Social Network and Weight Misperception among Adolescents

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Abstract

It is recognized that public health interventions targeted towards changing lifestyle behaviors to reduce overweight is a considerable challenge. It is important that individuals recognize their overweight status to be a health risk in order for an effective change in lifestyle behaviors to occur and growing evidence suggest that actual weight and perception of weight status often do not match especially among adolescents. In this paper, we explore the extent to which exposure to heavier peers and parent affects misperception of own weight status by the adolescent. Using data from a nationally representative sample of adolescents we estimate instrumental variable models with school level fixed effects to account for bi-directionality of peer influence and environmental confounders. Our results indicate that individuals who live in environment that exposes them to overweight/obese parent and heavier peers tend to misperceive their weight status and think of themselves to be of lower weight than they actually are. Our analysis also revealed differential effect by gender and type of peers.

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Keyword: Weight Misperception; Adolescents; Peer Influence.

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1. Introduction

Excess body weight among children and adolescents over the last two decades has been documented widely and is considered one of the most pressing health problems today. The prevalence of overweight has more than doubled in children (age 6-11) and more than tripled in adolescents (age 12-19) since 1976-80 (Hedley et al. 2004). In 2003-2004, 37.2% of children ages 6 to 11, and 34.3% of adolescents ages 12 to 19 were at risk for overweight or were overweight (Ogden et al. 2006). This shift to the right of the body weight distribution may have affected individuals' view of their own body weight status, especially if individuals use people around them as reference point to assess their own weight status. In this study we investigate if an adolescent's misperception of his/her own weight status is affected by the average body weight of those who are in his/her reference group.

Since the dramatic increase in average weights and obesity has occurred in genetically stable populations, the weight gains can only be attributed to behavioral factors related to an increase in calorie intake or a decrease in physical activity. In 2000, American children consumed on average 350 more calories per day then they did in 1970.[4] In addition, poor dietary choices and health behaviors such as skipping breakfast, a diet low in fruits and vegetables, eating at fast food restaurants, and consuming calorie-dense snacks - all of which are associated with a risk of abnormal weight gain and adiposity among children and adolescents, have been on the rise in recent years (Millimet et al., 2008; Niemeier et al., 2006). Contemporaneously, changes in school curricula, parental rules in relation to safety, and physical environmental factors have contributed to a decline in the level of physical activity and an increase in sedentariness among

[4] http://www.sciencedaily.com/releases/2009/05/090508045321.htm

adolescents (Dollman, 2005). Finally, shifts in family dynamics, such as maternal employment, have also been associated with childhood obesity (Anderson et al, 2003).

Related studies have emphasized the potential importance of social forces, in addition to changing economic fundamentals, in understanding the rapid increase in weights. Burke and Heiland (2007) argue that social norms about the "normal" body weight act as a social multiplier to the effects of changing fundamentals on individuals' weight. For example, they estimate that rising reference weights might have magnified the impact of the decline in the full price of calories since 1977 on female weights by 24%. Consistent with the existence of such social multiplier effects, Christakis and Fowler (2007) report evidence of a direct person-to-person spread of obesity in social networks. They find that the likelihood of becoming obese increases if a close friend became obese during the same period. Although it is difficult to talk about causal relationship, evidence of a positive correlation between peer and individual weight outcomes has been reported for adolescents in a number of subsequent papers using complementary measures of weight status, peer group, and using alternative data and study samples (Ali et al., 2008; Cohen-Cole and Fletcher, 2008; Fowler and Christakis, 2008; Renna et al., 2008; Trogdon et al., 2008; Halliday and Kwak, 2009). Social networks may play an important role not only in the dynamics of the body weight, but also on the perception of one's own body weight status, since adolescents are more likely to assess their body weight status by looking at others in their network rather than by using clinical recommendations. In fact, being in school with heavier classmates has been associated with a decrease in the likelihood that obese and overweight teenagers will perceive themselves as such (Brown III et al., 2009).

To date, most of the public health interventions targeted especially towards overweight adolescents have not had much success, in part, because it is not easy to change lifestyle behaviors related to weight. Summerbell et al. (2005) found that interventions aimed towards childhood obesity prevention resulted in no reduction of overweight status and only modest improvements in altering diet or exercise patterns. Misperception of weight status has been proposed as one possible explanation for the limited success of obesity prevention interventions (Kuchler and Variyam, 2003). It is important that individuals recognize their overweight status to be a health risk in order for an effective change in lifestyle behaviors to occur. Growing evidence suggests that actual weight and perception of weight status often do not match and that deviations between actual and perceived weight are more prevalent among obese and overweight individuals (Paeratakul et al., 2002; Truesdale and Stevens, 2006). Effective behavior change might not occur if there is a lack of recognition on the part of the individual that their weight status exceeds the normal healthy weight norm.

Placing oneself in a weight category that is incongruent with clinical classification is quite common (Chang and Christakis, 2003). The literature has consistently found that self-assessment or even parents-assessment of their children's weight status is often incorrect (Welch et al. 2004, Hackie and Bowles, 2007; Wald et al., 2007). Although it is unclear what factors may influence misperception of weight status, a growing literature suggests that weight norms, ideals, and perceptions are greatly influenced by the adolescent's social networks (Maximova et al., 2008; Mackey and Greca, 2008). This literature suggests that individuals underestimate their weight status when they are exposed to overweight and obese people in their immediate surroundings such as home, neighborhood and school. In particular, children and adolescents who are surrounded by many overweight peers and family members may inaccurately perceive their weight status, i.e. their own weight status might appear to them as normal by comparison. However, this area of research was either limited to cross tabulations (Mackey and Greca, 2008) or was unable to fully separate the influence of environmental factors from the direct influence of social networks on weight misperception (Maximova et al., 2008). In this paper, we aim to explore the extent to which exposure to heavier peers and parent affects misperception of own weight status by the adolescent. We extend the analysis by estimating models of social interactions that account for environmental confounding factors and the bi-directionality of peer influence. In addition, we also utilize various measures of reference groups including close friends and more exogenous groups constructed at the school and neighborhood levels.

2. Methods and Data

2.1 Statistical Analyses

We estimate a linear regression model of peer and family weight status on adolescent's weight misperception. Weight misperception, m_{is} of person *i* at school *s*, is given by the following equation:

$$m_{is} = \alpha + \beta_1 \bar{y}_{js} + \beta_2 y_{fs} + \beta_4 x_{is0} + \varepsilon_{is}\,,\; i \neq j \qquad (1)$$

Here *j* indexes peers and *f* indexes family; $\bar{y}_{js}$ refers to the average weight status within peer group, y_{fs} refers to the obesity status of the adolescent's parent, x_{is0} refers to the vector of adolescent's individual and family characteristics measured at the baseline (W1), and ε_{is} is a random error.

We are primarily interested in the coefficient β_1, which indicates the extent of peer influence on an individual's weight misperception. If β_1 is estimated to be negative, then this would imply that adolescents will tend to misperceive themselves to be of lower weight due to their exposure to higher weight individuals (peers). However, identifying social network effects in observational data is not without challenges. First, there is the concern of confounding due to non-random selection of friends. In addition, unobserved characteristics in the shared environment that affect all individuals in the social network may cause environmental confounding. These confounding factors, if unaccounted for, can cause correlations suggestive of social network effects when none are present. To control for these possible sources of bias, we estimate several variations of the main specification. First, we add a vector of school dummies γ_s to the baseline model:

$$m_{is} = \alpha + \beta_1 \bar{y}_{js} + \beta_2 y_{fs} + \beta_4 x_{is0} + \gamma_s + \varepsilon_{is}, \; i \neq j \tag{2}$$

Estimating our models with γ_s, the school-level fixed effects, potentially mitigates the problem of shared environment. Next, we use more exogenous definitions of peer groups, like classmates and neighbors. Since classmates and neighbors are more likely to be randomly assigned to each individual, the estimation of the coefficient β_1 is less likely to be affected by the fact the individuals may select their friends according to their appearance. Finally, we estimate a two stage least square regression (2SLS) to address the bi-directionality of the peer influence. According to social networks theory, peer behavior affects individual behavior and vice versa (Manski, 1993). Since own BMI is used in computing the measure of weight misperception, the variable $\bar{y}_{js}$ could be endogenous. Manski (1993) demonstrated that most estimates of β_1 are not identified without utilizing instrumental variables or other similar methodologies.

Key to implementing the 2SLS technique is finding instruments that have two properties. First, they affect (cause variation in) the variable whose effect we want to know about; in our case the peer measure. Second, these instruments must have no direct effect on the outcome measure (m_{is}) so they must be independent of the latent factors that drive that outcome. The list of our instruments includes peers' birth weight, peers' mothers' obesity, and peers' mothers' self-reported health status (the data section expands more on these variables). The intuition behind the instruments follows the previous literature (Renna et al., 2008; Trogdon et al., 2008) in assuming that average peer background characteristics do not directly affect adolescent's own weight misperception, and hence can be excluded from the second stage of the two-stage procedure. A further advantage of having multiple potential instruments is that we are able to test overidentifying restrictions. Combined with the school-level fixed effects, the 2SLS procedure can control for the some of the endogeneity that plagues the peer effect estimates.[5]

2.2. Data Source

The data for this study are drawn from the National Longitudinal Survey of Adolescent Health (henceforth "Add Health"). Add Health surveyed adolescents in 132 schools nationwide between grades 7 to 12. The in-school portion of the first wave of the survey (1994) contains a cross-section of about 90,000 adolescents. A subset of the initial sample (20,745 respondents in 1994) was also interviewed in their homes with follow-up

[5] The 2SLS cannot solve all of the endogeneity problems. If individuals select their friends on the basis of their body weight then our instruments are not strictly speaking exogenous. However, including own BMI percentile and the use of more exogenous peer groups (such as classmates one grade older) should alleviate concerns about selection problems. When we look at more aggregate peer groups (school and county), our instruments control for both reverse causality and correlated effects, because we are no longer able to use school fixed effects.

surveys in 1996 (about 15,000 respondents) and again in 2002. A unique feature of Add Health is that it contains information on individuals' nominations of their closest friends (up to five male and five female friends). Since these friends were also surveyed, peer weight measures were constructed from actual responses of the peers themselves. Add Health also allows us to identify the schools the respondents attended and this enabled us to construct various school based reference groups. In addition, one parent (mostly mothers) for each adolescent was interviewed as part of the parent survey in 1994. This parent survey is our primary source of the instruments for dealing with the problem of bi-directionality of peer influence in the estimate of the peer effect. It also allows us to account for familial structures and context, including mother's weight status and other control variables to account for the endogeneity of school choice (Clark and Loheac, 2007).

2.3. Measures

Outcome Variable

Our outcome variable is a misperception score which was calculated as the difference between the perceived weight Z-score and the BMI (percentile) Z-score. The misperception score has the advantage of being a continuous measure of misperception, which allows for a greater measurement precision (Maximova et al., 2008). To calculate the misperception score we first transformed the BMI percentile values into Z-scores using the 2000 Center for Disease Control and Prevention (CDC) age and gender specific growth chart cutoffs.

This standardized BMI Z-score indicates how many standard deviations apart an adolescent's BMI is from the mean BMI of the population reference group for their age and sex. The BMI Z-score is negative if the individual's BMI is below the population mean BMI and it is positive if the individual's BMI is above the population mean BMI. Add Health also asked the respondents what they thought of themselves in terms of weight and the responses ranged from being very underweight, slightly underweight, about the right weight, slightly overweight and very overweight. The perceived weight status was then assigned the corresponding Z-score of *-2*, *-1*, *0*, *1* and *2*, respectively. We chose these cut off points to reflect the CDC weight categories for adolescents. According to CDC, adolescents in the 85th to the 95th percentile are defined as "overweight" while those above the 95th are defined "obese". The Z score corresponding to the threshold for being "overweight" is 1.04 and the Z-score for being "obese" is 1.65, which are similar to our cut off points.[6] Thus the misperception score is $Misperception = Z_{perceived\,weight} - Z_{BMI}$. If the misperception score is positive it indicates that the adolescent overestimated his/her weight status, i.e. the adolescent perceived himself/herself to be heavier than the actual BMI. A negative misperception score on the other hand means the reverse, i.e. the adolescent underestimated their weight status and perceived himself/herself to be thinner than their measured BMI.

Peer or Reference Group Measures

We use three reference groups for our analysis: friends, schoolmates, and neighbors. For each reference group, we created alternative measures pertaining to the average BMI percentile of individuals within the reference group. Our first reference group consists of close friends nominated by the respondent. Following Christakis and Fowler (2007), we distinguish between mutual friends (i.e. individuals who nominate each other as friend)

[6] Since our Z-score for "very overweight" is higher than the CDC's Z-score for "obese", we estimated a model using the CDC threshold. However the results are similar to those presented herein, so they will be omitted.

and non-mutual friends (i.e. individuals who nominate another individual as friend but they are not reciprocated).

Our second reference group consists of schoolmates. First, we look at all individuals who went to the same school as the respondent, but were one grade above them. It is important to note that this peer group potentially mitigates the endogeneity issue since older adolescents are only little affected by their younger cohort, whereas, younger adolescents are more inclined to look-up to their older peers (Clark and Loheac, 2007). Moreover, this definition of peers does not suffer from the problem of self selection that may plague the estimation for nominated friends, since grade assignment is only based on age while adolescents may select their friends according to their physical appearance. We did not conduct the analysis using classmates as the reference group (same grade as the adolescent) because of some inherent difficulties associated with the calculation of the peer effect. When computing the average BMI of classmates, we need to subtract the respondent from the peer group. Thus, for a given class, students with a BMI above average will face a peer group with a lower average BMI and students with a BMI below average will face a peer group with a higher average BMI. Guryan et al. (2009) show that this operation creates a mechanical bias that leads to underestimate the real peer effect. By focusing on schoolmates one year older than the respondent, we are able to avoid this mechanical bias.

Our next reference group refers to all individuals who went to the same school as the respondent (schoolmates). The schoolmates' average BMI percentile was calculated by excluding the respondent himself/herself. Our final measure of the reference group consists of all individuals who resided in their same neighborhood as the respondent. We utilized spatial geo code identifiers to construct neighborhood reference groups at the Census tract, Census block and county levels.

Parental Measures and Demographics Characteristics

The parent survey of Add Health allowed us to control for a number of parental characteristics including biological mother's obesity status[7], the age of the adolescent when they first moved in their current location and whether the parents chose their residence because of the school district. Indicators for whether the family is a recent mover and whether the neighborhood was chosen because of the school help us to account for the endogeneity of school choice or residential location (Clark and Loheac, 2007; Gaviria and Raphael, 2001). Additional controls of parental characteristics include whether the adolescent lives with both biological parents, whether each parent has college degree, whether both parents work full time and family income. Variables from the parent survey were linked to individual's peers to create mean peer birth weight, proportion of peers whose mothers are obese, and mean parental health of peers to be used as instruments. Other controls we include in our analysis are demographic factors like age, race and gender. In addition, we include log of own BMI percentile[8] in all models. This will mitigate bias in peer effect estimate if weight status is systematically related to weight misperception and if teens select their peers (especially close friends) based on weight.

2.4. Analysis sample

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[7] Add Health parent questionnaire asked whether biological mother or father had obesity. Add Health used student's mother as the preferred respondent to complete the parent questionnaire and most of the actual respondents were mothers. Due to many missing observations on father's obesity and in order to minimize recall bias, we used only mother's obesity status and recorded it only when student lived with biological mother.

[8] We chose natural log as a functional form for own BMI percentile in order to capture possible non-linearity in the relationship between BMI and weight misperception.

The samples in this study are drawn primarily from wave II (1996) respondents in grade 7 through 12. Wave II contains interviewer measured height and weight of the adolescents and thus our measure of BMI [*weight(kg)/height*(m^2)] is not subject to reporting bias. For each individual, we link the data with the parent survey in 1994. We also link the data of the nominated friends to the individual himself/herself. However, not all the nominated friends of the respondent were part of the survey. The average number of nominated friends per individual is 2.54 and approximately 85% of the friends are from the same school as the respondent. This limited our sample size to 2,816 individuals for our analysis with nominated friends and to 1,452 individuals for our analysis with mutual friends. The analysis on school measures of peer groups instead is based on the entire dataset from wave II. After deleting the observations with missing information we are left with 10,850 adolescents. For the variables “Pretax income”, “Chose neighborhood for school”, “Age when moved” and “Grade” we prefer to impute the missing cases with the sample averages and create dummy variables indicating missing cases because deleting them would considerably reduce the sample size. Detailed summary statistics on all the respondents who were surveyed in wave II (1996) and their peers are reported in Table 1.

3. Results

Features of the estimation sample

Adolescents on average tend to underestimate own weight, as indicated by negative mean of the misperception Z-score. The mean BMI in the 1996 sample is 22.9; 25% of adolescents in the sample are overweight (i.e., greater than the 85^{th} percentile of the CDC growth charts); 11.8% of adolescents in the sample are obese (i.e., greater than the 95th percentile of the CDC growth charts).

[Insert Table 1-A here]

There were no sizable differences in the observable characteristics between the entire sample of adolescents in Table 1-A and adolescents who had at least one matched friend in Table 1-B. The mean BMI percentile of friends was less than the overall sample average of all students, indicating that heavier adolescents are less likely to be nominated as friends.

[Insert Table 1-B here]

When peers are defined as students in one grade above the respondent, we restrict the sample size to only schools that offer grades 7 to 12. This decreases the sample to 1,545 individuals. However, it is necessary in order to maximize the variation of the peer measure to get any meaningful estimate of the peer effect in the school fixed effects model. If we had included middle schools and high schools in the sample, after we deleted students in their last year of school (for whom we do not have a reference group), we would be left with only one cohort for middle schools and three cohorts for high schools. Hence, the school fixed effects would have taken over the peer effects. We do not observe any difference between the average peer BMI in the entire sample and the average peer BMI in our restricted sample of older students. In fact, the mean BMI percentile of the peer group in our restricted sample of schoolmates is similar to the overall sample average in Table 1-A.

[Insert Table 1-C here]

Influence of self nominated friends

We begin our analysis by estimating the effect of all nominated friends' weight on the individual's weight misperception. Our results indicate that friends' weight is negatively correlated with adolescent's own weight misperception after controlling for such covariates as log of own BMI percentile, demographics, birth weight, and household characteristics. The OLS estimates indicate that when the mean weight of adolescent's friends is one BMI percentile higher, adolescent's weight misperception Z-score will be lower by 0.002 units, i.e. adolescents underestimate their own BMI percentile by an additional 0.002 of its standard deviation (Table 2, column 1).[9] The effect remains significant after controlling for school fixed effects and the magnitude of the effect does not change. Mother's obesity status is negatively correlated with weight misperception and exhibits a much larger effect compared with close friends.

[Insert Table 2 here]

Our results also indicate that females overestimate own weight compared to males. Adolescents who are Black tend to underestimate their weight status more compared with other groups. Higher birth weight and higher own BMI percentile are also associated with the underestimation of one's own weight. In addition, older adolescents tend to overestimate their own weight. The remaining control variables in the model did not exhibit statistically significant effects, including Hispanic ethnicity, choosing neighborhood for school, age when moved, having parents working full time, family income, having both biological parents at home, mother's and father's education, and parental health. Lack of significance on the dummy variables indicating missing

[9] Alternatively, a one percentile decrease in the average peer BMI is associated with a reduction in overestimating the own weight percentile of an additional 0.002 standard deviation.

observations on family income, choosing neighborhood for school, age when moved and grade suggests that there are no systematic differences between individuals with complete and those with missing observations on weight misperception. Finally, the insignificance of the variables “choosing neighborhood for its school” and “age when moved” suggests that selection of neighborhood to live in by parents is not based on weight misperception.

Our OLS estimates of peer effects cannot be interpreted to imply causation due to bi-directionality of the relationship between the respondent’s body weight (used in the measure of misperception) and the peer measure. Hence, we check whether the effect of the peer group persists after running 2SLS models. The last column of Table 2 shows that the coefficient on average friend’s weight remains negative and statistically significant in the 2SLS estimates with school fixed effects. Consistently with the results from previous studies (Trogdon et al, 2008; Renna et al, 2008), we found that the 2SLS estimate of the peer effect is larger than the OLS estimate. The instruments are strongly correlated with peer weight in the first stage; the F test for the instruments in the first stage is 51.63 ($p<0.001$). Our instruments also pass the overidentification tests which, under the usual assumptions, support their validity as instruments.

[Insert Table 3 here]

We repeat the analysis using friends as the peer group separately for females and males (Table 3). Since the other covariates have the same expected effect across all model specifications we report results for our main variables of interest only and focus the rest of the analysis on peer measures and mother’s obesity status. In both specifications, the effect of peers vanishes but the effect of mother remains statistically significant under our preferred specification (2SLS with school-level fixed effects). .

Following Christakis and Fowler (2007), we exploit the asymmetry of friendship nominations to assist the identification of the peer effects in case of close friends. The idea is that if confounding factors were the only source of correlation between misperception and peer weight, the strength of the correlation would be the same regardless of who named who as a friend. In this case mutual friends (i.e. individual *i* nominated individual *j* as a close friend and individual *j* also nominated individual *i* as a close friend) would appear to have the same influence as non-mutual friends. However, if there are differences in the magnitude of influence, confounding factors cannot be the only source of the correlation. Christakis and Fowler (2007) found that the closeness of friendship is relevant to the spread of obesity and concluded that influence in friendship ties was directional. Persons in closer, mutual friendships had stronger effect on each other than persons in other types of friendships. In Table 4 we looked at whether the influence of mutual friends on weight misperception is indeed stronger. Hence, we limited the peer group to nominated friends who reciprocated the nomination. In the 2SLS specification with school fixed effects the effect of mutual friends was statistically significant and its magnitude (-0.011) was twice as big as the effect of all nominated friends. This implies that a one percentile reduction in the average weight of friends will result in a (0.011*0.853=0.0094) increase in the misperception score. Since the sample average misperception score is -0.136, a one percentile reduction (or increase) in the average weight of friends will induce an increase (or reduction) of the misperception score by about 7 percent of its mean value. When we ran the estimation separately by gender we found that the effect was stronger for females than for males.

[Insert Table 4 here]

Influence of students one grade above

As discussed previously, close friends are an endogenously determined peer group. As an alternative (and in addition) to instrumental variables models and its strict identifying assumptions, we conduct further analysis to assess the impact of exposure to obesity on weight misperception by using more exogenous measures of peer or reference group. First, we define one such reference group as students in the same school who are one grade above the adolescent (see Table 5). As expected, the results in Table 5 suggest that peers in the grade above negatively influence misperception of adolescent's own weight. This signifies that exposure to a heavier and more exogenously determined reference group is also associated with underestimating one's weight status. Stratifying our analysis by gender revealed a larger effect for females, although this effect is no longer significant. Mother's obesity status exhibits a greater and statistically significant effect, suggesting the importance of mothers as a primary source of reference weight.

[Insert Table 5 here]

Influence of other reference groups

Next, we estimated our models with the reference group defined as everyone in the school (excluding self). The results again indicate a strong negative correlation between school-level average weight, mother's obesity status and the misperception score (Table 6). Thus an increase in schoolmate BMI and mother's obesity status will result in adolescents underestimating their weight status. Separate gender analysis shows that the negative predictor of misperception is comparable between males and females.

[Insert Table 6 here]

The last reference group used in this study is based on different levels of the neighborhood using the following geographical identifiers: Census tract level (Neighborhood Grouping Level 1), Census block level (Level 2), and County. In these regressions we were no longer able to control for correlated effects via school fixed effects or 2SLS. Again, the coefficients in Table 7 show a statistically significant negative association between these measures of average reference group weight and own weight misperception. The neighborhood average BMI percentile estimates are comparable to the OLS results for all nominated friends, but smaller than the 2SLS for other lower aggregation reference groups. The effect of the county level average BMI is larger than the corresponding effect at the neighborhood level, but smaller or comparable to the effect of mutual friends, individuals one grade above, and schoolmates.

[Insert Table 7 here]

In sum, our results are indicative of the fact that exposure to higher weight individuals will result in adolescent's underestimation of their own weight. In all our analysis, mother's obesity status consistently exhibited an effect of greater magnitude, implying the importance of familial context in influencing children's perception of weight status. However, we hesitate talking about causal relationship here, because we cannot determine if this effect is driven by latent family heterogeneity.

4. Conclusions

This study assessed the extent to which exposure to heavier peers and parent influences misperception of own weight status by the adolescent. Utilizing various definitions of reference group and a continuous measure of weight status misperception, our results indicated that individuals who live in an environment that exposes them to heavier peers and parent tend to misperceive their weight status and think of themselves to be of lower weight than they actually are. These finding were also consistent under various model specifications that accounted for environmental confounders and bi-directionally of peer influence. In addition, we found that the effect of peers on weight misperception differs by gender and type of peers. These results provide new evidence on the influence of social networks on the misperception of weight status.

The alarming increase in the incidence of obesity among children has become a key public health problem in many developed countries. Although several measures have been implemented to target this problem, the success of these policies has been quite limited to date. Previous literature has recognized that the success of weight control policies depends on the self-awareness of the target population (Chang and Christakis, 2003; Maximova et al., 2008). Even if a clinically overweight adolescent is aware of the health complications related to excessive body weight, he or she may be unresponsive to policy interventions if there is a disconnect between their own body weight perception and the objective weight category he or she falls under. This study suggests that policies aimed at reducing the prevalence of obesity among adolescents may not be realizing their intended effect since the shift to the right of the weight distribution of the population itself has increased the probability of underestimating one’s own weight status. In fact, this study found that adolescents use the weight distribution of the people around them (friends, schoolmates, and neighbors) to assess their own weight status. Our results also exhibit that mother's weight status is an important determinant of how an adolescent perceives his or her weight status. Previous literature that analyzed parental involvement in obesity prevention among children suggested that parents might be better facilitators of behavior modification than children themselves (Edmunds et al., 2001) and our result is consistent with this finding.

In light of these results, this study supports school based policies that would help students to become more aware of their body weight and the health risks it might cause. A curriculum that teaches students how to compute their BMI (or alternative measure of body fatness) and determine where on the clinical weight category they fall under could be the first step towards an effective weight management program. Misperception awareness could also be incorporated into programs that are designed to encourage healthy lifestyles such as increasing physical activities and improving diets[10]. Additionally, policies that target specifically the right hand tail of the weight distribution may have a trickle effect: by reducing the body weight of individuals with higher body weight, the overall mean of the weight distribution would be lowered and this might result in a decline in the probability of adolescents underestimating their body weight.

One limitation of our study is that not all nominated friends and schoolmates were surveyed in the in-home portion of Add Health. To the extent that information on the BMI of some friends is missing at random, this will introduce attenuation bias and thus coefficients in this study provide conservative estimates of the effect of peers on weight misperception. Another limitation is that the data do not allow us to separate the effect of biology from the effect of home environment in the coefficient on mothers' obesity status. Future research should examine whether evaluations of one's own body weight based on peers' weight apply to adults as well, or are limited to adolescents only.

[10] For example, several states recently started to require public schools to send children's BMI as part of the report cards to parents along with nutrition and exercise recommendations.

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Table 1-A: Adolescent own characteristics, W2, all adolescents.

Variable	Mean	Std. Dev.	Min.	Max.
Misperception Z-score	-0.136	0.853	-3	3
BMI	22.917	4.948	12.926	61.031
BMI percentile	58.295	29.639	0	99.968
Overweight	0.249	0.432	0	1
Obese	0.118	0.322	0	1
Age	16.107	1.568	11	20
Male	0.493	0.5	0	1
Black	0.206	0.405	0	1
Hispanic	0.162	0.368	0	1
Both parents	0.562	0.496	0	1
Mom college	0.271	0.444	0	1
Dad college	0.229	0.42	0	1
Mother obese	0.169	0.375	0	1
Log(family income)	3.52	1.044	-4.605	6.907
Par. work fulltime	0.347	0.476	0	1
Chose neighb.	0.489	0.492	0	1
Age when moved	8.097	5.556	0	19
Parental health	0.85	0.357	0	1
Birth weight	6.82	1.386	3	12
Dummy (income miss.)	0.13	0.336	0	1
Dummy (chose neighb. miss.)	0.032	0.175	0	1
Dummy (age moved miss.)	0.005	0.074	0	1
Dummy (grade miss.)	0.1	0.301	0	1
N		10850		

Table 1-B: Adolescent own characteristics, W2, adolescents with friend’s BMI.

Variable	Mean	Std. Dev.	Min.	Max.	Diff.
Misperception Z-score	-0.124	0.831	-3	3	-0.011
BMI	22.969	4.999	14.042	51.686	-0.052
BMI percentile	58.311	29.519	0	99.916	-0.017
Overweight	0.246	0.431	0	1	0.003
Obese	0.124	0.329	0	1	-0.006
Age, W2	16.114	1.524	12	20	-0.008
Male	0.494	0.5	0	1	-0.001
Black	0.172	0.377	0	1	0.035***
Hispanic	0.139	0.346	0	1	0.023***
Both parents	0.611	0.488	0	1	-0.049***
Mom college	0.281	0.449	0	1	-0.010
Dad college	0.246	0.431	0	1	-0.017*
Mother obese	0.173	0.378	0	1	-0.003
Log(family income)	3.577	0.975	-4.605	6.907	-0.057***
Par. work fulltime	0.367	0.482	0	1	-0.020**
Chose neighb.	0.478	0.491	0	1	0.011
Age when moved	7.701	5.566	0	18	0.396***
Parental health	0.86	0.347	0	1	-0.010
Birth weight	6.875	1.416	3	12	-0.055*
Dummy (income miss.)	0.129	0.335	0	1	0.001
Dummy (chose neighb. miss.)	0.033	0.179	0	1	-0.001
Dummy (age moved miss.)	0.004	0.059	0	1	0.002
Dummy (grade miss.)	0.072	0.258	0	1	0.029***
Friend's BMI percentile	56.906	24.386	0.192	99.914	
Friend's mother obese	0.149	0.305	0	1	
Friend's birth weight	6.861	1.212	3	11	
Friend's parental health	0.858	0.283	0	1	
N			2816		

Note: Column “Diff.” indicates the difference in means between Table 1-A and Table 1-B and the statistical significance of this difference: * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

Table 1-C: Grade above peer characteristics, W2

Variable	Mean	Std. Dev.	Min.	Max.
BMI percentile	57.698	7.958	42.324	83.584
Mother obese	0.16	0.096	0	0.5
Birth weight	6.949	0.353	6.031	7.75
Parental health	0.807	0.135	0.263	1
N		1545		

Table 2: Regressions of weight misperception Z-score on BMI percentile of all nominated friends.

	OLS		OLS, school FE		2SLS, school FE	
Peer BMI percentile	-0.002***	(0.001)	-0.002***	(0.001)	-0.005**	(0.002)
Mother obese	-0.168***	(0.036)	-0.148***	(0.037)	-0.141***	(0.036)
Male	-0.315***	(0.027)	-0.305***	(0.027)	-0.304***	(0.027)
Black	-0.125***	(0.037)	-0.134***	(0.050)	-0.127***	(0.049)
Hispanic	-0.009	(0.040)	-0.045	(0.052)	-0.038	(0.052)
Birth weight	-0.027***	(0.010)	-0.022**	(0.010)	-0.023**	(0.010)
Chose neighb.	0.013	(0.027)	0.005	(0.029)	0.005	(0.028)
Age when moved	0.001	(0.003)	-0.001	(0.003)	-0.001	(0.003)
Par. work fulltime	0.036	(0.029)	0.045	(0.030)	0.038	(0.029)
Log(family income)	-0.002	(0.015)	-0.015	(0.016)	-0.015	(0.015)
Both parents	0.020	(0.031)	0.012	(0.032)	0.009	(0.031)
Mom college	0.063*	(0.033)	0.038	(0.035)	0.033	(0.034)
Dad college	-0.006	(0.036)	-0.022	(0.037)	-0.020	(0.037)
Parental health	0.088**	(0.041)	0.084**	(0.042)	0.088**	(0.041)
Age, W2	0.050***	(0.009)	0.056***	(0.013)	0.054***	(0.012)
Ln(own BMI percentile)	-0.391***	(0.015)	-0.400***	(0.015)	-0.393***	(0.016)
Dummy (grade miss.)	0.034	(0.054)	0.040	(0.056)	0.039	(0.055)
Dummy (income miss.)	0.054	(0.042)	0.053	(0.043)	0.053	(0.043)
Dummy (chose neib. miss.)	0.016	(0.080)	0.021	(0.082)	0.022	(0.080)
Dummy (age moved miss.)	0.234	(0.223)	0.289	(0.225)	0.303	(0.220)
Observations	2816		2816		2816	
R-squared	0.293		0.331		0.323	
Overid test (p-value)					0.944	
F-statistic (first stage)					51.630	
IV F-test p-value					0.000	

* p < 0.1, ** p < 0.05, *** p < 0.01 Notes: Standard errors in parentheses. Source: Add Health data, authors' calculations. Instruments include birth weight, mother's obesity status, and parental health.

Table 3: 2SLS regressions with school fixed effects of weight misperception Z-score on BMI percentile of all nominated friends, by gender.

	Females		Males	
BMI percentile	-0.006	(0.004)	-0.002	(0.003)
Mother obese	-0.162***	(0.051)	-0.110**	(0.050)
Observations	1425		1391	
R-squared	0.310		0.372	
Overid test (p-value)	0.701		0.869	
F-statistic (first stage)	17.974		28.232	
IV F-test p-value	0.000		0.000	

* p < 0.1, ** p < 0.05, *** p < 0.01 Notes: Standard errors in parentheses. Source: Add Health data, authors' calculations. Instruments include birth weight, mother's obesity status, and parental health. The models include all of the variables listed in Table 2.

Table 4 : 2SLS regressions with school fixed effects of weight misperception Z-score on BMI percentile of mutual friends, by gender.

	Everybody		Females		Males	
Peer BMI percentile	-0.011***	(0.003)	-0.014**	(0.006)	-0.008*	(0.005)
Mother obese	-0.120**	(0.050)	-0.137*	(0.073)	-0.139*	(0.072)
Observations	1452		789		663	
R-squared	0.281		0.187		0.336	
Overid test (p-value)	0.714		0.453		0.696	
F-statistic (first stage)	22.504		6.873		11.461	
IV F-test p-value	0.000		0.000		0.000	

* p < 0.1, ** p < 0.05, *** p < 0.01 Notes: Standard errors in parentheses. Source: Add Health data, authors' calculations. Instruments include birth weight, mother's obesity status, and parental health. The models include all of the variables listed in Table 2.

Table 5: 2SLS regressions with school fixed effects of weight misperception Z-score on BMI percentile of grade above

	Everybody		Females		Males	
BMI percentile	-0.026**	(0.013)	-0.023	(0.016)	-0.018	(0.019)
Mother obese	-0.208***	(0.050)	-0.265***	(0.067)	-0.125*	(0.073)
Observations	1545		799		746	
R-squared	0.270		0.248		0.305	
Overid test (p-value)	0.721		0.325		0.665	
F-statistic (first stage)	35.336		21.011		14.203	
IV F-test p-value	0.000		0.000		0.000	

* p < 0.1, ** p < 0.05, *** p < 0.01 Notes: Standard errors in parentheses. Source: Add Health data, authors' calculations. Instruments include birth weight, mother's obesity status, and parental health. The models include all of the variables listed in Table 2. Only schools offering grades 7-12 are included.

Table 6: 2SLS regressions of weight misperception Z-score on BMI percentile of school.

	Everybody		Females		Males	
BMI percentile	-0.016***	(0.004)	-0.016***	(0.005)	-0.017***	(0.005)
Mother obese	-0.157***	(0.019)	-0.149***	(0.026)	-0.167***	(0.029)
Observations	10850		5506		5344	
R-squared	0.252		0.234		0.219	
Overid test (p-value)	0.081		0.238		0.168	
F-statistic (first stage)	625.569		297.273		327.663	
IV F-test p-value	0.000		0.000		0.000	

* p < 0.1, ** p < 0.05, *** p < 0.01 Notes: Standard errors in parentheses. Source: Add Health data, authors' calculations. Instruments include birth weight, mother's obesity status, and parental health. The models include all of the variables listed in Table 2.

Table 7: OLS regressions of weight misperception Z-score on BMI percentile of reference groups.

	Neighborhood level 1		Neighborhood level 2		County	
BMI percentile	-0.003***	(0.001)				
BMI percentile			-0.002***	(0.001)		
BMI percentile					-0.010***	(0.002)
Mother obese	-0.156***	(0.023)	-0.163***	(0.023)	-0.156***	(0.021)
Observations	10166		9509		10777	
R-Square	0.251		0.251		0.252	

* p < 0.1, ** p < 0.05, *** p < 0.01 Notes: Standard errors in parentheses. Source: Add Health data, authors' calculations. The models include all of the variables listed in Table 2.