How does the self-perception of overweight affect weight-loss intentions and behaviors of U.S. adolescents?

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ABSTRACT

This paper investigates the effects of the self-perception of overweight on weight-loss intentions and behaviors among US adolescents using the Youth Behavioral Risk Factor Surveillance System (YRBSS) data of 2001-2009. We find that, irrespective of the reported weight status, the self-perception of overweight causes adolescents to have a stronger intention of losing weight, but it does not improve eating habits by making adolescents consume more fruits and vegetables or fewer soft drinks, or increase physical activity and reduce sedentary activity. Our findings highlight the important distinctions between weight-loss intentions and implementing changes in diet and physical activity to lose weight. We also find one unwanted result: for non-overweight adolescents, the self-perception of overweight causes them to utilize unnecessary and health-compromising weight-loss methods such as fasting and taking weight-loss medication without the doctor's advice. The results have important policy implications in designing effective educational and behavioral interventions against childhood obesity.

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1. Introduction

The prevalence of obesity among US adolescents aged 12 to 19 almost quadrupled from 5% in 1980 to 18% in 2009 (CDC, 2010). Childhood obesity has significantly negative health, psychological, and social consequences due to impaired quality of life and increased morbidity (Must and Strauss, 1999; Reilly et al., 2003). Behavioral intervention is one of three major weight management (the other two are pharmacological plus behavioral intervention and surgical treatment) treatments for overweight and/or obese adolescents (Whitlock et al., 2008). Given that adolescence is a period of increasing self-control over food choices and time use (Haywood, 1991), a correct self-perception of body weight can be crucial for behavioral interventions. Adolescents need to correctly perceive themselves to be at risk of being overweight or obese and recognize the adverse consequences of such a weight status before they are incentivized to engage in diet moderation or the appropriate level of physical activity control weight (Desmond et al., 1986; Emmons, 1994). Thus, understanding the role of the self-perception of weight status on weight management among adolescents can help design effective intervention policies and education programs and improve the efficacy of obesity control efforts.

The objective of this article is to investigate how the self-perception of overweight affects adolescents' choices of food and time use pertaining to weight-loss using the Youth Risk Behavior Surveillance Survey (YRBSS) data. Overweight adolescents may have an acceptable self-perception of their body weight and believe that their weight status is not hazardous to their health and, thus have no incentive to control weight. Normal-weight adolescents, on the other hand, may not be ot satisfied with their body weight and perceive themselves as overweight and, thus engaging in weight-loss strategies that sometimes can be health-compromising. Recognizing that adolescents may intend

to lose weight but not necessarily through healthy diet and physical activity, we distinguish between weight-loss intentions and behaviors. We also examine subgroups by gender and overweight status as they may face different types of peer and social pressure.

Employing a propensity score matching technique, we find that, irrespective of their reported weight status, the self-perception of overweight causes adolescents to have a stronger intention to lose weight, but not through the improvement in eating habits such as consuming more fruits and vegetables and fewer soft drinks, or engagement in more physical activity and less sedentary activity. Instead, we find that the self-perception of overweight causes non-overweight adolescents to adopt weight-loss methods to achieve immediate weight loss that are likely to be health compromising or even dangerous. These findings indicate that misperception of weight status can be a cognitive barrier to promoting healthy eating and exercise habits. Interventions and education that foster an appropriate self-perception of body weight are critical to helping adolescents take the appropriate actions for weight manage. Our results are consistent across a series of robustness checks.

The study offers important policy implications. Various education programs have been implemented to increase fruit and vegetable consumption and improve participation in physical activity to fight against childhood obesity. Furthermore, policy makers and professionals have been trying to bring behavioral interventions into real world (e.g. schools) to fight childhood obesity based on the outcomes of random clinical trials (Whitlock et al., 2008). To both education programs and behavior interventions, a correct self-perception of weight status is critical to the program success as well as to the long lasting program effect on weight improvements and healthy lifestyle.

2. Literature review

The literature on the self-perception of body weight/image mainly focuses on either body dissatisfaction (BD) or body image distortion (BID). BD measures the discrepancy between the actual and ideal weight status, while BID refers to the discrepancy between the perceived and actual

weight status. Both BD and BID are associated with a wide spectrum of problems ranging from eating disorder (Shaw et al., 2004; Thompson, 2001) to depression (Stice and Bearman, 2001; Stice et al., 2000). Liechty (2010) states that "Compared to body dissatisfaction, a potentially more discriminating risk marker for unsafe weight loss is body image distortion" (p. 176), but that "the role of BID in adolescent weight-loss behavior remains understudied." (P. 177). The direction of BID can go either way as overweight adolescents do not necessarily perceive themselves as such or non-overweight adolescents may think they are (Brener et al., 2004; Strauss, 1999). The direction and magnitude of BID varies by socio-demographic factors such as gender and race (Brener et al., 2004; Ricciardelli and McCabe, 2001; Strauss, 1999).

The self-perception of body weight has been found to be a strong determinant of dietary and nutritional habits, a physically active life style, and weight management among adolescents (Brener et al., 2004; Desmond et al., 1986; Thompson, 2001). Emmons (1994) and Desmond et al. (1986) find that the self-perception of weight offers a better prediction than actual weight of whether high school students engage in diet or exercise to control weight. Individuals who perceive themselves as non-overweight are less likely to engage in weight-loss behaviors such as moderate dieting and exercise (Desmond et al., 1986; Emmons, 1994; Strauss, 1999). Adolescents who are not overweight but perceive themselves as such are at a higher risk for an eating disorder such as anorexia nervosa (Desmond et al., 1986) or potentially harmful behaviors such as purging, laxative use, diet pill use, and fasting (Boutelle et al., 2002; Liechty, 2010), but not associated with onset of exercise to lose weight (Liechty, 2010). Jackson-Elmoore (2007) finds that self-perceived weight status is a reasonable factor in investigation of perceived adequacy of physical activity among adults. Hausenblas and Fallon (2006) find a positive association between body image and exercise based on a meta-analysis of 121 cross-sectional, longitudinal and experimental studies.

Although whether weight perception induces health-promoting or health-compromising weight-

loss behaviors has important implications for obesity interventions and overall health promotion among adolescents, the literature on the self-perception of weight status is fragmented as previous studies use small samples, focus on subpopulations such as non-overweight adolescents, or examine a subset of weight control behaviors. This article offers its contribution by examining the effects of the self-perception of overweight on a wide spectrum of weight-loss intentions, eating and exercise behaviors, and unhealthy weight-loss strategies, for both non-overweight and overweight adolescents.

3. Data

This study uses the YRBSS data of 2001, 2003, 2005, 2007, and 2009.[1] The YRBSS is a nationally representative sample of 9th- through 12th-grade students in both public and private schools in the US. As shown in Table 1, in each survey year more than ten thousand adolescents were surveyed that equally distributed between genders and grades and with the majority being non-Hispanic white. A total of more than 70,000 observations are used in this study (Appendix A includes variable definitions). Sampling weights are used in all analyses in the paper.

An adolescent is classified as overweight (obese) if the self-reported BMI is at or above the 85th (95th) percentile for his/her age and sex. The respondents were also asked to describe their weight using a 5-point Likert-type scale: very underweight, slightly underweight, about the right weight, slightly overweight, and very overweight. We then classify their perceived weight status as overweight if they choose one of the last two options and non-overweight if they choose one of the first three options. As shown in Table 1, significant discrepancies exist in overweight prevalence bases on the reported or perceived weight statuses. The overweight prevalence is higher (lower) based on the perceived weight status than on the reported BMI for females (males). This is consistent with the literature as female adolescents are found to be less satisfied with their body weight and want to be thinner, while male adolescents prefer to increase muscle tone (McCabe and

Ricciardelli, 2011).

3.1. Outcome Variables: Weight Loss Intensions and Behaviors

We distinguish weight-loss intentions and behaviors (See table A2 in Appendix A for more details). We use the word "intentions" for claims made by respondents about their weight-loss behaviors because our empirical results show that the claimed weight-loss behaviors are dramatically different from what the respondents actually do. The three weight-loss intention variables indicate whether the respondent tried to lose weight (*LoseWeight*) and whether the respondent specifically did so through eating less food and fewer calories (*LoseWeight_Diet*) or exercise (*LoseWeight_Exer*) during the past 30 days. As shown in Table 2**,** the self-perception of weight status is related to weight-loss intentions. First, among both overweight and non-overweight adolescents, those who perceive themselves as overweight have a statistically greater intention to lose weight or keep from gaining weight in general as well as through moderate diet or exercise than among those who do not for both genders (e.g., compare columns (1) and (2) for the reported overweight female). Second, irrespective of their reported weight status, adolescents who perceive themselves as overweight have similar weight-loss intentions for both genders (e.g., compare columns (2) and (5) for female). However, weight-loss is not necessary for non-overweight adolescents.

The 2010 Dietary Guidelines for Americans promote fruit and vegetable intake as they are found to be associated with a decreased risk for various chronic diseases and help aid in weight management (USDA-USDHHS, 2010). However, the CDC estimate that 28.5% of high school students consumed fruit less than one time daily and 33.2% consumed vegetables less than one time daily.[2] We create two dummy variables indicating whether the respondent meets the recommended level of fruit and vegetable consumption: ate vegetables at least three times per day (*Vegetables_3*) and ate fruits at least twice per day (*Fruit_2*) during the past seven days.[3] The third eating habit variable is about consumption of soft drinks (*Soda*) which indicates whether one consumed soft

drinks, excluding diet coke and diet pop, at least once a day during the past seven days. As shown in Table 2, the self-perception of overweight is not associated with a higher likelihood of meeting the recommended level of fruit and vegetable consumption or a lower level of soft drink consumption; and the effect is negative for overweight male subsample.

Physical activity is found to have health benefits (USDHHS, 2001) and should be considered when addressing weight management (USDA-USDHHS, 2010). The 2008 Physical Activity Guidelines for Americans, the first ever Federal guidelines in physical activity in the US, recommend that children and adolescents should complete 60 minutes or more of physical activity daily. [4] However, almost a quarter (23%) of 9th- through 12th-grade students did not meet this recommended level (Hausenblas and Fallon, 2006). We create seven dummy variables for physical activity. The first four variables are related to personal exercise habits. They concern whether the respondent in the past seven days was physically active for at least 60 minutes on at least five days (*Active_5Days*), engaged in vigorous exercise that made them sweat and breath hard for at least 20 minutes on at least three days (*Vigorous_Exer*), or engaged in moderate exercise that did not make them sweat and breath hard for at least 30 minutes on at least five days (*Moderate_Exer*). We also create two dummy variables for team exercise indicating whether the respondent attended physical education classes on at least one day in an average week (*PE_class*) and whether the respondent played on at least one sport team in the past year (*Sport_Team*). Two dummy variables, indicating whether the respondent had watched television (*TV_Time*) or played video or computer games for more than three hours (*Video_Time*) on an average school day, are also included to measure sedentary activity. As shown in Table 2, all the statistically significant associations are negative for physical activity and positive for sedentary activity, which suggest that regardless of the reported weight status, adolescents who perceive themselves as overweight are less likely to engage in either personal or team exercise and are more likely to watch TV or play video games than the perceived non-overweight adolescents.

We also consider two unhealthy weight-loss methods: going without eating for at least 24 hours, i.e., fasting, (*LoseWeight_Fasting*) and taking diet pills, powders, or liquid without a doctor's advice or laxatives (*LoseWeight_Med*). These two extreme weight-loss methods are associated with medical complications such as cardiac problems and refeeding complications (Katzman, 2005) as well as severe, potentially life-threating psychosocial distress such as psychiatric disorders, depression and suicidality (Petersen et al., 1993; Stice, 2002; Stice et al., 2000) that may not be completely reversible (Liechty, 2010). As shown in Table 2, non-overweight adolescents who perceive themselves as overweight have the highest probability of undertaking theses unsafe methods for both females (column 5) and males (column 11) though such efforts are not necessary.

4. Methodology

We use the propensity score matching technique to estimate the effects of the self-perception of overweight on weight-control efforts. When lacking exogenous changes in weight perception matching techniques have some distinct advantages over other non-experimental evaluation techniques. First, matching does not impose any specific functional form between the dependent variable and independent variables, thus avoiding possible model misspecification errors (Rosenbaum and Rubin, 1983). The so-called LaLonde's (1986) critiques suggest that non-experimental estimates are sensitive to model specification and differ greatly from the experimental estimates. Second, matching can impose a common support requirement. The poor overlap on support between the treated and untreated groups raises questions about the robustness of parametric methods relying on the functional form to extrapolate outside the common support (Dehejia and Wahba, 1998; Smith and Todd, 2005). Third, matching allows endogenous covariates(Caliendo and Kopeinig, 2008). Appendix B provides a detailed discussion of matching techniques.

We define the treatment (control) group as adolescents who (do not) perceive themselves as

slightly or significantly overweight. The BMI difference between two groups are statistically significant at the 1% level -- more than one BMI point for the reported non-overweight females, more than three points for the reported overweight females, and more than two points for males in both reported overweight and non-overweight subsamples. Other important differences also exist between the treatment and control groups before matching. We have to emulate the random assignment environment conditional on observables.

The basic idea of matching is to select from a large group of potential comparison observations a sufficient number of candidates that closely resemble the treated units conditional on observables. To address possible unobserved factors related to both gender and weight status as well as weight-control behaviors, we divide the full sample into four subsamples by gender and overweight status. For example, females and males have different levels and direction of BID (see Table 1) and adopt different strategies to control weight (see Table 2). For each gender, we examine overweight and non-overweight subsamples separately because these two cohorts face different types of pressure from their parents and peers, which we could not observe based on the YRBSS data. The propensity score matching technique is seemingly an appropriate estimation strategy for our purpose. But it is based on the assumption that selection is exclusively based on observable characteristics. We are confident that by comprising extensive information on individual characteristics and behavioral variables, we are utilizing a rather complete range of observables necessary to make this empirical strategy viable. To account for the sensitivity of the matching technique, we examine the matching quality and conduct a series of robustness checks. The main results are remarkable consistent across all variations on these themes.

4.1. Matching covariates

We select a total of 16 matching covariates to best control for confounding factors in additional to region dummies. We include the BMI category[5] and age as matching covariates as they are

significant predictors of weight perceptions and are expected to be correlated with weight-loss behaviors. We include three dummy variables for race and ethnicity (Non-Hispanic white, Hispanic, and African Americans). We include grade indicators to capture the effect of peer pressure on body image in school. The average GPA, which is a proxy for cognitive ability and the awareness of nutrition and physical activity, is also included. We expect that, to great extent, risky behaviors and attitudes pick up the unobserved information about an individual's likelihood of perceiving oneself as being overweight. We include two depression-related variables, a dummy variable for feeling sad and a dummy for making a suicide plan or attempting to commit suicide, to capture the effect of depression on weight perceptions and weight-loss behaviors. We also include an indicator for smoking because it may be a causal factor of obesity according to some studies (Saarni et al., 2009); binge drinking because it is found to be associated with obesity (Arif and Rohrer, 2005); a marijuana usage; driving under influence or riding with a driver under influence; and sexual activities because they are likely to be related to the self-perception of body image and therefore eating and exercise behaviors. We also match on a set of region dummies to control for the bias caused by geographical differences. Year dummies are also included to control for the change in both self-perceptions and weight-loss behaviors over time.

The diagnostic analyses show that all of the matching variables are correlated with weight perceptions and weight-loss behaviors. Furthermore, all covariates demonstrate substantial overlaps between the treatment and comparison groups as suggested by the distribution of the BMI percentile between two groups (see Appendix C).[6]

5. Matching Results

For all estimations we impose common support to ensure that characteristics observed in the treatment group is also observed in the comparison group.[7] We also trim the sample by one percent to avoid the bias caused by extreme propensity scores.[8] Table 3 summarizes the estimated treatment

effects for the treated based on the nearest neighbor matching (NNM) with five neighbors and the local linear regression matching (LLR) with a plug-in rule-of-thumb bandwidth. Every estimate is a percentage point (not a percent change) representing the difference in the probability of certain weight-loss intentions or behaviors between an average adolescent with and without self-perceived overweight status. For example, if the probability of using exercise to lose weight is 20% for the self-perceived non-overweight group, an increase of 4 percentage points from 20% to 24% translates to a 20 percent increase, and the reported treatment effect is 0.04 in this case. The results based on the NNM and LLR algorithms are remarkably similar. This is exactly what the theory predicts: when the sample size is large enough all matching algorithms produce the same results asymptotically (Smith, 2000).

Based on Panel A of Table 3, we have the following findings about the effect of the self-perception of overweight on weight-loss intentions. First, all estimated effects are positive, statistically significant at the 1% level. That is, regardless of their reported weight status, adolescents who perceive themselves as overweight have a much stronger intention of losing weight and through diet or exercise. The treatment effects on weight-loss intentions are also economically significant for both females and males, as suggested by their magnitude. For example, the self-perception of overweight increases the weight-loss intention approximately 20 percentage points for females and 37 percentage points for males. Second, the treatment effects for the reported non-overweight subsample are almost twice as large as those for reported overweight subsample. This indicates that non-overweight adolescents who perceive themselves as overweight are more obsessed with body image and more likely to have an intention to lose weight, though such weight loss effort is not necessary.

As shown in Panel B of Table 3, we do not find any statistically significant, positive effect of the self-perception of overweight on the probability of meeting the recommended level of daily fruit and

vegetable consumption and none of the estimates on soft drink consumption are statistically significant. The results indicate that the self-perception of overweight does not necessarily improve eating habits through increased consumption of fruits and vegetables and reduced consumption of soft drink.

Panel C of Table 3 presents the effect of the self-perception of overweight on physical activity. As to personal exercise behaviors, the self-perception of overweight makes male adolescents less physically active and less likely to engage in moderate or vigorous exercise regardless of their reported BMI, and it has no effect on female adolescents except that it makes non-overweight females less active. In terms of team physical activity, the self-perception of overweight makes both non-overweight and overweight male adolescents less likely to go to PE classes or play on team sports. In contrast, the self-perception of overweight only decreases the probability of going to PE classes or joining a sports team for non-overweight females, not for overweight females. We do not find any statistically significant, negative effect of the self-perception of overweight on sedentary activities. On the contrast, the self-perception of overweight makes overweight males watch more TV and non-overweight males play more video games. One possible explanation for the findings on physical activity is related to feeling 'too fat to exercise' or "behavioral incapability" that is found to be a barrier to physical activity participation among overweight adults (Ball et al., 2000) or adolescents (Pate et al., 1996). That is, irrespectively of their reported weight status, adolescents who perceive themselves as overweight might be associated with the misperception of being incapable of engaging in physical activity and, therefore making them less physical active as our results show.

Panel D of Table 3 presents the effect of the self-perception of overweight on unhealthy weight-loss behaviors. For non-overweight subsamples, the self-perception of overweight makes both female and male adolescents more likely to engage in fasting or take weight-loss medication without the doctor's approval even though these unsafe weight-loss strategies are health-

compromising and are most likely unnecessary based on their reported weight status. The self-perception of overweight makes overweight females more likely to take weight-loss medication without the doctor's approval and causes overweight males to adopt both unhealthy weight-loss methods based on the LLR estimates but not on the NNM estimates. The findings warn researchers and policy makers that weight perception could exacerbate eating disorders and other adverse health consequences as adolescents favor unhealthy weight-loss methods to gain immediate effects.

Overall, the results show that US adolescents who perceive themselves as overweight have a stronger weight-loss intention irrespective of their reported BMI, but not necessarily through improved eating and exercises habits and instead likely through extreme weight-loss methods. Non-overweight adolescents who perceive themselves as such have an even stronger weight-loss intention and a higher likelihood to engage in unnecessary, but health-compromising weight-loss methods.

6. Matching quality and Robustness Checks

6.1. Quality of matching

The balancing test of matching covariates for each outcome variable suggests an effective matching. Take the general weight-loss intention as an example. Table 4 reports the mean difference of each matching variable between the treatment and comparison groups before and after matching as well as the p-values for the equal mean tests between two groups.[9] Out of 16 reported matching covariates, 14 for the reported non-overweight subsample and 12 for the reported overweight subsample are statistically significant at the 5% level before matching for females, and the corresponding numbers for males are 8 and 10. None of the differences between two groups are still statistically significant for the post-matching samples, and the magnitude of the differences also decreases dramatically (e.g., age and GPA).

We also compare the propensity scores of the treatment and comparison groups before and after matching for the same outcome variable to assess the matching quality. As shown in figure 1,

the distributions of the propensity scores for the general weight-loss intention differ significantly between two groups before matching, but the distribution for matched adolescents almost completely overlaps with that of the treatment group for all four subsamples by gender and the reported weight status. We again conclude that the matching indeed has been effective.

6.2. Robustness checks

We provide four different types of robustness checks for the matching results, including using different PSM specifications, an alternative matching technique (covariate matching), and an alternative treatment group, as well as correcting for self-reported BMI.

6.2.1. Different Propensity Score Matching Specifications

We experiment with different PSM specifications to ensure the matching results do not happen by chance. First, we incorporate all other risk behavior factors available in the YRBSS into the propensity score function and re-estimate the treatment effects.[10] Second, we employ different matching parameters – using 1 and 10 neighbors in the comparison group to match every treated individual for NNM and a series of fixed bandwidths for LLM.[11] Third, we do matching without trimming. The treatment effects are qualitatively similar as the main results (see tables D1-D3 in Appendix D).

6.2.2. An alternative Matching Method: Covariate Matching

The main difference between the PSM and the covariate matching (CVM) lies on the imputation of the missing potential outcomes. The PSM uses the estimated propensity score and the CVM uses untreated individuals with similar values of covariates (See Appendix A2 for the technical details of the CVM). We re-estimate the treatment effects using the CVM with the same set of covariates for the main results. The results are remarkably consistent (see Table D4 in Appendix D).

6.2.3. An alternative Treatment Group

The original treatment group consists of adolescents who perceive themselves as either slightly

or significantly overweight. One concern is that adolescents in the treatment group can be significantly similar to the comparison group if they only deem themselves to be slightly overweight and, therefore underestimate the treatment effects. We define an alternative treatment group that only consists of adolescents who think themselves as significantly overweight.

As shown in table D4 of Appendix D, the effects on weight-loss intentions as well as on eating and exercise habits are similar to those for the original treatment group. The only exception is that the perception of being significantly overweight does not make non-overweight males want to exercise to lose weight. Compared to the main results, we also observe much larger effect of the perception of being significantly overweight on unhealthy weight-loss methods for non-overweight adolescents. This finding indicates that a stronger bias in the self-perception of overweight could be more harmful because of the usage of unhealthy weight-loss methods.

6.2.4. Correct for Self-reported BMI

Researchers have found that adolescents underreport their body weight weights and overreport their heights, which lead to self-reported measurement errors (Elgar et al., 2005). Following Fan (2010), we correct for self-reported BMI by using NHANES data[12] that have both self-reported and doctor-measured height and weight. Using the corrected BMI rather than the self-reported BMI to re-estimate the effects of self-perceived overweight status, we have results significantly similar to the main results.[13] Details about the estimation of correction equations are provided in Appendix E.

7. Conclusions and Policy Implications

We find that, irrespective of the reported weight status, the self-perception of overweight causes adolescents to have a stronger intention to lose weight, but it does not improve eating habits by making adolescents consume more fruits and vegetables or fewer soft drinks. As to physical activity, we find that the self-perception of overweight does not make adolescents more likely to stay active, engage in exercise, join a sport team, attend PE classes, or reduce sedentary activity. Our

findings highlight the important distinctions between weight-loss intentions and implementing changes in diet and physical activity to lose weight. We also find one unwanted result: for non-overweight adolescents, the self-perception of overweight causes them to utilize unhealthy weight-loss methods such as fasting and taking unguided weight-loss medication that are health-compromising or even dangerous.

We propose two explanations for the difference between weight-loss intentions and behaviors among adolescents and the use of the extreme weight-loss methods. First, the self-perception of overweight among adolescents might be associated with the misperception of being incapable of engaging in healthy lifestyle behaviors as suggested by "behavioral incapability" in the literature. Public health strategies promoting physical activity and healthy diet habits among adolescents should not overlook the role of an incorrect weight perception and behavioral barriers in weight management and control. Instead, intervention strategies should focus on helping children overcoming these physical and psychological barriers. The other explanation is time-inconsistent preferences which are characterized by a hyperbolic discounting rate over time (Laibson, 1997). Applying this phenomenon in our context, adolescents with the self-perception of overweight might be impatient and have self-control problems as hyperbolic discounting leads to procrastination in adopting health-promoting weight-loss strategies such as healthy eating and being physically active to lose weight. Instead, they are more likely to adopt unhealthy weight-loss strategies to gain immediate effect. Understanding and modeling the inter-period decision making process of adolescents might be a fruitful research area if data are available in the future.

Whitlock et al. (2008) conduct an extensive review on behavioral interventions in either school or in specialty health care settings among children and adolescents. They find that behavior interventions can effectively produce short-term improvements in weight, but very limited evidence suggests such improvements can be maintained even partially over the 12 months following the end

of interventions. They also find that teaching behavior management techniques through establishing healthful eating habits and increasing physical activity improves the chance of a program's success as well as makes weight improvements long lasting. In order to successfully teach these useful techniques and eventually improve efficacy of obesity control efforts among adolescents, this study suggests one critical element -- fostering an appropriate perception of body weight and improving the individual's behavioral capability or self-control capability.

We are aware of several caveats. First, exploring the dynamical relations between weight status and weight-loss behaviors could shed more light on the question of obesity persistence. However, we could not do it because the YRBSS data is cross-sectional and lack exogenous changes in weight perception. Second, although the YRBSS data have weight-related information and risk factors, it does not have information about household, parents, and schools that are found to be important in childhood obesity. Third, the measurement errors in self-reported weight-loss behaviors in the YRBSS data could potentially bias the results.

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Table 1
Summary statistics of the Youth Rick Behavior Surveillance Survey (YRBSS) data

		2001	2003	2005	2007	2009
Overall response rate		63	67	67	68	71
No. of observations		13,588	15,186	13,903	14,019	16,382
Male		48.59	51.15	50.32	50.46	52.03
Age:	13 and 14	11.02	12.34	10.50	11.32	11.44
	15	25.57	25.51	26.47	26.13	24.78
	16	26.22	26.26	25.99	25.85	26.28
	17	23.35	23.36	23.39	23.33	24.28
	18 and above	13.84	12.54	13.65	13.37	13.57
Race:	Non-Hispanic white	70.09	64.84	65.37	63.89	62.11
	Hispanic and Latino	11.93	16.56	15.08	16.80	18.52
	African American	12.96	13.87	14.64	15.04	14.40
	Other races	4.17	4.72	4.90	4.27	4.97
Grade:	9^{th} grade	29.78	29.45	29.06	29.00	28.00
	10^{th} grade	25.93	26.16	25.94	26.27	26.21
	11^{th} grade	23.09	23.40	23.35	23.40	23.55
	12^{th} grade	21.20	20.99	21.65	21.32	22.25
Prevalence of Reported and Perceived Overweight/Obese						
Female:	Reported	20.29	27.48	25.63	24.66	24.01
	Perceived	34.65	37.05	38.02	34.53	33.22
Male:	Reported	33.31	30.59	31.69	32.65	30.99
	Perceived	23.25	23.55	24.90	24.32	22.54

All entries except number of observations are in percent.

Table 2

Summary statistics of weight-loss intentions and behaviors by the reported and perceived weight status [a]

	Female						Male					
Reported overweight (Yes/No)	Yes			No			Yes			No		
Perceived overweight (Yes/No)	No	Yes	*P* [b]	No	Yes	*P* [b]	No	Yes	*P* [b]	No	Yes	*P* [b]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	Panel A: Weight-loss Intentions											
LoseWeight	64.91	92.15	0.000	42.67	91.54	0.000	32.85	78.82	0.000	10.70	70.69	0.000
LoseWeight_Diet	53.12	75.62	0.000	43.39	77.80	0.000	31.06	58.70	0.000	15.65	53.70	0.000
LoseWeight_Exer	68.97	80.98	0.000	60.61	81.77	0.000	63.33	80.30	0.000	40.88	74.42	0.000
	Panel B: Eating Habits											
Fruit_2	18.07	17.22	0.500	17.76	17.70	0.925	21.09	16.40	0.000	17.79	17.10	0.601
Vegetable_3	6.12	4.96	0.158	4.49	4.81	0.506	8.09	4.80	0.000	5.06	6.29	0.172
Soda	29.83	28.35	0.581	25.45	23.93	0.268	36.82	35.67	0.501	36.36	39.10	0.264
	Panel C: Physical activity											
Active_5Days	26.64	20.75	0.002	29.99	26.17	0.003	50.19	35.20	0.000	47.82	33.32	0.000
Moderate_Exer	20.00	21.47	0.241	24.70	24.61	0.914	30.24	25.19	0.000	30.57	25.80	0.001
Vigorous_Exer	51.82	52.65	0.614	58.56	60.00	0.179	75.70	68.80	0.000	74.79	65.56	0.000
PE_Class	55.66	49.64	0.003	52.04	51.46	0.651	64.28	57.05	0.000	59.67	55.02	0.009
Sport_Team	43.34	40.45	0.060	54.15	53.62	0.612	70.04	54.60	0.000	64.53	52.91	0.000
TV_Time	48.83	42.22	0.000	33.39	31.25	0.050	41.49	45.92	0.001	35.90	39.41	0.043
Video_Time	18.77	21.09	0.103	17.07	18.29	0.196	28.18	30.94	0.054	26.30	30.49	0.022
	Panel D: Unhealthy Weight-loss Methods											
LoswWeight_Fasting	18.30	23.72	0.000	11.85	28.28	0.000	8.67	11.19	0.000	4.72	15.02	0.000
LoseWeight_Med	11.61	21.10	0.000	8.31	22.03	0.000	8.09	9.79	0.051	3.63	10.73	0.000

[a] We create an indicator variable for each measure of weight-loss intentions and behaviors and report the percentage of having such intention and behavior. Definitions of these indicator variables are given below (see table A2 of Appendix A for details):
LoseWeight equals one if the respondent indicated he/she tried to lose weight or keep from gaining weight during the post 30 days.

LoseWeight_Diet equals one if the respondent ate less food, fewer calories, or foods low in fat to lose weight or keep from gaining weight during the past 30 days.
LoseWeight_Exer equals one if the respondent exercised to lose weight or keep from gaining weight.
Fruit_2 equals one if the respondent ate fruits at least two times per day during the past seven days.
Vegetable_3 equals one if the respondent ate vegetables at least three times per day during the past seven days.
Soda equals one if the respondent drank a can, bottle, or glass of soda/pop such as Coke, pepsi or Sprite, excluding diet Coke and diet pop, on at least once a day during the past seven days.
Active_5Days equals one if the respondent was physically active for a total of at least 60 minutes per day on at least five days during the past seven days.
Moderate_Exer equals one if the respondent exercised or participated in physical activity for at least 30 minutes that did not make him or her sweat or breather hard on at least five days during the past seven days.
Vigorous_Exer equals one if the respondent participated in physical activity for at least 20 minutes that made him or her sweat and breathe hard on at least three days in the past several days.
PE_Class equals one if the respondent took physical education classes on at least one day in an average week.
Sport_Team equal one if the respondent played in at least one sports team during the past 12 months.
TV_Time equals one if the respondent watched TV for at least three hours per day on an average school day.
Video_Time equals one if the respondent played video or computer games or used a computer for something that was not school work at least three hours on an average school day.
LoseWeight_Med equals one if the respondent took any diet pills, powders, or liquid without a doctor's advice, vomited, or took laxatives to lose weight or keep from gaining weight.
LoseWight_Fasting equals one if the respondent did not eat for 24 hours or more (also called fasting) to lose weight or to keep from gaining weight during the past 30 days.
[b] P-value for the equal mean of weight-loss intentions and behaviors between perceived overweight and non-overweight groups.

Table 3
Effects of the self-perception of overweight on weight-loss intentions and behaviors using propensity score matching

	Self-Reported Overweight Sample				Self-Reported Non-overweight Sample			
	Female		Male		Female		Male	
	NNM	LLR	NNM	LLR	NNM	LLR	NNM	LLR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Panel A: Weight-loss intentions							
LoseWeight	0.188**	0.203**	0.366**	0.366**	0.33**	0.313**	0.539**	0.551**
	(0.018)	(0.016)	(0.017)	(0.014)	(0.01)	(0.008)	(0.018)	(0.014)
LoseWight_Diet	0.148**	0.145**	0.218**	0.212**	0.235**	0.219**	0.313**	0.309**
	(0.02)	(0.017)	(0.017)	(0.014)	(0.011)	(0.009)	(0.019)	(0.016)
LoseWeight_Exer	0.075**	0.082**	0.123**	0.117**	0.12**	0.104**	0.245**	0.227**
	(0.018)	(0.016)	(0.016)	(0.013)	(0.011)	(0.008)	(0.019)	(0.015)
	Panel B: Eating Habits							
Fruit_2	0.003	-0.01	-0.057**	-0.05**	-0.015	-0.019*	-0.002	-0.011
	(0.016)	(0.014)	(0.014)	(0.012)	(0.009)	(0.008)	(0.015)	(0.012)
Vegetable_3	-0.007	-0.01	-0.026**	-0.023**	-0.002	-0.002	-0.012	-0.002
	(0.011)	(0.008)	(0.009)	(0.007)	(0.005)	(0.004)	(0.008)	(0.007)
Soda	-0.042	-0.016	-0.024	-0.036	-0.013	-0.017	0.011	0.024
	(0.034)	(0.027)	(0.026)	(0.023)	(0.016)	(0.014)	(0.03)	(0.024)
	Panel C: Physical activity							
Active_5days	-0.028	-0.036	-0.101**	-0.116**	-0.031*	-0.04**	-0.122**	-0.12**
	(0.026)	(0.021)	(0.023)	(0.018)	(0.014)	(0.011)	(0.025)	(0.02)
Moderate_Exer	0.002	-0.008	-0.061**	-0.065**	-0.011	-0.017	-0.102**	-0.105**
	(0.022)	(0.018)	(0.015)	(0.012)	(0.012)	(0.01)	(0.019)	(0.015)
Vigorous_Exer	-0.006	0.002	-0.049**	-0.051**	-0.015	-0.008	-0.053**	-0.052**
	(0.019)	(0.015)	(0.017)	(0.013)	(0.01)	(0.009)	(0.019)	(0.014)
PE_Class	0.006	-0.011	-0.073**	-0.07**	-0.033**	-0.034**	-0.077**	-0.08**
	(0.022)	(0.018)	(0.017)	(0.014)	(0.013)	(0.01)	(0.019)	(0.015)
Sport_Team	-0.024	-0.018	-0.107**	-0.115**	-0.022	-0.028**	-0.131**	-0.139**
	(0.023)	(0.019)	(0.017)	(0.014)	(0.012)	(0.01)	(0.02)	(0.016)
TV_Time	0.007	0.011	0.04*	0.032*	-0.022	-0.016	0.039	0.033*
	(0.022)	(0.018)	(0.018)	(0.015)	(0.012)	(0.009)	(0.02)	(0.016)
Video_Time	0.015	0.011	0.002	0.01	-0.001	0.002	0.063**	0.05**
	(0.022)	(0.017)	(0.019)	(0.016)	(0.011)	(0.009)	(0.02)	(0.016)
	Panel D: Unhealthy Weight-loss Methods							
LoseWeight_Fasting	0.01	0.019	0.019	0.024**	0.11**	0.109**	0.09**	0.087**
	(0.019)	(0.015)	(0.011)	(0.009)	(0.01)	(0.008)	(0.012)	(0.01)
LoseWeight_Med	0.038*	0.051**	0.018	0.022**	0.095**	0.098**	0.063**	0.061**
	(0.017)	(0.013)	(0.01)	(0.008)	(0.008)	(0.007)	(0.011)	(0.009)

Figures in parentheses are bootstrapped standard errors. Asterisks, ** and *, indicate the 1%, and 5% significance level, respectively. The definitions of the weight-loss variables are given in table 2.

Table 4

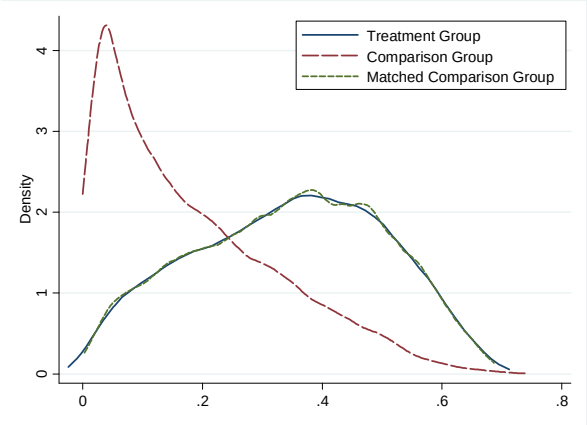
Balancing tests of matching covariates for the outcome variable (*LoseWeight*) [a]

U=Unmatched M=Matched		Female				Male			
		Reported Non-Overweight		Reported Overweight		Reported Non-overweight		Reported Overweight	
		diff.	*P* [b]	diff.	*P* [b]	diff.	*P* [b]	diff.	*P* [b]
BMI category	U	**1.860**	0.000	**0.250**	0.000	**1.752**	0.000	**0.380**	0.000
	M	0.051	0.176	0.007	0.438	0.036	0.612	-0.002	0.824
Age (years)	U	**0.102**	0.000	**0.244**	0.000	0.042	0.259	0.028	0.310
	M	-0.003	0.920	-0.025	0.304	0.016	0.755	0.009	0.737
Non-Hispanic White	U	**0.041**	0.000	**0.162**	0.000	-0.014	0.368	**0.071**	0.000
	M	0.010	0.354	0.009	0.354	0.006	0.762	0.014	0.174
Hispanics	U	**0.043**	0.000	0.018	0.181	**0.043**	0.001	**0.028**	0.008
	M	-0.012	0.241	-0.008	0.391	-0.008	0.671	-0.018	0.055
African American	U	**-0.094**	0.000	**-0.194**	0.000	**-0.073**	0.000	**-0.106**	0.000
	M	0.002	0.782	0.009	0.243	0.003	0.793	0.006	0.352
GPA	U	**0.157**	0.000	**0.122**	0.000	**0.242**	0.000	**0.280**	0.000
	M	-0.012	0.556	0.028	0.136	-0.017	0.684	0.001	0.956
10th grade	U	0.000	0.985	**-0.037**	0.004	-0.016	0.222	-0.013	0.200
	M	0.000	0.980	-0.005	0.546	0.008	0.630	-0.004	0.647
11th grade	U	0.013	0.085	**0.038**	0.003	-0.001	0.951	0.003	0.784
	M	0.005	0.597	0.008	0.345	0.004	0.847	0.006	0.494
12th grade	U	**0.019**	0.015	**0.078**	0.000	0.021	0.121	0.019	0.065
	M	-0.001	0.902	-0.007	0.425	-0.003	0.882	0.001	0.884
Risk Behavior Variables [c]									
Depression	U	**0.088**	0.000	**0.050**	0.001	**0.069**	0.000	**0.030**	0.002
	M	-0.021	0.060	0.004	0.684	-0.013	0.491	-0.009	0.290
Suicide	U	**0.066**	0.000	**0.057**	0.000	**0.058**	0.000	**0.022**	0.003
	M	-0.013	0.148	0.005	0.580	-0.005	0.747	-0.006	0.340
Sex	U	**-0.018**	0.038	**-0.126**	0.000	**-0.081**	0.000	**-0.142**	0.000
	M	0.003	0.818	0.007	0.501	0.000	0.993	-0.012	0.245
Drink	U	**0.053**	0.000	0.019	0.121	0.004	0.801	**-0.033**	0.002
	M	-0.005	0.624	-0.008	0.343	0.000	0.993	-0.016	0.102
Smoke	U	**0.059**	0.000	0.006	0.659	-0.024	0.113	-0.005	0.663
	M	-0.010	0.375	0.001	0.927	-0.002	0.919	-0.012	0.232
Marijuana	U	**0.038**	0.000	**-0.051**	0.000	**-0.048**	0.002	**-0.034**	0.003
	M	-0.002	0.850	0.000	0.962	0.005	0.812	-0.006	0.548
Drive	U	**0.033**	0.000	-0.019	0.160	-0.005	0.755	-0.016	0.137
	M	-0.008	0.446	-0.005	0.614	0.003	0.865	-0.007	0.476

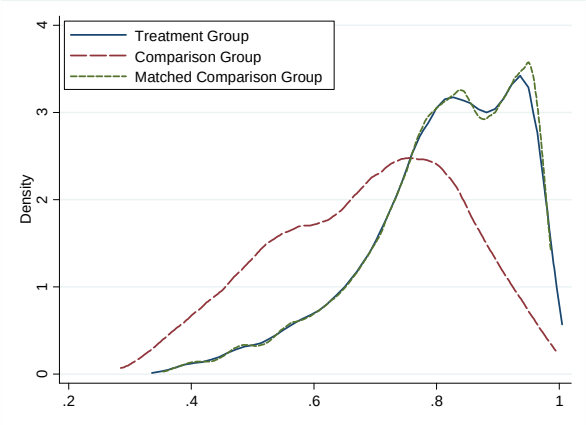
[a] All tests for the mean difference of each matching covariate between the comparison and treatment groups are based on the PSM with five neighbors. Let n_1 and n_2 represent the number of observations in the treatment and comparison groups on the support. The corresponding t-statistics are calculated as $\left(\overline{X}_{treat} - \overline{X}_{control}\right) = \left(\overline{X}_{treat} - \overline{X}_{control}\right) \Big/ \sqrt{\frac{\sigma^2_{treat}}{n_1} + \frac{\sigma^2_{control}}{n_2}}$. Figures in bold indicate the mean difference is statistically different at the 10% significance level.

[b] P-value for the equal mean of each matching covariate between the treatment and comparison groups.

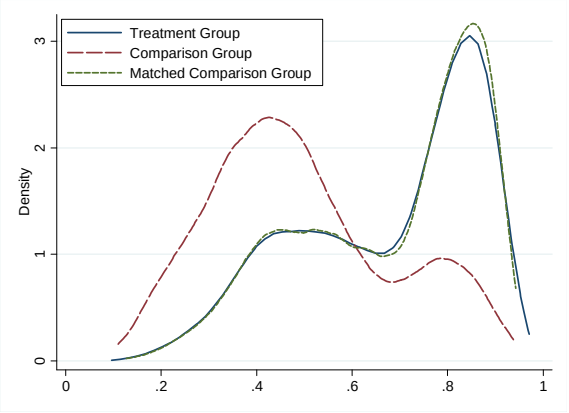
[c] We create an indicator variable for each risk behavior measure. The definitions for those indicator variables are given below (see table A3 of Appendix A for additional details):
Depression equals one if the respondent felt sad or hopeless almost every day for two or more weeks in a row in the past 12 months that he/she stopped doing some usual activities.
Suicide equals one if the respondent either attempted or tried suicide at least once in the last 12 months.
Sex equals one if the respondent ever had sexual intercourse.
Alcohol equals one if the respondent who was a binger drinker such that he or she had at least one drink of alcohol on more than five days in the past 30 days.
Smoke equals one if the respondent ever had cigarettes.
Marijuana equals one if the respondent ever used marijuana.
DUI equals one if the respondent either drove a car or other vehicle when he or she had been drinking alcohol or rode in a car or other vehicle driven by someone who had been drinking alcohol at least once in the past 30 days.



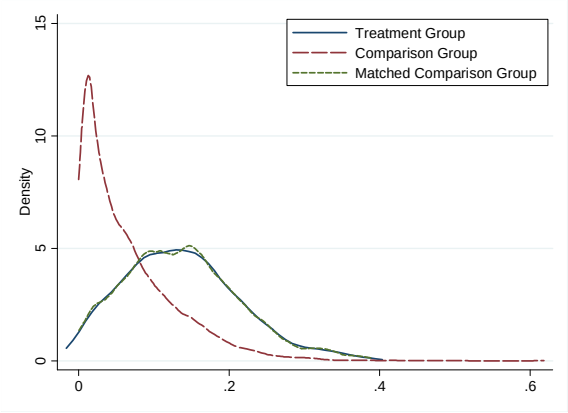
Female: Overweight Subsample



Female: Non-overweight Subsample



Male: Overweight Subsample



Male: Non-overweight Subsample

Figure 1. Kernel density estimate of the distribution of the propensity score based on nearest neighbor matching

APPENDIX A: VARIABLE DESCRIPTIONS

The Youth Behavioral Risk Factor Surveillance System is conducted by the Centers for Disease Control and Prevention (CDC) biennially since 1990. The following tables summarize definitions of variables for basic demographics, weight-loss intentions and behaviors, and risk behaviors.

Table A1
Basic demographic variables

YRBSS information	**Descriptions of constructed variables**
age, gender, weight, height	BMI percentile by age and gender using the CDC's SAS program at www.cdc.gov/nccdphp/dnpao/growthcharts/resources/sas.htm. *Reported_Non-overweight* for BMI being at and below the 85th percentile *Reported_Overweight* for BMI being greater than or equal to the 85th percentile
Respondents described their weight status in a 5-point Likert-type scale	*Perceived_Non-overweight* for choosing "very underweight, slightly underweight, and about the right weight" *Perceived_Overweight* for choosing "slight overweight" or "very overweight" *Perceived_Very_Overweight* if choosing "very overweight"
Race/Ethnicity	Four dichotomous variables to indicate the respondent's ethnicity/race: Non-Hispanic White, African-American, Hispanic and Latinos, and others.
Age	Age (years)
School grade (9-12)	Grade dummies
Respondents' GPA in the past 12 months	*GPA_A*: mostly A's *GPA_B*: mostly B's *GPA_C*: Mostly C's *GPA_DF*: Mostly D's and F's

Table A2
Dichotomous variables for weight-loss intentions and behaviors

YRBSS information	**Variable Descriptions**
Did the respondent try to lose weight in the past 30 days?	*LoseWeight* = 1 if he/she did.
Did the respondent exercise to lose weight in the past 30 days?	*LoseWeight_Exer* = 1 if exercised.
Did the respondent eat less food, fewer calories, or foods low in fat to lose weight during the past 30 days?	*LoseWeight_Diet* = 1 for dieting.
Did the respondent go without eating for 24 hours or more to lose weight during the past 30 days?	*LoseWeight_Fasting* = 1 if he/she did fasting.
Did the respondent take any diet pills, powders, or liquids without a doctor's advice or vomited or took laxatives to lose weight during the past 30 days?	*LoseWeight_Med* = 1 for taking the mentioned medical means to lose weight.
How many times did the respondent ate fruits, green salad, carrots, or other vegetables during the past seven days?	*Fruit_2* (*Vegetables_3*) = 1 for eating fruits (vegetables) at least 2 (3) times a day on each day in the past 7 days.
How many times did the respondent drink soda or pop, excluding diet coke or diet pop, during the past 7 days	*Soda* = 1 if drinking soda at least once in the past seven days.
How many days was the respondent physically active for at least 60 minutes per day during the past 7 days?	*Activve_5Day* = 1 for being physically active on at least five days.
How many days had the respondent exercised or participated in physical activity for at least 20 minutes that made him or her sweat and breathe hard during the past seven days?	*Vigorous_Exer* = 1 for taking vigorous exercise on at least three days in the past seven days.
How many days had the respondent participated in	*Moderate_Exer* = 1 for taking moderate

physical activity for at least 30 minutes that did not make him or her sweat or breathe hard during the past 7 days?	exercise on at least five days in the past seven days.
How many hours did the respondent watch TV on an average school day?	*TV_Time* = 1 if watched TV for more than 3 hours.
How many hours did the respondent play video or computer games or use a computer for something that was not school work on an average school day?	*Video_Time* = 1 if played video for more than 3 hours.
How many days did the respondent take PE class on an average week when he or she was in school?	*PE_Class* = 1 for attending at least one PE class.
How many sports teams had the respondent played during the past 12 months?	*Team_Sport* = 1 for playing at least on one sport team.

Table A3
Dichotomous variables for risk behaviors

YRBSS information	**Variable Descriptions**	Note[a]
Did the respondent feel sad or hopeless almost every day for two or more weeks in a row in the past 12 months that he/she stopped doing some usual activities?	*Depression* = 1 for feeling depressed.	1, 2
Did the respondent seriously consider attempting suicide during the past 12 months?	*Thinksuicide* = 1 for considering suicide.	2
Did the respondent either attempt or try suicide at least once in the last 12 months?	*Suicide* = 1 for having suicide attempt.	1, 2
Did the respondent have ever consumed at least one alcoholic drink in his life?	*Everdrink* = 1 if an ever drinker.	2
Did the respondent have alcohol in the past 30 days?	*Drinklm* = 1 if he/she did.	2
Did the respondent have alcohol drink at least once for more than five days in the past 30 days?	*Alcohol* = 1 for a binger drinker.	1, 2
Did the respondent ever have cigarettes?	*Smoke* = 1 if ever smoked.	1, 2
Did the respondent smoke at least once during the past 30 days?	*Smokelm* = 1 if he/she smoked during the past 30 days.	2
Did the respondent ever use marijuana?	*Marijuana* = 1 for marijuana use.	1, 2
Did the respondent have marijuana in the past 30 days?	*Marijuanalm* = 1 if he/she did.	2
Did the respondent ever use illegal drugs?	*Everdrug* = 1 if he/she did.	2
Did the respondent ever use cocaine?	*Evercocaine* = 1 if he/she did.	2
Did the respondent have cocaine in the past 30 days?	*Cocainelm* = 1 if he/she did.	2
Did the respondent ever have sexual intercourse?	*Sex* = 1 if he/she has sex.	1, 2
Did the respondent have at least 4 sex partners?	*Sex4P* = 1 if he/she did.	2
Did the respondent have at least one sexual intercourse in during the past three months?	*Sex3M* = 1 if he/she did.	2
Did the respondent drive a car/vehicle when he/she had been drinking alcohol or ride in a car/vehicle driven by someone who had been drinking alcohol in the past 30 days?	*DUI* =1 for driving under influence.	1, 2
Did the respondent always wear a seatbelt or most of the time as a passenger?	*Seatbelt* = 1 is he/she did so.	2
Was the respondent involved in a physical fight in the past 12 months?	Fight = 1 if he/she was involved in a physical fight.	2

[a] Variables indicated as "1" ("2") are used as matching variables for the main matching or the robust check.

APPENDIX B: PROPENSITY SCORE MATCHING AND COVARIATE MATCHING

Appendix B1: Propensity score matching

Let Y_1 (Y_0) measures weight-loss intentions or eating and exercise habits when an adolescent perceives himself or herself as overweight (non-overweight). The treatment effect is the difference between two outcomes: $Y_1 - Y_0$. However, this difference is not observable due to a missing data problem: perceived overweight (non-overweight) reveals Y_1 (Y_0), but conceals the other potential outcome. To address the selection bias due to the lack of random assignment of self-perceived weight status, we employ a matching technique, propensity score matching (PSM).

The following two assumptions are critical for the matching estimator:

A1. Conditional Independence Assumption: $(Y_0, Y_1) \perp T \mid X$; and

A2. Common Support Assumption: $0 < prob(T = 1 \mid X) < 1$;

where $\perp$ is the notation for statistical independence and T indicates the treatment status. Assumption **A1** says that all the variables driving self-selection are observable to researchers, i.e., the treatment assignment is independent of outcomes conditional on covariates (LaLonde, 1986). Assumption **A2** says that the probability of participation in treatment is bounded between zero and one. Based on these two assumptions, the estimated counterfactual outcome of treated individual i is:

$$\hat{Y}_{0i} = \sum_{j \in C_i^0} \left(w_{ij} Y_j \middle| T_j = 0 \right) \tag{B1}$$

where C_i^0 is the set of matches of individual i, $w_{ij} \in [0,1]$, and $\sum_i w_{ij} = 1$. Since we are interested in knowing whether children's self-perception of overweight has any effect on their weight-loss efforts, we focus on the sample average treatment effect on the treated (SATT):

$$SATT = \frac{1}{N_1} \sum_{i|T_i=1} \left(Y_{1i} - \hat{Y}_{0i} \right) \tag{B2}$$

where $N_1 = \sum_i T_i$ and $\hat{Y}_{0i}$ is the estimated potential outcome if not treated in equation (1). The estimated treatment effects for the population and on the control group are available upon request. We employ two widely used PSM algorithms: nearest neighbor matching (NNM) and local linear regression matching (LLR). See Appendix B1 for technical details of these two algorithms.

There are two commonly used propensity score matching (PSM) algorithms: nearest neighbor matching (NNM) and local linear regression matching (LLR). The NNM estimator compares every treated unit with one or more units from the comparison group that are most similar in terms of the propensity score. It defines the set of matches with replacement is given below:

$$C_i^0 \left(M \right) = \left\{ l = 1, \ldots, N \middle| T_l = 0, \left| P_i - P_l \right| \leq d_i \left(M \right) \right\} \tag{B3}$$

where M indicates the number of matches (neighbors) and $d_i \left(M \right)$ is the distance from individual i to the M^{th} nearest match in the comparison group. We implicitly define $d_i \left(M \right)$:

$$\sum_{l:T_l=0} 1\left\{ \left| P_i - P_l \right| < d_i \left(M \right) \right\} < M \tag{B4-a}$$

and

(B4-b) $$\sum_{l:T_l=0} 1\left\{\left|P_i - P_l\right| \le d_i(M)\right\} \ge M$$

where $1\{\cdot\}$ is the indicator function that equals to 1 when the value in brackets is true, and zero otherwise. In NNM, the estimator could be biased if the distances between "best" matches are sizeable. The caliper matching estimator imposes a tolerance level on maximum propensity score distance so that it can avoid bad matches. We find that the NNM and caliper estimators are similar for our data set.

We implement this method using one or five nearest neighbors and with replacement. Replacement means that untreated units can be used more than once as the matches for the treated units.

The LLR uses a kernel-weighted average over multiple persons in the comparison group as the counterfactual outcome of the treated observation. Fan (1992) shows that LLR converges faster and that it is more robust to different densities of data than kernel matching. The weight of LLR is given below:

(B5) $$w_{ij} = \frac{G_{ij}\sum_{l\in C_i^0} G_{il}\left(P_l - P_i\right)^2 - \left[G_{il}\left(P_l - P_i\right)\right]\left[\sum_{l\in C_i^0} G_{il}\left(P_l - P_i\right)\right]}{\sum_{j\in C_i^0}\left[G_{ij}\sum_{l\in C_i^0} G_{il}\left(P_l - P_i\right)^2\right] - \left[\sum_{l\in C_i^0} G_{il}\left(P_l - P_i\right)\right]^2}$$

where $G_{ij} = G\left(\left(P_j - P_i\right)/h\right)$ and h is the bandwidth. We use the Epanechnikov distribution as the kernel function. We also experimented with different distributions such as tricube and normal kernel. The choice of kernel function has very little effect on the performance of the LLR estimator.

Bootstraping is often used to obtain standard errors for matching estimators to test the hypothesis (e.g. Black and Smith, 2004; Heckman et al., 1997; Sianesi, 2004). Each bootstrap sample is a random sampling with replacement from the original data set. We draw 500 bootstrap samples and estimate 500 average treatment effects for the treated. The distribution of these means approximates the sampling distribution (and thus the standard error) of the population mean.

Appendix B2: Covariate matching

The covariate matching (CVM) estimator is not based on assumptions about either treatment assignment or the relationship between covariates and outcomes. In CVM, every treated unit is matched to a number of units in the control group based on the distance measured by the vector norm $\|\cdot\|$. Let $\|x\|_V = \left(x'Vx\right)^{1/2}$ be the vector norm with positive definite matrix V. We use the diagonal matrix, of which the diagonal elements are the inverses of the variances of X_i (the element of the set of covariates), as our weighting matrix V. The weighting matrix V accounts for the difference in the scale of the covariates. The CVM defines $\|z - x\|_V$ as the distance between the vectors x and z, where x and z represent the covariates for a treated unit and a potential match, respectively. Let $d_M(i)$ be the distance from unit i to the M^{th} nearest match with the opposite treatment. Consider the set of observed covariates for unit i to be X_i. The set unit i will match with is defined as follows:

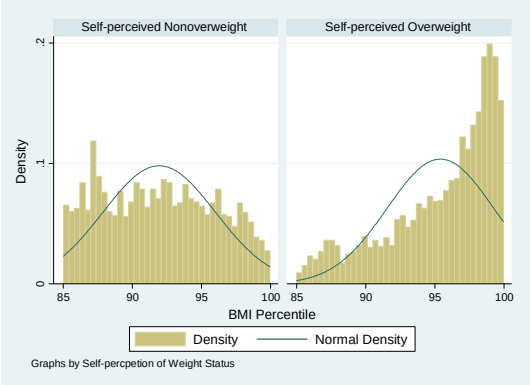
(B6) $$\Psi_M(i) = \left\{l = 1,\ldots,N \,\middle|\, T_l = 1 - T_i, \|X_l - X_i\|_V \le d_M(i)\right\}$$

and $d_M(i)$ is defined as

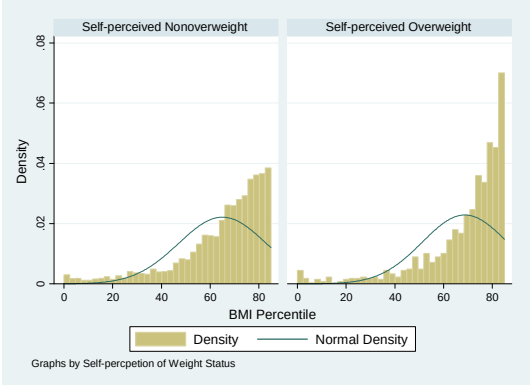
(B7) $$\sum_{l:T_l=1-T_i} 1\left\{\left\|X_l - X_i\right\|_V \le d_M\left(i\right)\right\} = M$$

where $1\{\cdot\}$ is the indicator function, which equals 1 when the expression in brackets is true and zero otherwise. The simple CVM matching estimator will be biased in finite samples when the matching is not exact. Abadie and Imbens (2002) develop a bias-corrected matching estimator adjusting the difference within the matches for the differences in their covariate values. Although matching on multidimensional covariates can theoretically lead to substantial bias, the matching approach combined with bias adjustment often leads to estimates with little remaining bias.

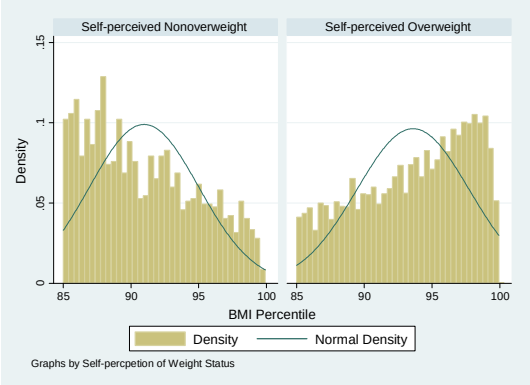
APPENDIX C: DISTRIBUTION OF THE PROPENSITY SCORE



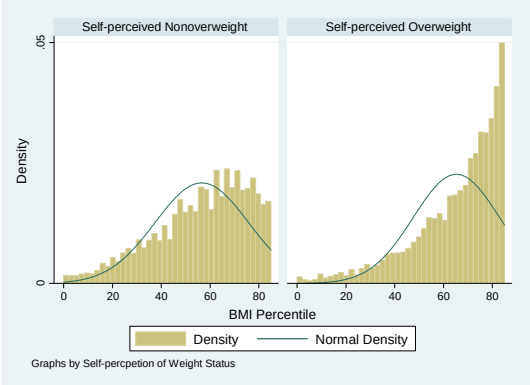
(a) Self-reported Overweight Sample (Male)



(b) Self-reported Non-overweight Sample (Male)



(c) Self-reported Overweight Sample (Female)



(d) Self-reported Non-overweight Sample (Female)

Figure C. Overlap of the BMI percentile between the treatment and comparison groups

APPENDIX D: ROBUSTNESS CHECKS

Table D1

Propensity score matching results using an expanded set of risk behavior variables

	Self-Reported Overweight Sample				Self-Reported Non-overweight Sample			
	Female		Male		Female		Male	
	NNM	LLR	NNM	LLR	NNM	LLR	NNM	LLR
				Panel A: Weight-loss intentions				
LoseWeight	0.192**	0.204**	0.345**	0.358**	0.326**	0.303**	0.564**	0.554**
	(0.019)	(0.017)	(0.017)	(0.014)	(0.011)	(0.008)	(0.020)	(0.017)
LoseWight_Diet	0.142**	0.142**	0.224**	0.217**	0.227**	0.22**	0.308**	0.306**
	(0.024)	(0.019)	(0.020)	(0.018)	(0.012)	(0.010)	(0.020)	(0.017)
LoseWeight_Exer	0.068**	0.080**	0.120**	0.118**	0.115**	0.102**	0.239**	0.231**
	(0.02)	(0.017)	(0.018)	(0.013)	(0.011)	(0.009)	(0.022)	(0.015)
				Panel B: Eating Habits				
Fruit_2	0.001	-0.002	-0.053**	-0.052**	-0.006	-0.011	-0.017	-0.012
	(0.019)	(0.015)	(0.015)	(0.013)	(0.011)	(0.008)	(0.016)	(0.013)
Vegetable_3	-0.015	-0.009	-0.025*	-0.023**	-0.003	-0.001	0.005	0.003
	(0.011)	(0.008)	(0.010)	(0.008)	(0.005)	(0.004)	(0.009)	(0.007)
Soda	-0.040	-0.007	-0.029	-0.034	-0.031	-0.021	0.016	0.032
	(0.034)	(0.031)	(0.027)	(0.025)	(0.018)	(0.015)	(0.027)	(0.022)
				Panel C: Physical activity				
Active_5Days	-0.041	-0.041	-0.089**	-0.104**	-0.032*	-0.038**	-0.112**	-0.116**
	(0.025)	(0.022)	(0.022)	(0.017)	(0.016)	(0.013)	(0.027)	(0.022)
Moderate_Exer	0.002	-0.018	-0.049**	-0.064**	-0.002	-0.017	-0.109**	-0.103**
	(0.024)	(0.020)	(0.019)	(0.016)	(0.012)	(0.010)	(0.019)	(0.017)
Vigorous_Exer	-0.017	-0.010	-0.047*	-0.049**	-0.010	-0.008	-0.056**	-0.054**
	(0.02)	(0.016)	(0.019)	(0.015)	(0.012)	(0.009)	(0.021)	(0.017)
PE_Class	0.008	-0.014	-0.096**	-0.076**	-0.020	-0.026*	-0.080**	-0.085**
	(0.023)	(0.016)	(0.019)	(0.016)	(0.016)	(0.011)	(0.022)	(0.015)
Sport_Team	-0.032	-0.026	-0.103**	-0.112**	-0.020	-0.023*	-0.122**	-0.135**
	(0.02)	(0.017)	(0.019)	(0.015)	(0.013)	(0.011)	(0.020)	(0.015)
TV_Time	0.004	0.015	0.033	0.034*	-0.014	-0.012	0.054**	0.047**
	(0.023)	(0.02)	(0.018)	(0.014)	(0.012)	(0.009)	(0.02)	(0.016)
Video_Time	-0.011	0.001	-0.004	0.005	-0.005	0.000	0.034	0.046**
	(0.026)	(0.017)	(0.02)	(0.015)	(0.011)	(0.008)	(0.021)	(0.018)
				Panel D: Unhealthy Weight-loss Methods				
LoseWeight_Fasting	0.026	0.033*	0.023*	0.025*	0.109**	0.113**	0.080**	0.080**
	(0.019)	(0.015)	(0.011)	(0.010)	(0.01)	(0.008)	(0.012)	(0.010)
LoseWeight_Med	0.029	0.042**	0.022*	0.024**	0.099**	0.099**	0.054**	0.056**
	(0.019)	(0.013)	(0.01)	(0.008)	(0.009)	(0.008)	(0.011)	(0.009)

Asterisks, ** and *, indicate the 1%, and 5% significance level, respectively. NNM uses 5 neighbors in the comparison group and LLR uses a rule-of-thumb bandwidth.

Table D2
Propensity score matching results using one neighbor and a fixed bandwidth (0.1)

	Self-Reported Overweight Sample				Self-Reported Non-overweight Sample			
	Female		Male		Female		Male	
	NNM	LLR	NNM	LLR	NNM	LLR	NNM	LLR
				Panel A: Weight-loss intentions				
LoseWeight	0.181**	0.187**	0.374**	0.36**	0.34**	0.329**	0.555**	0.550**
	(0.020)	(0.018)	(0.018)	(0.014)	(0.012)	(0.007)	(0.023)	(0.014)
LoseWight_Diet	0.143**	0.145**	0.199**	0.208**	0.241**	0.231**	0.314**	0.313**
	(0.024)	(0.02)	(0.02)	(0.014)	(0.015)	(0.01)	(0.023)	-00.016
LoseWeight_Exer	0.091**	0.078**	0.120**	0.120**	0.118**	0.121**	0.265**	0.241**
	(0.019)	(0.019)	(0.02)	(0.013)	(0.014)	(0.009)	(0.026)	(0.014)
				Panel B: Eating Habits				
Fruit_2	-0.005	-0.004	-0.05**	-0.047**	-0.013	-0.017*	-0.009	-0.008
	(0.017)	(0.015)	(0.017)	(0.012)	(0.012)	(0.008)	(0.023)	(0.015)
Vegetable_3	-0.011	-0.013	-0.025*	-0.028**	-0.009	-0.003	-0.009	-0.002
	(0.012)	(0.011)	(0.010)	(0.009)	(0.006)	(0.004)	(0.010)	(0.006)
Soda	-0.054	-0.036	-0.032	-0.028	-0.005	-0.025	-0.037	0.015
	(0.038)	(0.032)	(0.033)	(0.025)	(0.022)	(0.016)	(0.035)	(0.025)
				Panel C: Physical activity				
Active_5Days	-0.025	-0.022	-0.089**	-0.095**	-0.031	-0.033**	-0.100**	-0.110**
	(0.028)	(0.021)	(0.024)	(0.020)	(0.020)	(0.012)	(0.038)	(0.021)
Moderate_Exer	-0.002	0.010	-0.057**	-0.061**	-0.012	-0.011	-0.095**	-0.097**
	(0.026)	(0.020)	(0.017)	(0.013)	(0.017)	(0.011)	(0.023)	(0.014)
Vigorous_Exer	-0.010	-0.006	-0.044*	-0.05**	-0.014	-0.006	-0.054*	-0.049**
	(0.021)	(0.018)	(0.020)	(0.013)	(0.015)	(0.010)	(0.026)	(0.014)
PE_Class	-0.004	00.00	-0.058**	-0.084**	-0.018	-0.031**	-0.076**	-0.074**
	(0.024)	(0.022)	(0.019)	(0.016)	(0.015)	(0.009)	(0.028)	(0.016)
Sport_Team	-0.030	-0.010	-0.121**	-0.109**	-0.017	-0.022*	-0.143**	-0.126**
	(0.028)	(0.024)	(0.020)	(0.016)	(0.015)	(0.01)	(0.025)	(0.015)
TV_Time	0.009	0.011	0.0400	0.031	-0.026	-0.022*	0.029	0.029
	(0.022)	(0.018)	(0.022)	(0.016)	(0.016)	(0.010)	(0.028)	(0.016)
Video_Time	0.007	0.006	-0.002	0.002	0.005	0.000	0.068**	0.046**
	(0.027)	(0.023)	(0.024)	(0.019)	(0.014)	(0.009)	(0.025)	(0.016)
				Panel D: Unhealthy Weight-loss Methods				
LoseWeight_Fasting	0.010	0.003	0.026*	0.021	0.105**	0.109**	0.087**	0.086**
	(0.023)	(0.019)	(0.013)	(0.011)	(0.012)	(0.008)	(0.015)	0.011
LoseWeight_Med	0.021	0.036*	0.017	0.019*	0.091**	0.097**	0.071**	0.063**
	(0.017)	(0.018)	(0.012)	(0.010)	(0.011)	(0.008)	(0.012)	(0.009)

Asterisks, ** and *, indicate the 1%, and 5% significance level, respectively.

Table D3
Propensity score matching results without trimming

	Self-Reported Overweight Sample				Self-Reported Non-overweight Sample			
	Female		Male		Female		Male	
	NNM	LLR	NNM	LLR	NNM	LLR	NNM	LLR
	Panel A: Weight-loss intentions							
LoseWeight	0.189**	0.186**	0.366**	0.360**	0.329**	0.328**	0.539**	0.550**
	(0.019)	(0.017)	(0.015)	(0.014)	(0.01)	(0.007)	(0.018)	(0.014)
LoseWight_Diet	0.148**	0.146**	0.218**	0.208**	0.235**	0.231**	0.313**	0.312**
	(0.020)	(0.020)	(0.016)	(0.015)	(0.011)	(0.01)	(0.018)	(0.017)
LoseWeight_Exer	0.075**	0.077**	0.125**	0.120**	0.120**	0.120**	0.243**	0.241**
	(0.018)	(0.018)	(0.016)	(0.013)	(0.011)	(0.009)	(0.018)	(0.014)
	Panel B: Eating Habits							
Fruit_2	0.002	-0.005	-0.058**	-0.047**	-0.015	-0.017*	-0.004	-0.009
	(0.015)	(0.016)	(0.013)	(0.012)	(0.009)	(0.008)	(0.016)	(0.015)
Vegetable_3	-0.008	-0.012	-0.026**	-0.028**	-0.002	-0.002	-0.012	-0.002
	(0.011)	(0.011)	(0.008)	(0.009)	(0.005)	(0.004)	(0.007)	(0.006)
Soda	-0.041	-0.036	-0.024	-0.029	-0.012	-0.025	0.010	0.016
	(0.030)	(0.030)	(0.026)	(0.024)	(0.017)	(0.016)	(0.027)	(0.024)
	Panel C: Physical activity							
Active_5Days	-0.025	-0.021	-0.099**	-0.094**	-0.030*	-0.032**	-0.122**	-0.106**
	(0.023)	(0.021)	(0.023)	(0.02)	(0.014)	(0.012)	(0.028)	(0.021)
Moderate_Exer	0.000	0.011	-0.06**	-0.062**	-0.011	-0.011	-0.100**	-0.095**
	(0.020)	(0.020)	(0.013)	(0.013)	(0.013)	(0.011)	(0.018)	(0.014)
Vigorous_Exer	-0.004	-0.006	-0.048**	-0.049**	-0.014	-0.005	-0.054**	-0.05**
	(0.018)	(0.018)	(0.017)	(0.014)	(0.012)	(0.010)	(0.020)	(0.014)
PE_Class	0.004	-0.001	-0.072**	-0.083**	-0.035**	-0.032**	-0.079**	-0.076**
	(0.021)	(0.022)	(0.017)	(0.016)	(0.011)	(0.009)	(0.019)	(0.016)
Sport_Team	-0.021	-0.009	-0.106**	-0.109**	-0.024*	-0.022*	-0.132**	-0.127**
	(0.026)	(0.024)	(0.017)	(0.016)	(0.011)	(0.01)	(0.019)	(0.015)
TV_Time	0.007	0.012	0.039*	0.030	-0.023*	-0.023*	0.037	0.027
	(0.02)	(0.018)	(0.018)	(0.016)	(0.012)	(0.010)	(0.020)	(0.017)
Video_Time	0.015	0.005	0.001	0.002	-0.001	0.000	0.062**	0.045**
	(0.025)	(0.023)	(0.020)	(0.018)	(0.011)	(0.009)	(0.02)	(0.016)
	Panel D: Unhealthy Weight-loss Methods							
LoseWeight_Fasting	0.010	0.003	0.019	0.021	0.109**	0.108**	0.089**	0.085**
	(0.021)	(0.019)	(0.012)	(0.011)	(0.009)	(0.008)	(0.013)	(0.011)
LoseWeight_Med	0.036*	0.035	0.018	0.018	0.095**	0.098**	0.063**	0.063**
	(0.018)	(0.018)	(0.010)	(0.010)	(0.009)	(0.008)	(0.010)	(0.009)

Asterisks, ** and *, indicate the 1%, and 5% significance level, respectively. NNM uses 5 neighbors in the comparison group and LLR uses a fixed bandwidth (0.1).

Table D4
Effects of the Self-Perception of Overweight on Weight-loss Intentions and Behaviors using Covariate Matching

	Self-Reported Overweight Sample				Self-Reported Non-overweight Sample			
	Female		Male		Female		Male	
	N=5	N=10	N=5	N=10	N=5	N=10	N=5	N=10
	Panel A: Weight-loss intentions							
LoseWeight	0.195**	0.195**	0.355**	0.357**	0.316**	0.317**	0.555**	0.558**
	(0.015)	(0.014)	(0.012)	(0.011)	(0.007)	(0.007)	(0.014)	-00.014
LoseWight_Diet	0.143**	0.144**	0.222**	0.218**	0.222**	0.222**	0.300**	0.306**
	(0.016)	(0.016)	(0.012)	(0.012)	(0.009)	(0.008)	(0.016)	-00.016
LoseWeight_Exer	0.090**	0.088**	0.118**	0.119**	0.108**	0.105**	0.231**	0.231**
	(0.015)	(0.015)	(0.012)	(0.011)	(0.008)	(0.008)	(0.015)	-00.014
	Panel B: Eating Habits							
Fruit_2	0.007	0.001	-0.039**	-0.040**	-0.018*	-0.016*	-0.007	-00.004
	(0.012)	(0.012)	(0.01)	(0.01)	(0.007)	(0.007)	(0.012)	-00.012
Vegetable_3	-0.004	-0.007	-0.019**	-0.019**	0.002	00.00	00.00	00.002
	(0.007)	(0.007)	(0.005)	(0.005)	(0.004)	(0.004)	(0.007)	-00.006
Soda	-0.028	-0.020	-0.031	-0.033	-0.019	-0.020	0.006	00.013
	(0.023)	(0.022)	(0.020)	(0.019)	(0.013)	(0.013)	(0.025)	-00.024
	Panel C: Physical activity							
Active_5Days	-0.020	-0.023	-0.109**	-0.113**	-0.033**	-0.039**	-0.109**	-0.114**
	(0.019)	(0.018)	(0.017)	(0.016)	(0.012)	(0.011)	(0.021)	-00.02
Moderate_Exer	0.007	0.006	-0.057**	-0.06**	-0.016	-0.016	-0.102**	-0.102**
	(0.016)	(0.016)	(0.011)	(0.011)	(0.01)	(0.009)	(0.016)	-00.015
Vigorous_Exer	0.001	0.001	-0.044**	-0.047**	-0.009	-0.006	-0.051**	-0.051**
	(0.014)	(0.013)	(0.012)	(0.011)	(0.008)	(0.008)	(0.015)	-00.014
PE_Class	-0.012	-0.014	-0.08**	-0.078**	-0.03**	-0.025**	-0.072**	-0.069**
	(0.015)	(0.015)	(0.012)	(0.012)	(0.009)	(0.009)	(0.016)	-00.015
Sport_Team	-0.013	-0.014	-0.107**	-0.110**	-0.025**	-0.027**	-0.130**	-0.137**
	(0.016)	(0.016)	(0.012)	(0.012)	(0.01)	(0.009)	(0.017)	-00.016
TV_Time	0.010	0.012	0.043**	0.046**	-0.005	-0.006	0.040*	0.045**
	(0.016)	(0.016)	(0.012)	(0.012)	(0.009)	(0.009)	(0.016)	-00.015
Video_Time	0.012	0.015	0.017	0.016	0.005	0.008	0.047**	0.044**
	(0.014)	(0.014)	(0.013)	(0.013)	(0.008)	(0.008)	(0.017)	(0.017)
	Panel D: Unhealthy Weight-loss Methods							
LoseWeight_Fasting	0.011	0.009	0.028**	0.028**	0.110**	0.113**	0.082**	0.085**
	(0.011)	(0.011)	(0.007)	(0.007)	(0.007)	(0.007)	(0.01)	(0.009)
LoseWeight_Med	0.055**	0.053**	0.024**	0.024**	0.090**	0.092**	0.062**	0.060**
	(0.010)	(0.010)	(0.006)	(0.006)	(0.007)	(0.007)	(0.008)	-00.008

Figures in parentheses are bootstrapped standard errors. Asterisks, ** and *, indicate the 1%, and 5% significance level, respectively.

Table D5
Effects of the self-perception of **significantly** overweight on weight-loss intentions and behaviors using propensity score matching

	Self-Reported Overweight Sample				Self-Reported Non-overweight Sample			
	Female		Male		Female		Male	
	NNM	LLR	NNM	LLR	NNM	LLR	NNM	LLR
	Panel A: Weight-loss intentions							
LoseWeight	0.129**	0.154**	0.310**	0.308**	0.335**	0.347**	0.362**	0.404**
	(0.025)	(0.025)	(0.035)	(0.028)	(0.038)	(0.022)	(0.088)	(0.077)
LoseWight_Diet	0.136**	0.161**	0.161**	0.182**	0.314**	0.333**	0.388**	0.367**
	(0.038)	(0.035)	(0.037)	(0.036)	(0.038)	(0.027)	(0.085)	(0.069)
LoseWeight_Exer	0.043	0.065*	0.081*	0.065*	0.137**	0.158**	0.019	0.091
	(0.032)	(0.028)	(0.032)	(0.028)	(0.035)	(0.027)	(0.097)	(0.073)
	Panel B: Eating Habits							
Fruit_2	-0.010	-0.007	-0.052	-0.054	0.021	0.036	0.063	0.050
	(0.033)	(0.028)	(0.029)	(0.028)	(0.040)	(0.034)	(0.079)	(0.060)
Vegetable_3	-0.023	-0.017	-0.017	-0.031*	0.036	0.032	0.071	0.098
	(0.019)	(0.018)	(0.017)	(0.015)	(0.023)	(0.019)	(0.065)	(0.058)
Soda	-0.083	-0.087	-0.038	-0.034	-0.074	-0.068	-0.008	0.024
	(0.068)	(0.088)	(0.057)	(0.057)	(0.065)	(0.055)	(0.130)	(0.092)
	Panel C: Physical activity							
Active_5Days	-0.009	0.005	-0.067	-0.069	0.010	0.015	0.006	-0.036
	(0.048)	(0.039)	(0.046)	(0.042)	(0.058)	(0.046)	(0.120)	(0.095)
Moderate_Exer	0.012	0.023	-0.113**	-0.115**	0.065	0.043	-0.216*	-0.234**
	(0.036)	(0.038)	(0.035)	(0.032)	(0.047)	(0.032)	(0.097)	(0.075)
Vigorous_Exer	-0.031	-0.024	-0.043	-0.026	0.065	0.052	-0.020	-0.025
	(0.033)	(0.031)	(0.034)	(0.029)	(0.041)	(0.031)	(0.086)	(0.061)
PE_Class	-0.017	-0.015	-0.13**	-0.106**	-0.013	-0.001	-0.127	-0.108
	(0.037)	(0.034)	(0.032)	(0.03)	(0.044)	(0.034)	(0.090)	(0.067)
Sport_Team	-0.038	-0.031	-0.164**	-0.155**	-0.038	-0.050	-0.224*	-0.228**
	(0.036)	(0.031)	(0.032)	(0.029)	(0.052)	(0.037)	(0.099)	(0.076)
TV_Time	0.049	0.031	0.035	0.046	0.052	0.022	0.165	0.185*
	(0.038)	(0.035)	(0.039)	(0.034)	(0.046)	(0.033)	(0.096)	(0.083)
Video_Time	-0.013	0.005	0.054	0.040	0.014	0.019	0.111	0.138
	(0.042)	(0.043)	(0.044)	(0.038)	(0.045)	(0.038)	(0.115)	(0.087)
	Panel D: Unhealthy Weight-loss Methods							
LoseWeight_Fasting	0.002	0.006	0.025	0.028	0.294**	0.300**	0.296**	0.294**
	(0.038)	(0.034)	(0.024)	(0.024)	(0.044)	(0.033)	(0.068)	(0.064)
LoseWeight_Med	0.055	0.057*	0.062**	0.049*	0.278**	0.295**	0.353**	0.357**
	(0.038)	(0.034)	(0.024)	(0.024)	(0.044)	(0.033)	(0.068)	(0.064)

Asterisks, ** and *, indicate the 1%, and 5% significance level, respectively.

APPENDIX E: CORRECTION OF SELF-REPORTED HEIGHT AND WEIGHT

Measurement error resulting from the self-reported height and weight in YRBSS data could potentially bias our estimates, especially for underweight and overweight adolescents. The National Health and Nutrition Examination Survey (NHANES) examines a nationally representative sample of approximately 5,000 persons including adolescents each year since 1999. The respondents were asked to report their current height (inches) without shoes and weight (pounds) without shoes and clothes and also had the doctor measured height and weight information. It is so far the best source to study the measurement error of self-reported height and weight.

In order to determine how the self-reported BMI is correlated with the actual outcome, we first present the scatter plots of the self-reported BMI and the doctor-measured BMI using the sample including adolescents aged 16 to 18 since self-reported height and weight are not available for adolescents aged 14 or 15 in NHANEs (see figure E). We also add a 45-degree line in the each graph. It clearly suggests discrepancies between the self-reported and the doctor-measured BMIs.

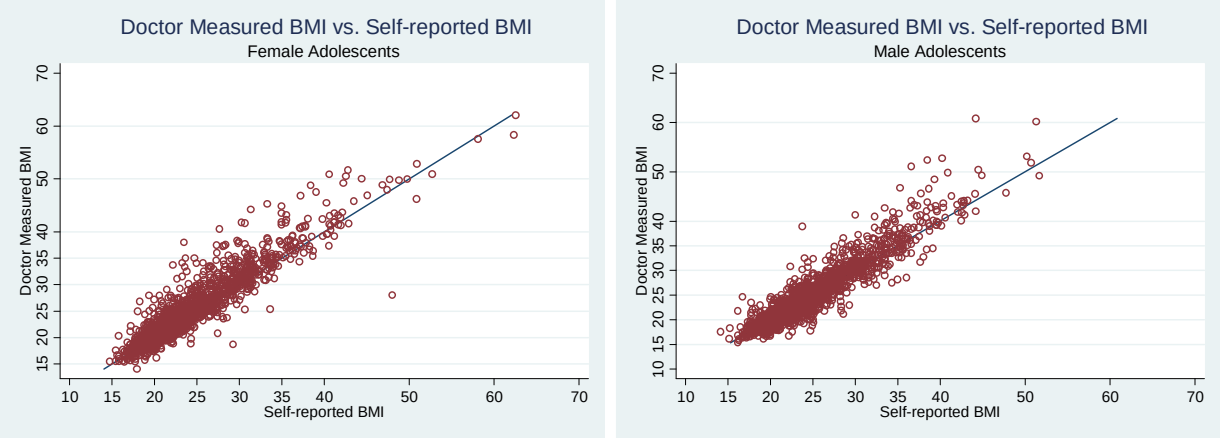


Figure E: Self-reported BMI versus doctor measured BMI

Using the NHEANS adolescent sample, we conduct an ordinary linear regression in which the dependent variable is the doctor measured BMI value and the independent variables consists of the reported BMI value and other covariates (see table E1 for estimation results). We predict the BMI for the YRBSS respondents using the relevant variables in the YRBSS data and conduct a robustness check as discussed in section 6.2.4.

Table E1
BMI Correction Functions using the NHEANS Data

VARIABLES	Female	Male
Self-reported BMI	0.98**	1.03**
	(28.68)	(28.42)
Underweight Indicator (BMI<18.5)	-0.04	0.49*
	(-0.20)	(2.01)
Overweight Indicator (25=<BMI<30)	0.60*	0.32
	(2.25)	(1.26)
Obese Indicator (BMI>=30)	1.10*	1.06*
	(2.29)	(2.00)

Age	-6.03	-3.48
	(-1.51)	(-0.83)
Age Squared	0.18	0.10
	(1.53)	(0.84)
Non-Hispanic White	-0.05	-0.23
	(-0.21)	(-0.89)
Hispanic/Latino	-0.24	-0.44
	(-0.91)	(-1.55)
African American	0.17	-0.29
	(0.61)	(-1.04)
Grade	0.02	-0.05
	(0.20)	(-0.47)
Constant	51.19	29.19
	(1.53)	(0.82)
Observations	1,204	1,294
R-squared	0.915	0.908

The dependent variable is the doctor measured BMI value. Figures in parentheses are the robust t-statistics. Asterisks, ** and *, indicate the 1% and 5% significance level, respectively.

[1] We exclude the earlier waves of data from our study either because BMI information is missing or because important matching variables (e.g., average GPA) are not available.

[2] http://www.cdc.gov/mmwr/preview/mmwrhtml/mm6046a3.htm.

[3] The definitions of *Fruit_2* and *Vegetable_3* follow the objectives of fruit and vegetable consumption outlined in the national *Healthy People 2010* – increasing the proportion of Americans aged at least two years consuming more than two servings of fruit daily to 75% and more than three servings of vegetables daily to 50% (objective 19-6), respectively (see USDA-USDHHA (2010) for additional details).

[4] http://www.health.gov/paguidelines/default.aspx.

[5] The BMI category is coded based on the BMI percentile. It equals one for the 5th percentile, two for the 5th-15th percentiles, and so on until the BMI equals eleven for above the 95th percentile.

[6] The distribution graphs for other matching variables are available upon request.

[7] The common support restriction is imposed prior to matching to improve the quality of the matches. This procedure limits the matching sample to those observations whose propensity score belongs to the intersection of the distributions of the propensity scores of the treatment and comparison groups. Individuals in the treatment (comparison) group with propensity scores close to zero (one), which is lower (higher) than the minimum (maximum) propensity score observed among

the opposite group, are deleted, as their observed characteristics are not comparable to any of the individuals in the opposite group.

[8] Trimming could theoretically improve the matching quality and reduce the bias Heckman, J., Ichimura, H., Smith, J., Todd, P., 1998. Characterizing Selection Bias Using Experimental Data. Econometrica 66, 1017-1098, Heckman, J., Ichimura, H., Todd, P., 1997. Matching as an Econometric Evaluation Estimator: Evidence from Evaluating a Job Training Programme. Review of Economic Studies 64, 605-654.. We conduct robustness checks without trimming.

[9] The results of the balancing tests for other outcome variables are available upon request.

[10] Besides the original set of matching covariates, we also include the following dummy variables for having suicidal thoughts during last 12 months; always wearing a seatbelt while driving or being a passenger in a car; being in a physical fight during last 12 months; ever smoked, drank, used cocaine, or used any other drug during past 30 days, respectively; having sexual intercourse with more than 4 people; and having sex during the past three months (See Table A3 in Appendix A for additional details of these risk variables).

[11] The results are remarkably similar for LLR using different bandwidths (0.3, 0.2, 0.1, and 0.06). We only show the results for a bandwidth of 0.1, but the results for other bandwidths are available upon request.

[12] We are using data from NHANES 1999-2000 to NHANES 2007-2008, which is closely related to the YRBSS used for this study in terms of timing.

[13] Due to space limit, we are not presenting the results, but they are available upon request.