 I\{\text{Overweight}\}_{i,t-1} \cdot |\Delta\text{BMI Percentile}_{i,t}| \cdot I\{\Delta\text{BMI Percentile} \geq 0\}_{i,t} \\
& + \theta_3 I\{\text{Not Overweight}\}_{i,t-1} \cdot |\Delta\text{BMI Percentile}_{i,t}| \cdot I\{\Delta\text{BMI Percentile} < 0\}_{i,t} \\
& + \theta_4 I\{\text{Overweight}\}_{i,t-1} \cdot |\Delta\text{BMI Percentile}_{i,t}| \cdot I\{\Delta\text{BMI Percentile} < 0\}_{i,t} \\
& + \gamma X_{i,t} + \omega Y_{i,j,t-1} + \varepsilon_{i,t} \qquad (4)
\end{aligned}$$

$|\Delta$BMI Percentile$|$ is the absolute value of the change in BMI Percentile between period $t-1$ and

t. $X_{i,t}$ include the same controls as specified in Equation 3.[10]

3 Data

We use matched mother-children data from the NLSY79-CYA to perform our analysis. The NLSY79-CYA includes all children born to the NLSY79 female respondents, resulting in a sample containing 11,464 children linked to 4,925 mothers. It is administered biannually starting in 1986 and we use responses through the 2012 wave. The NLSY79-CYA allows us to follow mothers and children over both time and space and provides detailed, repeated measurements of many individual and household characteristics, including a child's height and weight throughout her childhood and adolescence as well as a battery of tests designed to measure her cognitive and non-cognitive development.

For the main focus of the paper–childhood non-cognitive abilities–the NLSY79-CYA asks a set of questions about both behavioral problems and self-esteem. For behavioral problems, the NLSY79-CYA forms a Behavioral Problem Index (BPI) based on responses from mothers of children aged 4-14. The NLSY79-CYA calculates BPI percentile scores and multiple subscales that measure several distinct types of behavioral problems. In addition to the overall BPI index, we focus on a set of subscales that measures the extent to which behavioral problems are externalized or internalized. Externalized behavior problems involve the child acting out in some way (e.g., physical aggression, strong temper) while internalized behavior problems are those that describe the child's inner mental state (e.g., socially withdrawn, feeling worthless).[11]

[10] Equation 4 is an equivalent of the equation below:

$$\begin{aligned} Y_{i,t} = \; & \alpha + \beta_1 \text{BMI Z-score}_{i,t-1} + \beta_2 I\{\text{Overweight}\}_{i,t-1} \\ & + \beta_3 I\{\Delta\text{BMI Percentile} < 0\}_{i,t} + \beta_4 |\Delta\text{BMI Percentile}_{i,t}| \\ & + \beta_5 I\{\Delta\text{BMI Percentile} < 0\}_{i,t} \cdot I\{\text{Overweight}\}_{i,t} \\ & + \beta_6 I\{\Delta\text{BMI Percentile} < 0\}_{i,t} \cdot |\Delta\text{BMI Percentile}_{i,t}| \\ & + \beta_7 I\{\text{Overweight}\}_{i,t-1} \cdot |\Delta\text{BMI Percentile}_{i,t}| \\ & + \beta_8 I\{\text{Overweight}\}_{i,t-1} \cdot |\Delta\text{BMI Percentile}_{i,t}| \cdot I\{\Delta\text{BMI Percentile} < 0\}_{i,t} \\ & + \gamma X_{i,t} + \omega Y_{i,j,t-1} + \varepsilon_{i,t} \end{aligned} \tag{5}$$

Each of the θ from Equation 4 is a linear combination of some β in Equation 5. We present the regression results for Equation 5 in Table A5.

[11] A number of other papers in the economic literature have also used these internalizing and externalizing behaviors in their analysis, including Heckman et al. (2013), Neidell and Waldfogel (2010), and Juhn et al. (2015). Studies in

A higher score on the BPI Percentile is associated with increased behavioral problems. In regressions not shown, we find that BPI and self-esteem measures are inversely correlated and that a higher BPI is predictive of worse self-esteem at the 1% significance level. Additionally, the NLSY79-CYA asks a set of 12 questions to measure childhood self-worth. All children ages eight and older were asked these questions from 1986-1992. In 1994 only children aged 8-14 were asked and from 1996 until 2012, self-worth questions were only asked to children aged 12-14.[12] Although the self-worth questions were asked of NLSY79-CYA children as young as eight in the earlier survey years, the NLSY79-CYA notes that "scores for younger children may have been somewhat less reliable and valid." As such we restrict our self-worth analysis to children aged 12-14 for reliability and consistency across survey waves. Unfortunately that means that, for each respondent, we have at most one or two measures of self-esteem, which prevents us from examining changes in self-worth over time or the impact of moving on self-worth, since the sample would be too small.

The NLSY79-CYA contains self-reported measures of height and weight. We follow the literature and adjust these for possible measurement and reporting errors (Cawley, 2004).[13] We are particularly interested in BMI percentile changes between waves for children who move between MSAs. Figure 3 plots the distribution of changes in BMI percentile rank between waves among movers. While the average moving child in the NLSY79-CYA only experiences a small percentile rank change following a move (on average 1.56 percentile points), there is in fact a wide range of positive and negative movement in relative weight for this sample.

Table 1 presents summary statistics of select variables from our NLSY79-CYA sample from 1986-2012. We restrict the sample to children between the ages of 5 and 16. Since our main

the psychology literature have found that internalizing and externalizing challenges are negatively correlated with positive attributes from other personality measures such as agreeableness, conscientiousness, and openness (Ehrler et al., 1999). More information about the NLSY79-CYA's construction of BPI and these subindices can be found in Baker et al. (1993).

[12] The NLSY79-Young Adult sample also has another set of measures–Rosenberg index that surveys those who are between age 15 or older.

[13] These adjustments are estimated using information from the National Health and Nutrition Examination Survey (NHANES) III survey which collected both self-reported and measured height and weight. We regress measured weight on a constant, self-reported weight, and the square of self-reported weight in four separate regressions for each combination of [black/white] and [male/female]. We then use these coefficients to correct self-reported weight in the NLSY79-CYA surveys. Further, the NHANES III has slight differences in recording self-reported weight based on the age of respondents—0-11 are based on parental response, 12-16 are based on youth's response at examination, and 17-40 are based on adult's response prior to examination—so we estimate different reporting corrections for each age group separately. We repeat this correction for self-reported height following the same procedure.

identification strategy restricts to children who move MSAs between waves, we show summary statistics for two groups: all children and just for children who moved between MSAs between survey waves. In the NLSY79-CYA, roughly 39% of surveyed children ever experience a move between MSAs and roughly 6% move between any two biannual survey waves. Children we observe moving between waves are not randomly drawn from the population; they are more likely to be white, have a slightly lower BMI Z-score, be slightly younger, and have slightly younger and less educated mothers.

It is possible that there are unobserved differences in families or destinations that are correlated with a child's pre-move weight. That is, could it be that only certain types of families move from the South to the Midwest, or vice versa, or only certain types of families move from a low-BMI MSA to a high-BMI MSA? Such unobserved differences in location decisions could lead to a spurious correlation even among moving families. To investigate this possibility we compare observable differences in household characteristics between children who gain relative weight and those who lose relative weight as a result of moving across MSAs. To compare these households and children, we classify children based on whether they gain or lose relative weight by calculating residuals from a regression of percentile rank change on absolute weight change and destination and origin state pair fixed effects. Children with positive residuals are classified as moving to places where they gain relative weight and those with negative residuals as losing weight due to their move. Table 2 presents summary statistics for these children with Columns 1 and 2 showing the average characteristics by this classification and Column 3 presenting p-values for a t-test of equality between Column 1 and 2.

We see that, in the survey wave prior to their move, children who gain relative weight and those who lose relative weight appear similar across a large set of family characteristics, including race, mother's age, and mother's education. Additionally, children who gain relative weight have similar ages, gender, previous behavioral problems, and self-worth measures to children who lose relative weight. We take this as validation of our identification strategy; the gain and loss of relative weight does not appear correlated with observed characteristics at the household and individual level, except their actual weight, which we control for in all specifications.[14] It should also be noted that the relationship between gaining and losing relative weight and prior weight in the top panel of Table 2 is essentially by construction. Children who have a high absolute weight or are high in their previous MSA's weight distribution have much more room to move downward in their relative weight distribution (and vice versa for lower-weight children).

Our empirical strategy also examines whether overweight children are more affected by changing relative weight than normal- weight children. We can perform a similar check exclusively for overweight children who gain and lose weight as a result of their move, with corresponding summary statistics presented in Appendix Table A1.

4 Results

Table 3 presents estimates of the importance of both absolute and relative body size on behavioral problems and feelings of self-worth, where relative body size is defined as a child's BMI percentile within her MSA, race, and gender (see Section 2 for how BMI percentile is constructed). The dependent variables are in percentile points. In Columns 1 and 4, we replicate established patterns in the literature finding that weight is positively associated with increased behavioral problems and lower self-esteem. A one-unit increase in absolute BMI Z-score change is associated with a 0.74 percentile point increase in behavioral problems and a 3 percentile point drop in self-esteem. However, when we include a measure of relative weight in Columns 2 and 5, we see that the coefficient on absolute body weight is either no longer significant or even reverses signs. This horse race between absolute and relative body size has never been explored in this literature. This result confirms our hypothesis that body size is, in part, a relative concept and it is the perception of relative body size (not absolute body size) that affects one's behavioral outcomes.

Columns 3 and 6 present our estimates of Equation 2, which includes an interaction term between relative weight and a child's own body size. We hypothesized that those children who are

[14] We should note that this table does not suggest that parental characteristics are not predictive of the type of places they move to. Instead, once we include destination and origin state pair fixed effects, these observables do not predict whether they would move to a higher-BMI or a lower-BMI MSA. This table also reinforces the illustration from Figure 2 that it may be difficult for parents to predict whether their child would gain or lose relative weight via moving.

heavier are more affected by changes in relative weight and so include interactions for whether the child is overweight or obese. The results indicate that the patterns seen in Columns 2 and 5 are primarily driven by overweight children. The estimate of β_3 on the interaction term suggests that children who are overweight are more affected by worsening relative weight for both behavioral problems and self-esteem. β_2 and β_3 are statistically different from each other at the 1% level in both Columns 3 and 6. Among those who are overweight or obese, if their BMI percentile ranks increase by 10 percentile points, their behavioral problem index would increase by 0.9 percentile points and their self-esteem would drop by 4.5 percentile points. This echoes our previous discussion that children who are already overweight or obese may be more likely to be subject to teasing and mocking by their peers and so their behavioral problems and self-esteem are more fragile than those of average-weight children.

4.1 The importance of relative weight for moving children

Interpreting these cross-sectional results as causal may be problematic since the variation in BMI percentile is almost entirely driven by one's MSA, gender, and race. It is possible that some unobserved characteristics are associated with both lower weight distributions and worsened child outcomes at the MSA level. Our preferred specification thus exploits variation in relative weight that arises when a child moves between MSAs. We restrict our analysis to children who move across MSAs between survey waves of the NLSY79-CYA.

Unfortunately, this sample restriction substantially reduces the number of respondents with self-worth answers. This leaves us unable to estimate the effect of changing relative weight alongside the rich set of covariates such as origin and destination state fixed effects pairs. Accordingly, we do not present any self-worth results for the rest of the analysis.

Table 4 Column 1 presents estimates from Equation 3. Column 1 reveals that when we interact the change in relative BMI with a dummy indicating whether a child is overweight or obese, we find that there are significant heterogeneities in the impact of relative obesity. That is, after experiencing a relative weight gain, the behavior of overweight children worsens while the behavior of non-overweight children is unaffected. A 10 percentile point increase in an overweight child's relative weight would increase her behavioral problem index by 2 percentile points. The magnitude of this coefficient is quite large. A two-year increase in maternal education is associated with a 2 percentile point improvement in a child's behavioral problem index (see Table A2 for the full regression results). The relative weight and BPI elasticity is 0.164 evaluated at the respective mean; in comparison, the elasticity for maternal education is 0.209.

Could there be an alternative hypothesis that explains this pattern? One possibility is that parents specifically move because their children are overweight and are being bullied in schools. Parents may select higher-BMI schools where their children seem to fit in, which in turn reduces their behavioral problems. This is possible but would need parents to respond not just by moving school districts but by moving MSAs, changing jobs, etc, in order to invalidate our identification strategy. Further, even moves to nearby MSAs are unlikely to drive our results as nearby MSAs tend to have similar weight distributions and as such these children would not experience a large change in our definition of relative weight.

Another possibility is that our findings are explained by unobserved differences in destination and origin MSA characteristics which are not adequately addressed by origin-destination state pair dummies. We address this concern in two ways. First, in an alternative specification we include a set of origin MSA and destination MSA dummies. These dummies should capture the time-invariant characteristics of the people who move to and from each MSA as well as the time-invariant MSA-level characteristics that might also influence a child's behavioral development. Estimates that include these fixed effects are presented in Table 4, Column 2. We see virtually no change in our estimated effect of increased relative weight on behavioral problems for overweight children.

Second, even if there are no selection effects on the type of households who choose to move to a particular MSA, another possibility is that differences in non-body size-related characteristics between origin and destination MSAs could cause behavioral problem changes. For example, in moving from Houston to LA, a child would not only experience relative weight gain but also may experience a shock in population density, racial composition, income, or economic development. It is not clear how this hypothesis might explain our finding that overweight children are affected more negatively by the shock than non-overweight children; we nevertheless test the hypothesis. We incorporate county-level characteristics, measured in the 1980s and 1990s, from the NLSY79-CYA geocode data. We also construct median height and median income within an MSA to capture some fixed differences in characteristics across MSAs. We then modify our original specification to include the difference in log population density, unemployment rate, percent black, median income, and median height between the origin and destination MSA for movers. These estimates are presented in Table 4 Column 3.

In Column 4, we include both real household income as well as relative income percentile within a given MSA/race/gender reference group. We lose 235 observations that either are missing information on income or have fewer than 15 unique observations within a reference group to identify household income distributions. We find that if anything, the inclusion of relative income increases the estimated impact of gaining relative weight on overweight children.[15] In Column 5, we omit children who experience extremely large changes in relative weight upon moving to ensure that our results are not solely driven by these outliers. In particular, we drop respondents whose BMI percentile change is at the top or bottom 5% from our sample. This restriction, if anything, strengthens our findings.

Additionally, we perform a falsification exercise by examining whether a child's relative weight change due to a move between period t and $t-1$ has any effect on changes in their behavioral problems from the previous period $t-1$ and $t-2$.

The results of this test can be found in Table A3.[16] We find that relative weight changes for children who move are not predictive of changes in behavioral problems that occurred prior to the move. This amounts to a pre-trend check where we find that trend changes in behavioral problems prior to a move are uncorrelated with the relative weight changes that a move induces. This, in combination with Table 2, says that both trends in child behavioral problems, as well as a large

[15] While the coefficient is not presented here, we find that gaining relative income is associated with fewer behavioral problems.

[16] There is a large drop in the sample size for two reasons. First, among the 735 movers in our main tables, this regression setup requires the movers to have valid BPI measures in survey waves $t-1$ and $t-2$. Given the fact that NLSY is only conducted every 2 years, and BPI is only surveyed of children between ages 4-13, that means we lose 200 of the movers because they were too young and BPI was not collected in the periods prior to the move $t-2$. For example, a 7-year old, who would be in Table 4, would not have entered this regression since at survey wave $t-2$, he would be only 3 year old. Furthermore, even among the ones who were old enough to be surveyed, almost 170 of them have missing BPI at $t-2$.

set of time-varying controls, are not predictive of whether a child will gain or lose relative weight upon moving to a new MSA.

As described in Section 2, results so far have all used NLSY-CYA and NLSY97 respondents under the age of 22 and with at least 15 unique respondents within a MSA/race/gender as a reference group. This results in using 18,547 unique individuals in our reference group estimation, with 33 individuals in the median reference group. If we increased the number of observations in reference groups, we could improve the precision of our child percentile rank estimates. Therefore, in Table 5 we explore using alternative, larger samples to estimate reference groups' BMI distribution.

First, we include all NLSY respondents in estimating local BMI distributions, forgoing the age 22 sample restriction. This adds another 2,000 individuals to our reference group calculation and, as a result, more reference groups contain more than 15 unique respondents, which also increases the total number of child observations to 778 from 735 in our sample of moving children. It would make little sense to compare adult and child body size directly; instead, we compare body sizes within gender and age group, converting all observations to z-scores according to the methodology described in Section 2. Thus, the expanded reference groups consist of the BMI z-scores of all respondents of same race and gender in each MSA. The results using this definition of reference group are presented in Column 2 of Table 5. Compared to the original specification where the reference groups only contain those under age 22, the results are robust and the magnitudes are similar.

Next we estimate reference-group weight distributions using data from the Behavioral Risk Factor Surveillance System (BRFSS), an annual cross-sectional survey of health behaviors with over 400,000 respondents age 18 and above each wave. We use BRFSS Selected Metropolitan/Micropolitan Area Risk Trends (SMART) data from 2002 to 2010 to calculate BMI distributions at the MSA, race, and gender levels.[17] BRFSS SMART data is available for individuals in counties with at least 500 respondents during a survey wave. We aggregate to the MSA level and then calculate BMI z-score percentiles at the MSA, race, and gender level. Among the reference groups that are available in BRFSS, we use 1.2 million observations to estimate distributions of 591 reference groups,

[17] We correct for reporting errors using NHANES adjustments, as we did for our NLSY weight data.

with a median size of 156 individuals; using this data set makes our percentile rank estimates more precise. However, as a result of the county size restriction imposed by BRFSS, we are left with fewer available reference groups and only 550 observations. Results using exclusively BRFSS-estimated weight distributions are presented in Table 5, Column 3. In Column 4, we use all available weight data at the MSA level – data from the NLSY-CYA, NLSY97, and BRFSS–in estimating the BMI distribution within MSA, race, and gender cells. We see that our results are robust to the broadest estimation of the BMI rank of a child within her reference group. Lastly, obesity was rising during this period. Different MSAs could have differential trends. In Column 5, we construct the reference group by MSA, race, gender, and decade using the same sample as Column 4. The results are robust and the magnitudes are similar to the original specification in Column 1.

In Section 2, we discuss our choice of using MSA as a reference group. In Columns 6 and 7, we examine whether our results are robust to using broader or narrower geographic level for reference groups. In Column 6, we estimate BMI distribution at the county, race, and gender levels. In Column 7, relative weight is assessed at the state, race and gender levels. We see that while the signs and magnitudes are similar using county reference group, they are insignificant at the state level, indicating that state might be too broad to consider as a reference group for body size.

We next focus on the subindices of the BPI to explore precisely the source of changes in child behavior after experiencing an increase in relative weight. Two of the main subindices that researchers have used are externalizing and internalizing behavioral problems. Externalizing behavior refers to behaviors including antisocial behavior, hyperactive behaviors, conduct disorders, and more general aggression. Internalizing behavior refers to a set of constructs including dependency and withdrawn behavior. Anxiety and depression are loaded in both externalizing and internalizing behaviors.[18]

Table 6 shows our estimated impact of relative weight change for both internalized and externalized behavioral problems. The results in this table suggest that only externalizing behavioral problems worsen when overweight children experience an increase in relative BMI. For an overweight child, a 10 percentile point increase in relative weight rank leads to a 1.6 percentile point increase in externalizing problems. The relative BMI to Externalizing BPI elasticity is 0.138.

[18]The full list of questions and their divisions to externalizing/interalizing behaviors is provided in the Appendix.

Heterogeneity by gender We examine the differential impact of relative weight by gender for behavioral problems and report these results for each of the two subindices. Results are reported in Table 7. For general behavioral problems, we find that both overweight boys and girls are affected. While the coefficients on boys are almost twice as large as the coefficients on girls, we fail to reject the null hypothesis that coefficients for boys and girls are statistically different. Consistent with our finding in Table 6, we find that neither boys' nor girls' internalizing behaviors are affected. In contrast, girls are more affected in terms of externalizing behavioral problems. We also examine whether there is a differential effect by race, but we find no statistically significant difference in the effect on black and non-black children. The results are presented in Table A4.

Gain versus Loss We further examine whether relative weight gains are experienced differently from relative weight losses for those who are overweight, as specified in Equation 4. We present the total effect of gaining/losing one percentile point by body size. Results are reported in Table 8. The regression result including all the double and triple interaction terms is reported in Table A5. There are two interesting patterns worth noting. First, the effect of losing relative weight is particularly large for those who were previously overweight. In other words, an overweight child moving to a place where she experiences a 10 percentile point decrease in relative weight leads to a 2.2 percentile point reduction in behavioral problems. The relative BMI-BPI elasticity for loss is 0.17. Second, the effect of losing relative weight is generally larger than the effect of gaining relative weight. We test whether the impacts are symmetric in gain and loss domains, for overweight and non-overweight individuals separately. P-values for the tests are both above 0.10, suggesting that while the impact may be larger for those who lose relative weight, we fail to reject the null hypothesis that they are symmetric.

Threat to Identification There are a few potential threats to identification. First, is there a psychological effect of moving, which could lead to more behavioral problems? While certainly possible, the psychological effect of the move should be uncorrelated with the changes in relative BMI percentile. Even if moving does have a psychological effect on children, since our sample is restricted to only movers, the average psychological effect of moving would have been captured by the constant or the set of fixed effects. An additional piece of evidence suggesting that this concern is not a serious threat to identification is our finding that movers do not gain more absolute weight between two periods relative to non-movers (results shown in Column 1 of Table A6). It is possible that if a child experiences a relative weight gain due to moving, she loses absolute weight as a result and her behavior improves due to the absolute weight gain. If the loss in absolute weight is a result of the increase in relative weight, we do not consider this to be a source of bias. Rather, we consider that a potential mechanism that could explain our findings. To investigate this mechanism, we try to examine whether moving to a place with a higher obesity rate would cause one to gain weight.[19] The results are presented in Column 2 of Table A6. We find that if one moves to a place where the obesity rate increases by 10%, the person would gain absolute weight by roughly one tenth of a standard deviation. While significant, this effect is small. Given this finding, we perform additional analysis, by including changes in absolute weight gain in regression specifications. The results are presented in Table A7. Inclusion of the change in absolute weight does not affect the interpretation nor the magnitude of the key variables of interest. These results suggest that changing absolute weight is not a mechanism that explains our prior findings.

5 Conclusion

In this paper, we utilize the fact that body size is, to an extent, a relative concept and there is large variation in average body sizes across MSAs. Children can therefore gain or lose weight in relative terms when their parents move between MSAs. We causally identify the impact of gaining weight on behavioral problems. We find that among overweight children who move between MSAs, those who gain relative weight as a result of moving have more behavioral problems. The magnitude of the short-term effect is large. Unfortunately, we were not able to apply the same identification strategy to detect the long term consequences of these moves on wages and education due to the limited size of our sample. A simple back-of-envelope calculation and a power calculation suggest that we need more than 50,000 observations to be able to detect the long-term effect. Alternatively, we

[19] A paper by (Datar and Nicosia, 2018) finds that children in military families gained weight when they were exogenously assigned to move to a neighborhood with higher BMI.

provide evidence that noncognitive ability at adolescence is an important determinant of education attainment, adult self-esteem, and wages (Appendix Table A8). This suggests that losing relative weight during their adolescence could have a long-term impact on wages and education attainment.

References

Baker, Paula C et al., "NLSY child handbook: A guide to the 1986-1990 National Longitudinal Survey of Youth child data," 1993.

Baum, Charles L and William F Ford, "The wage effects of obesity: a longitudinal study," *Health Economics*, 2004, *13* (9), 885–899.

Biro, Frank M, Ruth H Striegel-Moore, Debra L Franko, Justina Padgett, and Judy A Bean, "Self-esteem in adolescent females," *Journal of Adolescent Health*, 2006, *39* (4), 501–507.

Brown, Gordon DA, Jonathan Gardner, Andrew J Oswald, and Jing Qian, "Does Wage Rank Affect EmployeesŠ Well-being?," *Industrial Relations: A Journal of Economy and Society*, 2008, *47* (3), 355–389.

Brunello, Giorgio and Béatrice dŠHombres, "Does body weight affect wages?: Evidence from Europe," *Economics & Human Biology*, 2007, *5* (1), 1–19.

Burke, Mary A and Frank Heiland, "Social dynamics of obesity," *Economic Inquiry*, 2007, *45* (3), 571–591.

Card, David, Alexandre Mas, Enrico Moretti, and Emmanuel Saez, "Inequality at work: The effect of peer salaries on job satisfaction," *The American Economic Review*, 2012, *102* (6), 2981–3003.

Carneiro, Pedro, Claire Crawford, and Alissa Goodman, "The impact of early cognitive and non-cognitive skills on later outcomes," 2007.

Cawley, John, "The impact of obesity on wages," *Journal of Human Resources*, 2004, *39* (2), 451–474.

Chen, Alice J., "When does weight matter most?," *Journal of Health Economics*, 2012, *31* (1), 285 – 295.

Chetty, Raj and Nathaniel Hendren, "The Impacts of Neighborhoods on Intergenerational Mobility: Childhood Exposure Effects and County-Level Estimates," NBER Working Papers, National Bureau of Economic Research, Inc May 2015.

Clark, Andrew E, Paul Frijters, and Michael A Shields, "Relative income, happiness, and utility: An explanation for the Easterlin paradox and other puzzles," *Journal of Economic Literature*, 2008, pp. 95–144.

Conley, Dalton and Rebecca Glauber, "Gender, body mass, and socioeconomic status: new evidence from the PSID," *Advances in Health economics and Health Services Research*, 2007, *17*, 253–275.

Datar, Ashlesha and Nancy Nicosia, "Assessing social contagion in body mass index, overweight, and obesity using a natural experiment," *JAMA pediatrics*, 2018, *172* (3), 239–246.

Ehrler, David J, J Gary Evans, and Ron L McGhee, "Extending Big-Five theory into childhood: A preliminary investigation into the relationship between Big-Five personality traits and behavior problems in children," *Psychology in the Schools*, 1999, *36* (6), 451–458.

Fortin, Bernard and Vincent Boucher, "Some challenges in the empirics of the effects of networks," in "The Oxford Handbook of the Economics of Networks" 2015.

French, Simone A, Mary Story, and Cheryl L Perry, "Self-esteem and obesity in children and adolescents: a literature review," *Obesity Research*, 1995, *3* (5), 479–490.

Han, Euna, Edward C Norton, and Sally C Stearns, "Weight and wages: fat versus lean paychecks," *Health Economics*, 2009, *18* (5), 535–548.

Harrist, Amanda W, Taren M Swindle, Laura Hubbs-Tait, Glade L Topham, Lenka H Shriver, and Melanie C Page, "The Social and Emotional Lives of Overweight, Obese, and Severely Obese Children," *Child Development*, 2016.

Hebl, Michelle R and Todd F Heatherton, "The stigma of obesity in women: The difference is black and white," *Personality and Social Psychology Bulletin*, 1998, *24*, 417–426.

Heckman, James J and Yona Rubinstein, "The importance of noncognitive skills: Lessons from the GED testing program," *American Economic Review*, 2001, *91* (2), 145–149.

Heckman, James J., Jora Stixrud, and Sergio Urzua, "The effects of cognitive and noncognitive abilities on labor market outcomes and social behavior," *Journal of Labor Economics*, 2006, *24*, 411–482.

Heckman, James, Rodrigo Pinto, and Peter Savelyev, "Understanding the mechanisms through which an influential early childhood program boosted adult outcomes," *The American Economic Review*, 2013, *103* (6), 2052–2086.

Hesketh, Kylie, Melissa Wake, and Elizabeth Waters, "Body mass index and parent-reported self-esteem in elementary school children: evidence for a causal relationship," *International Journal of Obesity*, 2004, *28* (10), 1233–1237.

Juhn, Chinhui, Yona Rubinstein, and C Andrew Zuppann, "The Quantity-Quality Trade-off and the Formation of Cognitive and Non-cognitive Skills," Technical Report, National Bureau of Economic Research 2015.

Kernper, Karen A, Roger G Sargent, J Wanzer Drane, Robert E Valois, and James R Hussey, "Black and white females' perceptions of ideal body size and social norms," *Obesity Research*, 1994, *2* (2), 117–126.

Kuczmarski, Robert J, Cynthia L Ogden, Shumei S Guo, Laurence M Grummer-Strawn, Katherine M Flegal, Zuguo Mei, Rong Wei, Lester R Curtin, Alex F Roche, and Clifford L Johnson, "2000 CDC Growth Charts for the United States: methods and development.," *Vital and health statistics. Series 11, Data from the national health survey*, 2002, (246), 1–190.

Lumeng, Julie C, Patrick Forrest, Danielle P Appugliese, Niko Kaciroti, Robert F Corwyn, and Robert H Bradley, "Weight status as a predictor of being bullied in third through sixth grades," *Pediatrics*, 2010, *125* (6), e1301–e1307.

Luttmer, Erzo FP, "Neighbors as negatives: Relative earnings and well-being," *The Quarterly journal of economics*, 2005, *120* (3), 963–1002.

Mobius, Markus M and Tanya S Rosenblat, "Why beauty matters," *The American Economic Review*, 2006, pp. 222–235.

Mocan, Naci and Erdal Tekin, "Ugly criminals," *The review of Economics and Statistics*, 2010, *92* (1), 15–30.

_ **and** _ , "Obesity, Self-Esteem, and Wages," *Economic Aspects of Obesity*, 2011, p. 349.

Morris, Stephen, "The impact of obesity on employment," *Labour Economics*, 2007, *14* (3), 413–433.

Murphy, Richard and Felix Weinhardt, "Top of the class: The importance of ordinal rank," 2014.

Neidell, Matthew and Jane Waldfogel, "Cognitive and noncognitive peer effects in early education," *The Review of Economics and Statistics*, 2010, *92* (3), 562–576.

Persico, Nicola, Andrew Postlewaite, and Dan Silverman, "The Effect of Adolescent Experience on Labor Market Outcomes: The Case of Height," *Journal of Political Economy*, 2004, *112* (5).

Rimm, Sylvia, *Rescuing the Emotional Lives of Our Overweight Children: What Our Kids Go Through-And How We Can Help*, Rodale, 2004.

Strauss, Richard S, "Childhood obesity and self-esteem," *Pediatrics*, 2000, *105* (1), e15–e15.

Viner, Russell M and Tim J Cole, "Adult socioeconomic, educational, social, and psychological outcomes of childhood obesity: a national birth cohort study," *BMJ*, 2005, *330* (7504), 1354.

Welch, Claudette, Susan M. Gross, Yvonne Bronner, Natalie Dewberry-Moore, and David M. Paige, "Discrepancies in body image perception among fourth-grade public school children from urban, suburban, and rural Maryland," *Journal of the American Dietetic Association*, 2004, *104* (7), 1080 – 1085.

Table 1: Summary Statistics

	All Children	Movers Only	P-values for Col(1)=Col(2)
Body Size Measures			
BMI Z-score (gender-age)	.41	.26	0.00
	(1.34)	(1.36)	
BMI percentile (MSA-gender-race) (0..100)	51.24	47.93	0.00
	(29.08)	(29.44)	
Individual Characteristics			
Behavioral problem index percentile (BPI) (0..100)	58.18	60.1	0.01
	(28.17)	(27.55)	
Externalizing BPI percentile (0..100)	52.95	54.55	0.02
	(27.57)	(27.67)	
Internalizing BPI percentile (0..100)	51.02	53.48	0.00
	(26.87)	(27.54)	
Self Worth Index percentile	50.18	48.86	0.38
	(28.48)	(27.65)	
Black	.29	.25	0.00
	(.45)	(.43)	
Hispanic	.25	.26	0.27
	(.44)	(.44)	
Female	.49	.49	0.62
	(.5)	(.5)	
Child Age	10.57	10.02	0.00
	(3.39)	(3.38)	
Mother's Characteristics			
Mother's age at birth of child	25.97	24.26	0.00
	(5.64)	(5.21)	
Mother's highest grade completed	12.76	12.48	0.00
	(2.46)	(2.32)	
Total family Income, 2006 dollars (topcoded)	63.95	57.16	0.00
	(93.61)	(104.68)	
Mother is married	.62	.61	0.11
	(.48)	(.49)	
HOME Inventory percentile	47.17	47.34	0.82
	(29.3)	(28.67)	
Observations	34042	2185	

Note: Unweighted means and standard deviations are presented. Standard deviations in parentheses. Column 1 includes all NLSY-CYA (1986-2012) children between ages 5 and 16 who are in a reference group (MSA / race / gender) with more than 15 unique respondents. For body size calculation, reference groups used are noted in parentheses. Column 2 restricts this sample to children who moved MSAs between two consecutive survey waves.

Table 2: Summary Statistics Among Movers by Relative Weight Change

	Gain Relative Weight	Lose Relative Weight	P-values for Col (1)=Col (2)
Body Size Measures			
BMI Z score (gender-age)$_{t-1}$	.07	.06	0.85
	(1.24)	(1.66)	
BMI percentile (MSA-gender-race) (0..100)$_{t-1}$	37.41	49.46	0.00
	(28)	(30.51)	
Overweight$_{t-1}$	.18	.28	0.00
	(.39)	(.45)	
Individual Characteristics			
Behavioral Problem Index (BPI) Percentile$_{t-1}$	61.6	60.12	0.27
	(27.55)	(28.67)	
Self Worth Index percentile$_{t-1}$	45.61	50.85	0.93
	(28.56)	(28.46)	
Black dummy	.13	.11	0.58
	(.34)	(.32)	
Hispanic dummy	.11	.11	0.59
	(.31)	(.32)	
Female dummy	.5	.46	0.42
	(.5)	(.5)	
Age$_{t-1}$	7.14	7.03	0.60
	(2.82)	(2.87)	
Mother's and Household Characteristics			
Mother's age at birth of child	24.51	25.08	0.14
	(5.01)	(4.94)	
Mother's highest grade completed	12.87	13.09	0.25
	(2.21)	(2.24)	
Household income/1000 (2006 dollars) $_{t}$	.08	.09	0.74
	(.14)	(.15)	
Household income/1000 (2006 dollars) $_{t-1}$	.07	.08	0.90
	(.12)	(.13)	
Mother is married$_{t}$	.73	.74	0.55
	(.44)	(.44)	
Mother is married$_{t-1}$	.74	.75	0.85
	(.44)	(.43)	
Home Investment Score$_{t}$	54.25	54.9	0.88
	(27.01)	(27.25)	
Home Investment Score$_{t-1}$	54.47	55.94	0.67
	(26.02)	(27.72)	
Observations	474	475	

Note: Data is from NLSY-CYA (1986-2012) sample of children between ages 5 and 16 who are in a reference group (MSA / race / gender) with more than 15 unique respondents who moved MSAs between two consecutive survey waves. Unweighted means and standard deviations are presented. Standard deviations in parentheses. Column 1 restricts sample to children who gain relative weight as a result of moving. Column 2 restricts to children who lose relative weight as a result of moving. Column 3 presents p-values from t-tests for equality between Column 1 and Column 2.

Table 3: Absolute and Relative BMI on Behavioral Problem

	BPI_t			Self $Worth_t$		
	(1)	(2)	(3)	(4)	(5)	(6)
BMI $Z\text{-score}_t$	0.750**	-0.513	-0.494	-3.273***	3.072**	3.075**
	(0.235)	(0.461)	(0.461)	(0.462)	(1.392)	(1.390)
BMI $percentile_t$		0.041			-0.234***	
		(0.025)			(0.059)	
$Overweight_t$=0 X BMI $percentile_t$, β_2			0.035			-0.213***
			(0.026)			(0.060)
$Overweight_t$=1 X BMI $percentile_t$, β_3			0.092**			-0.431***
			(0.045)			(0.091)
N	20334	20334	20334	5404	5404	5404

Notes: Regressions include controls for age, mother's age at first birth, mother's highest grade completed, and reference group fixed effects. Robust standard errors are clustered at the individual level. Data from Children of the NLSY79 sample, 1986-2012. Dependent variables for Columns 1-3 are behavioral problem index (BPI) percentile between ages 5-16 and for Columns 4-6 are self-worth index percentile score between ages 12-16. The BPI and self-worth percentile points are provided by the NLSY. BMI percentile is calculated within reference groups (MSA/race/gender) using all NLSY79-CYA and NLSY97 respondents age 22 and under in an MSA with at least 15 unique respondents. Overweight is a dummy variable equal to 1 for those with BMI $\geq$ 85th percentile according to CDC weight distributions, 0 otherwise. $*$: significant at 10% level. $**$: significant at 5% level. $***$: significant at 1% level.

Table 4: Impact of Changing Relative BMI on Behavioral Problem

	Original Specification	Destination and Origin MSA FE	Diff in MSA Char	Income and Rel. Income	Omit Outliers
	(1)	(2)	(3)	(4)	(5)
BMI Z-Score$_{t-1}$	0.301	0.414	0.283	-0.323	0.0384
	(0.904)	(1.026)	(0.851)	(1.082)	(0.883)
Overweight=0_{t-1}*Δ BMI percentile$_{t-1,\, t}$	0.0367	0.0727*	0.0458	0.0608	0.0731
	(0.0428)	(0.0424)	(0.0413)	(0.0433)	(0.0600)
Overweight=1_{t-1}*Δ BMI percentile$_{t-1,\, t}$	0.206**	0.189**	0.204**	0.242**	0.319**
	(0.0766)	(0.0701)	(0.0843)	(0.0904)	(0.135)
N	735	735	729	500	660

Notes: All regressions restrict to those moved across MSAs between waves and include controls for destination and origin state pair fixed effects as well as controls for a child's previous-period outcome variable, race, gender, age, mother's age at first birth, and mother's highest grade completed. The dependent variables are behavioral problem index (BPI) percentile measured at period t. Column 1 is as specified in Equation 3. Column 2 drops the state pair fixed effects and includes origin MSA and destination MSA fixed effects. Column 3 includes differences between origin and destination MSA's median household income, median height z-score, log population density, share of black population, and unemployment rates. Column 4 includes household income and relative income percentile. Column 5 excludes those with top and bottom 5% of $abs(\Delta$ BMI percentile). Robust standard errors are clustered at the MSA level.
$*$: significant at 10% level. $**$: significant at 5% level. $***$: significant at 1% level.

Table 5: Robustness Checks: Alternative estimates of reference group BMI distributions

	Original	Alt Ref Group NLSY all	Alt Ref Group BRFSS	NLSY and BRFSS	NLSY and BRFSS By Decade	County as Ref. Groups	State as Ref. Groups
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
BMI Z-Score$_{t-1}$	-0.165	-0.772	-0.857	0.00513	-0.724	-1.391	-0.759
	(1.133)	(1.093)	(0.833)	(0.791)	(1.086)	(0.968)	(0.489)
Overweight=0_{t-1}*Δ BMI percentile$_{t-1, t}$	0.0367	0.00293	-0.0537	-0.00663	0.0175	-0.0256	-0.0221
	(0.0454)	(0.0437)	(0.0595)	(0.0397)	(0.0456)	(0.0427)	(0.0282)
Overweight=1_{t-1}*Δ BMI percentile$_{t-1, t}$	0.205**	0.162**	0.186**	0.152**	0.160*	0.249**	-0.0403
	(0.0761)	(0.0681)	(0.0672)	(0.0585)	(0.0856)	(0.125)	(0.0403)
N	720	763	550	939	671	680	1553

Notes: All regressions restrict to those moved across MSAs between waves and include controls for destination and origin state pair fixed effects as well as controls for a child's previous-period outcome variable, race, gender, age, mother's age at first birth, and mother's highest grade completed. The dependent variables are behavioral problem index (BPI) percentile measured at period t. Columns are all the same specification but with different samples used in constructing the empirical distribution of the local reference group BMI. Column 1 is the original specification and sample, same as Table 4, which uses the NLSY sample of individuals under 22. Column 2 shows estimates using all NLSY individuals without the age restriction. Column 3 shows estimates using a sample of BRFSS recipients in calculating the BMI distribution at the MSA/race/gender level. Column 4 includes both NLSY and BRFSS samples in calculating the BMI distribution. Column 5 imputes the change in relative weight using county/race/gender as reference groups. Column 6 imputes the change in relative weight using state/race/gender as reference groups. Each row conditions on at least 15 unique respondents within a reference group in calculating the reference group distributions. Robust standard errors are clustered at the MSA level.
$*$: significant at 10% level. $**$: significant at 5% level. $***$: significant at 1% level.

Table 6: Impact of Gaining Relative Weight, by Subindices

	$\text{Internalizing}_{\text{t}}$	$\text{Externalizing}_{\text{t}}$
	(1)	(2)
BMI $\text{Z-Score}_{\text{t-1}}$	0.439	-0.0430
	(1.155)	(1.037)
$\text{Overweight=0}_{\text{t-1}}$*Δ BMI $\text{percentile}_{\text{t-1, t}}$	0.0510	0.0508
	(0.0486)	(0.0423)
$\text{Overweight=1}_{\text{t-1}}$*Δ BMI $\text{percentile}_{\text{t-1, t}}$	0.0259	0.158**
	(0.0766)	(0.0691)
N	735	732

Notes: All regressions restrict to those moved across MSAs between waves and include controls for destination and origin state pair fixed effects as well as controls for a child's previous period outcome variable, race, gender, age, mother's age at first birth, and mother's highest grade completed. The dependent variables are behavioral problem index (BPI) percentile measured at period t. Robust standard errors are clustered at the MSA level. Data from Children of the NLSY79 sample, 1986-2012, restricted to children who moved MSAs between two consecutive survey waves. Distribution of BMI at the MSA level is calculated using all respondents ever observed in an MSA.
$*$: significant at 10% level. $**$: significant at 5% level. $***$: significant at 1% level.

Table 7: Impact of Gaining Relative Weight by Gender

	BPI_{t}	$\text{Internalizing}_{\text{t}}$	$\text{Externalizing}_{\text{t}}$
	(1)	(2)	(3)
Male*$\text{Overweight=0}_{\text{t-1}}$*Δ BMI $\text{percentile}_{\text{t-1, t}}$, θ_1	0.102	0.114*	0.107*
	(0.0654)	(0.0660)	(0.0634)
Male*$\text{Overweight=1}_{\text{t-1}}$*Δ BMI $\text{percentile}_{\text{t-1, t}}$ θ_2	0.299**	0.0544	0.102
	(0.153)	(0.141)	(0.151)
Female*$\text{Overweight=0}_{\text{t-1}}$*Δ BMI $\text{percentile}_{\text{t-1, t}}$ θ_3	-0.0203	0.0503	-0.00207
	(0.0489)	(0.0559)	(0.0510)
Female*$\text{Overweight=1}_{\text{t-1}}$*Δ BMI $\text{percentile}_{\text{t-1, t}}$ θ_4	0.162**	0.0162	0.190**
	(0.0682)	(0.0842)	(0.0723)
P-value for $\theta_1 = \theta_3$	.376	.779	.6
P-value for $\theta_2 = \theta_4$	.116	.458	.168
N	735	786	750

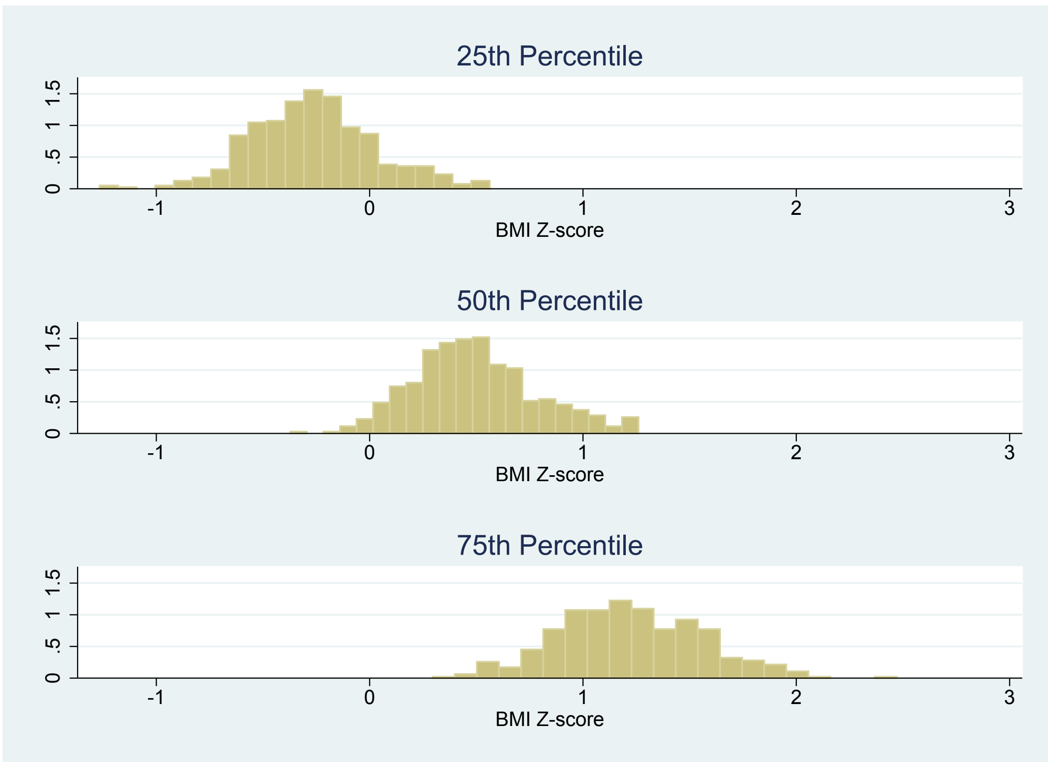
Notes: All regressions restrict to those moved across MSAs between waves and include controls for destination and origin state pair fixed effects as well as controls for a child's previous-period outcome variable, race, gender, age, mother's age at first birth, and mother's highest grade completed. The dependent variable in Column 1 is BPI percentile. The dependent variable in Column 2 is internalizing index percentile. The dependent variable in Column 3 is externalizing index percentile. Robust standard errors are clustered at the MSA level.
$*$: significant at 10% level. $**$: significant at 5% level. $***$: significant at 1% level.

Table 8: The Impact of Changing One Percentile Point, by Gain/Loss and by Body Size

Not Overweight X Gain Relative Weight, θ_1	0.0860
	(0.0859)
Overweight X Gain Relative Weight, θ_2	-0.0211
	(0.244)
Not Overweight X Lose Relative Weight, θ_3	-0.186
	(0.114)
Overweight X Lose Relative Weight, θ_4	-0.217*
	(0.116)
P-value for $\lvert\theta_1\rvert = \lvert\theta_3\rvert$	.508
P-value for $\lvert\theta_2\rvert = \lvert\theta_4\rvert$	.405
N	735

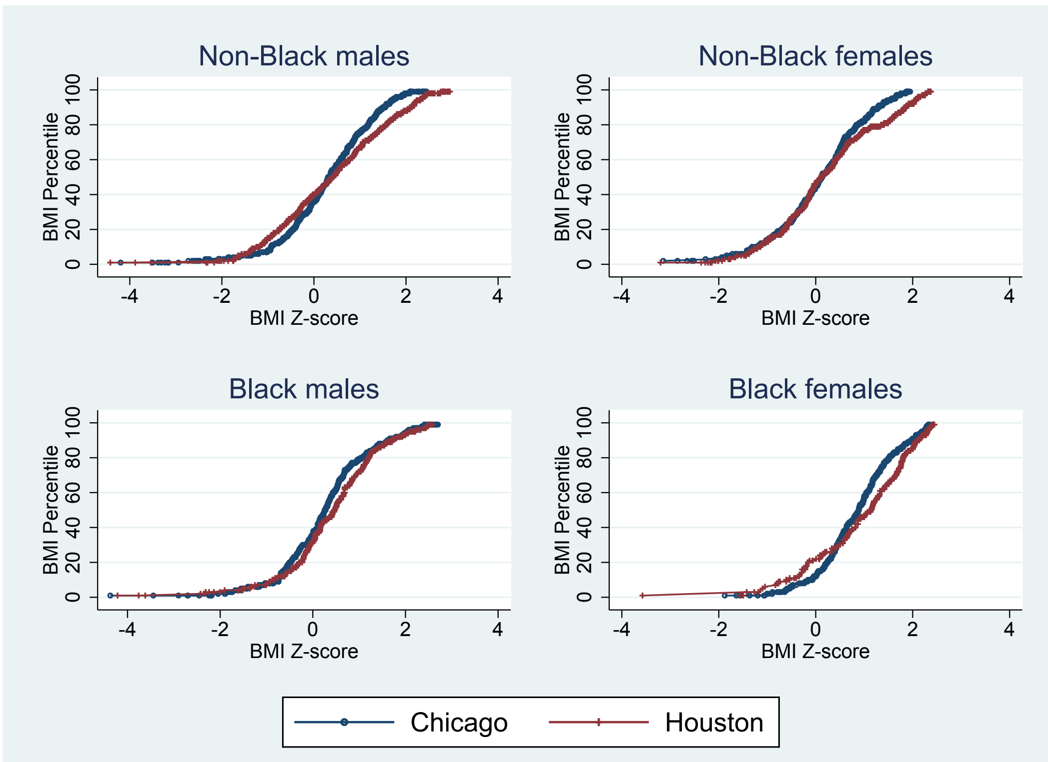
Notes: This table reports the total effect of changing relative body size one percentile point by gaining/losing relative weight and by body size. The equation is specified in Equation 4. Each of the θ coefficients is a linear combination of β coefficients from TableA5. $*$: significant at 10% level. $**$: significant at 5% level. $***$: significant at 1% level.

Figure 1: Distribution of MSA-level BMI Z-scores



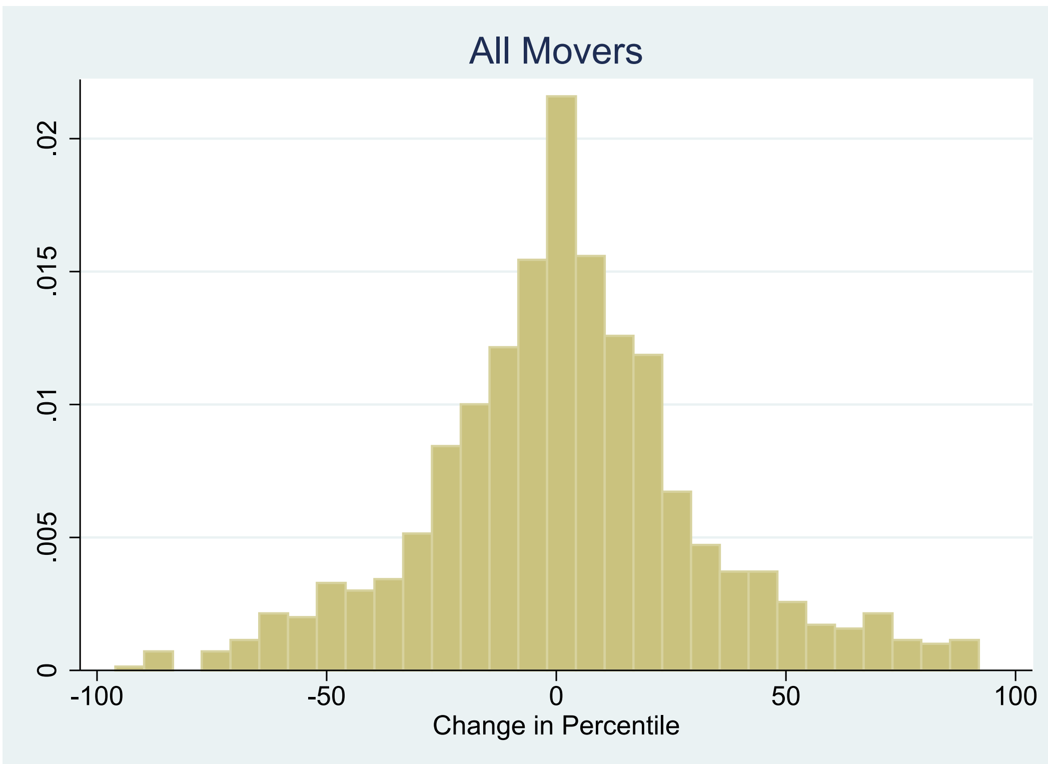
Notes: BMI Z-scores for each individual are imputed at gender-age-month level, using NLSY79-CYA and NLSY97 sample. Sample weights are not used. Panel A, B, and C present the distribution of the 25th, 50th and 75th percentiles, respectively, of BMI Z-scores for each MSA/race/gender reference group. MSAs with less than 15 unique respondents are not included.

Figure 2: CDFs of BMI Z-score Distributions, Chicago vs Houston



Notes: Data from NLSY79-CYA and NLSY97, restricted to respondents age 22 and under who reside in either the Chicago or the Houston MSA. BMI percentile is calculated based on the rank of one's BMI Z-score in the distribution of BMI Z-score for a given MSA/race/gender reference group.

Figure 3: Change in BMI Percentiles for Children Who Move



Notes: Restricted to those children who have moved between two consecutive waves in NLSY79-CYA. The y-axis presents the changes in BMI percentile between two consecutive waves among children who moved MSAs between two consecutive survey waves. We restrict the sample to reference groups with at least 15 unique respondents. The average change in BMI percentile among movers is only 1.56, but the standard deviation of the change is 0.29.

6 Appendix for Online Publication

NLSY79 Child Behavior Problems Index: Composition of the BPI subscales

Cheats or tells lies	E
Bullies or is cruel/mean to others	E
Does not seem to feel sorry after misbehaving	**
Breaks things deliberately (<12 yrs)	E
Is disobedient at school (>5 yrs)	E
Has trouble getting along with teachers (>5 yrs)	E
Has sudden changes in mood or feeling	E
Feels/complains no one loves him/her	I
Is too fearful or anxious	E/I
Feels worthless or inferior	I
Is unhappy, sad, or depressed	E/I
Clings to adults (<12 yrs)	I
Cries too much (<12 yrs)	I
Demands a lot of attention (¡12 yrs)	I
Is too dependent on others (<12 yrs)	I
Is rather high strung, tense, and nervous	E
Argues too much	E
Is disobedient at home	E
Is stubborn, sullen, or irritable	E
Has strong temper and loses it easily	E
Has difficulty concentrating/paying attention	E
Is easily confused, seems in a fog	E/I
Is impulsive or acts without thinking	E
Has trouble getting mind off certain thoughts	E
Is restless, overly active, cannot sit still	E
Has trouble getting along with other children	E
Is not liked by other children	E
Is withdrawn, does not get involved with others	I
Feels others are out to get him/her	**
Hangs around with kids who get into trouble	**
Is secretive, keeps things to self	**
Worries too much	**

Note: E=Externalizing and I=Internalizing. ** Does not load on the E-I dimensions. This can also be found on the following url: https://www.nlsinfo.org/content/cohorts/nlsy79-children/other-documentation/codebook-supplement/appendix-d-behavior-proble-0

Table A1: Individual and Household Characteristics by Relative Weight Change from Moving among Overweight Children

	Gain Relative Weight	Lose Relative Weight	P-values for T-tests
Body Size Measures			
BMI Z score (gender-age)$_{t-1}$	1.91	1.63	0.01
	(.93)	(.47)	
BMI percentile (MSA-gender-race) (0..100)$_{t-1}$	80.38	82.13	0.41
	(17.74)	(12.24)	
Overweight$_{t-1}$	1	1	.
	(0)	(0)	
Individual Characteristics			
Behavioral Problem Index (BPI) Percentile$_{t-1}$	63.28	58.3	0.12
	(29.85)	(29.27)	
Self Worth Index percentile$_{t-1}$	39.21	32.4	0.98
	(26.9)	(37.18)	
Black dummy	.25	.17	0.40
	(.43)	(.38)	
Hispanic dummy	.35	.15	0.75
	(.48)	(.36)	
Female dummy	.52	.45	0.65
	(.5)	(.5)	
Age$_{t-1}$	7.49	6.87	0.17
	(3.06)	(2.7)	
Mother's and Househond Characteristics			
Mother's age at birth of child	25.43	25.87	0.99
	(4.94)	(5.26)	
Mother's highest grade completed	12.61	13.37	0.20
	(2.74)	(2.23)	
Household income/1000 (2006 dollars)$_{t-1}$	.07	.06	0.05
	(.07)	(.05)	
Household income/1000 (2006 dollars) $_{t}$	.06	.07	0.74
	(.06)	(.13)	
Mother is married$_{t}$	.68	.63	0.14
	(.47)	(.49)	
Mother is married$_{t-1}$	.66	.67	0.81
	(.47)	(.47)	
Home Investment Score$_{t}$	50.28	52.74	0.39
	(27.34)	(26.76)	
Home Investment Score$_{t-1}$	49.25	52.23	0.73
	(27.42)	(27.15)	
Observations	110	129	

Note: Data is from NLSY-CYA (1986-2012) sample of children between ages 5 and 16 who are in a reference group (MSA / race / gender) with more than 15 unique respondents who moved MSAs between two consecutive survey waves. Unweighted means and standard deviations are presented. Standard deviations in parentheses. Column 1 restricts sample to children who gain relative weight as a result of moving. Column 2 restricts to children who lose relative weight as a result of moving. Column 3 presents p-values from t-tests for equality between Column 1 and Column 2.

Table A2: Determinants of BPI

	(1)	(2)
Overweight=1_t	0.0232	
	(1.310)	
Overweight=0_t*BMI percentile$_t$	0.0319	
	(0.0235)	
Overweight=1_t*BMI percentile$_t$	0.0933**	
	(0.0420)	
BMI Z-score$_t$	-0.431	
	(0.406)	
Mother's age at birth of child	-0.769***	-0.0233
	(0.0686)	(0.333)
Maternal years of education	-1.009***	0.449
	(0.160)	(0.577)
Maternal marital status	-6.714***	-5.850**
	(0.698)	(2.288)
Overweight=0_{t-1}		3.529
		(2.732)
Overweight=0_{t-1}*Δ BMI percentile$_{t-1,\ t}$		0.0367
		(0.0428)
Overweight=1_{t-1}*Δ BMI percentile$_{t-1,\ t}$		0.206**
		(0.0766)
Black=1		-7.745
		(4.748)
Hispanic=1		-4.965*
		(2.934)
Female=1		-2.162
		(1.928)
BPI$_{t-1}$		0.593***
		(0.0439)
N	25652	735

Column 1 present the regression results for Column 3 of Table 3. Column 2 presents the regression results for Column 1 of Table 4. Column 1 includes reference group fixed effects. Column 2 includes origin-destination state pair fixed effects

Table A3: Falsification Check

	(1)
Δ BMI percentile$_{\text{t-1, t}}$	-0.0231
	(0.0660)
N	364

Dependent variable is the change in BPI between period $t-1$ and period $t-2$. The regression restricts to those who move MSAs between period t and period $t-1$. The equation is specified as below:

$$\Delta\text{BPI percentile}_{t-2,t-1} = \alpha + \beta_1 \Delta\text{BMI percentile}_{t-1,t} + \beta_2 I\{\text{Overweight}\}_{t-1} + \beta_3 \text{BMI Z-score}_{t-1} + \gamma X_{i,t} + \varepsilon_{i,t}$$

$X_{i,t}$ includes race, gender, age, mother's age at first birth, mother's highest grade completed, mother's marital status, and a set of dummies for the origin and destination state pair of the moves. The regression also includes lagged overweight status, lagged absolute BMI Z-score.

Table A4: Heterogeneous Impa ct of Moving by Race

	BPI$_{\text{t}}$ (1)	Internalizing$_{\text{t}}$ (2)	Externalizing$_{\text{t}}$ (3)
non black*Overweight= $0_{t-1} * \Delta$ BMI percentile$_{\text{t-1, t}}$ θ_1	0.0367	0.0908**	0.0468
	(0.0416)	(0.0442)	(0.0406)
non black*Overweight= $1_{t-1} * \Delta$ BMI percentile$_{\text{t-1, t}}$ θ_2	0.227**	0.0335	0.174**
	(0.0881)	(0.0979)	(0.0828)
black*Overweight= $0_{t-1} * \Delta$ BMI percentile$_{\text{t-1, t}}$ θ_3	0.0379	-0.0163	0.0675
	(0.128)	(0.114)	(0.127)
black*Overweight= $1_{t-1} * \Delta$ BMI percentile$_{\text{t-1, t}}$ θ_4	0.108	0.00233	0.0774
	(0.108)	(0.134)	(0.145)
P-value for $\theta_1 = \theta_3$	.345	.837	.58
P-value for $\theta_2 = \theta_4$	.993	.356	.869
N	735	786	750

Table A5: Table for Gain vs Lose Relative Weight

Overweight=1_{t-1}	6.548
	(5.652)
$\lvert\Delta$BMI percentile$\rvert$	0.0860
	(0.0859)
I(Δ BMI percentile$<$ 0)=1 $\times$ Overweight=1_{t-1}	-5.959
	(7.099)
I(Δ BMI percentile$<$ 0)=1 $\times$ $\lvert\Delta$BMI percentile$\rvert$	-0.272**
	(0.134)
Overweight=$1_{t-1}\times$ $\lvert\Delta$BMI percentile$\rvert$	-0.107
	(0.256)
I(Δ BMI percentile$<$ 0)=1 $\times$ Overweight=1_{t-1} $\times$ $\lvert\Delta$BMI percentile$\rvert$	0.0760
	(0.308)
BPI_{t-1}	0.559***
	(0.0462)
BMI Z-score_{t-1}	0.333
	(1.051)
Black	-5.874
	(4.086)
Hispanic	1.882
	(3.256)
Female	-1.652
	(2.007)
Age	-1.128**
	(0.441)
Maternal age at the birth of the child	-0.412
	(0.342)
Maternal highest grade completed	-0.797
	(0.708)
Mother's marital status	-5.463*
	(2.889)
N	735

All regressions restrict to those moved across MSAs between waves and include controls for destination and origin state pair fixed effects as well as controls for a child's previous-period outcome variable, race, gender, age, mother's age at first birth, BMI Z-score, and mother's highest grade completed. It is as specified in Equation 5.

Table A6: Absolute Weight Change as a Result of Moving

	All	Movers Only
	(1)	(2)
Move $MSA_{t\text{-}1,\ t}$	-0.0135	
	(0.0508)	
Obesity Rate of New Ref Group-Obesity Rate of Prev Ref Group		1.063***
		(0.312)
N	25086	760

Column 1 includes all observations. Column 2 restricts to movers only. Controls include age, gender, and race. Obesity rate is calculated for each MSA/gender/race reference group. Difference in obesity rate equals to obesity rate from destination MSA/race/gender minus obesity rate from origin MSA/race/gender. Dependent variable is the changes in absolute weight between period t and period $t-1$.

Table A7: mechanism

	Original Specification	Destination and Origin MSA FE	Diff in MSA Char	Income and Rel. Income	Omit Outliers
	(1)	(2)	(3)	(4)	(5)
Change in BMI Z Scores	0.485	0.492	0.563	0.416	1.134
	(0.965)	(1.211)	(0.945)	(1.376)	(1.064)
Overweight=0_{t-1}*Δ BMI $\text{percentile}_{t-1,\ t}$	0.0219	0.0564	0.0287	0.0465	0.0365
	(0.0553)	(0.0558)	(0.0526)	(0.0705)	(0.0778)
Overweight=1_{t-1}*Δ BMI $\text{percentile}_{t-1,\ t}$	0.193**	0.172**	0.189**	0.229**	0.287**
	(0.0801)	(0.0782)	(0.0882)	(0.0999)	(0.137)
N	735	735	729	500	660

Notes: same specifications as Table 4 except we include a variable which capture changes in absolute weight. $*$: significant at 10% level. $**$: significant at 5% level. $***$: significant at 1% level.

Table A8: The Relationship between Adolescent Noncognitive Abilities and Education Outcome

Dependent Variable:	Highest Grade Completed (1)	Log Hourly Wage (2)	Adult Self-Esteem (3)
BPI Age 4-7	-.0012	-.00017	.0094
	(.0015)	(.00027)	(.033)
BPI Age 8-11	-.0025	-.00048	-.034
	(.0018)	(.00031)	(.038)
BPI Age 12-15	-.013***	-.00059**	-.12***
	(.0014)	(.00026)	(.033)
Mean(dep. var.)	11.57	6.72	50.02
N	18320	7493	3447