OBESITY AND SELF-CONTROL: FOOD CONSUMPTION, PHYSICAL ACTIVITY AND WEIGHT-LOSS INTENTION

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Abstract

We find that, despite a stronger intention to lose weight, overweight/obese individuals in the U.S. are less likely to meet the federal recommendations for fruits and vegetables, energy and nutrient intakes, and physical activity than normal-weight ones. By examining the Rotter score, we find that obese individuals have lower degree of self-control than normal-weight individuals and that the lack of self-control capability is associated with poor eating/exercise behaviors as well as increased body mass index and obesity risk. We discuss three mechanisms that are employed to overcome self-control problems: physician advice, improvement in the built environment, and commitment devices.

Keywords: Obesity, Self-Control, Food Consumption, Physical Activity, Weight-loss Intention, Doctor's Advice, Nudging, Commitment Device

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Introduction

Food consumption and engagement of physical activity are economic decisions, in that consumers balance the immediate and future utility and disutility resulting from current eating and exercise choices. The traditional economic model assumes that people have time-consistent inter-temporal preferences and rational expectations of future costs and benefits of their current decisions. As a result, the traditional economic model results in a utility-maximizing decision that is dynamically consistent. However, the gap between long-run intentions and short-run actions is apparent. Although individuals intend to exercise regularly and eat healthy when planning for the long run, it is likely to be difficult for them to run on the treadmill and skip the dessert after dinner in the short run. Many empirical studies have documented that people have time-inconsistent preferences and self-control problems (Ariely and Wertenbroch, 2002; Burger and Lynham, 2010; DellaVigna and Malmendier, 2006; Fang and Silverman, 2009; Hoch and Loewenstein, 1991; Read and Van Leeuwen, 1998; Shapiro, 2005; Thaler, 1981). Though models of rational decision-making have been developed for the consumption of addictive substances (i.e. Becker and Murphy, 1988), it is questionable to argue that the alarming obesity prevalence in the U.S. is the result of the optimal choice of individuals given that little uncertainty and straightforward reasoning about the health and economic consequences of overeating and the lack of physical activity.

The objectives of this study are to examine the differences of eating and exercise behaviors between normal-weight and overweight/obese individuals and to investigate the difference in their self-control capability and how the self-control capability affects eating and exercise behaviors. To achieve these objectives, we employ four nationally representative data sets: the Behavioral Risk Factor Surveillance System Survey (BRFSS), the National Health and Nutrition Examination Survey (NHANES), the National Longitudinal Survey of Youth 1979 (NLSY79), and the National Longitudinal Survey of Youth 1997 (NLSY97).

This study makes several contributions to the existing literature. First, this study provides a comprehensive comparison between normal-weight and obese individuals in terms of eating and excise behaviors, nutrition and energy intakes, and weight-loss intention for U.S. adult population. We find that overweight/obese individuals choose food consumption and physical activity that appear sub-optimal because their weight-loss intention is inconsistent with actual behaviors. Second, to our knowledge, this is the first study to empirically test the difference in self-control capability between normal-weight and obesity individuals in the obesity literature. We find that obese individuals have lower self-control capability than normal-weight counterparts. Finally, we find strong associations between the lack of self-control and poor eating/exercise behaviors and an increase in both BMI and obesity risk.

The analysis of individual behaviors is just the first step towards a better understanding of obesity where individuals display time-inconsistent preferences and exhibit a lack of self-control. The results suggest that inferences made under the assumption of complete rationality and time consistency can lead to significant bias. For example, an erroneous conclusion that individuals desiring less weight eat more fruits and vegetables and/or exercise more than others would have overstated the impact of knowledge-based intervening policies (e.g., nutrition educational programs). The U.S. consumers spend more than $65 billion dollars annually on various weight loss programs (Marketdata-Enterprises, 2012) and over 200,000 Americans undergo bariatric surgery annually (NIDDI, 2008). The central theme of the growing literature on behavioral obesity is to recognize the time-inconsistent features of individual behaviors and the lack of self-control and design intervening policies that responds to such features (Just, 2006; Ruhm, 2012). We discuss three mechanisms that are used to bridge the gap between weight-loss intention and eating/exercise behaviors. We find that weight-related counseling from health care professionals increases the intention to lose weight among overweigh/obese individuals and the probability of meeting the recommended levels of fruit and vegetable consumption,

but it has no positive effect on physical activity. The improvement in the built environment of food and physical activity is found to be effective to nudge individuals to improve healthy eating and increase physical activity. Commitment devices, on the other hand, are promising but face challenges to be effective.

Literature Review

Hyperbolic individuals have self-control problems caused by their tendency to pursue immediate gratification and render short-term impulses supreme over long-term goals (Angeletos et al., 2001; Laibson, 1997). In the context of weight management, a present-biased preference affects how individuals evaluate the benefits and costs of weight-related behaviors (e.g., food consumption and physical activity) and/or choices (weight-loss strategies). When actions involve immediate rewards, the present-bias effect causes the immediate gratification and/or gain to eclipse future health consequences. Examples could be overconsumption of food, especially excessively cheap and fatty food (Cutler, Glaeser and Shapiro, 2003) and the use of health-compromising weight-loss strategies (Fan and Jin, 2013). On the other hand, when actions involve immediate costs but rewards are delayed in the future such as diet moderation and engagement in physical activity, individuals who lack self-control procrastinate. Some studies find that obese individuals are more likely to choose smaller, immediate rewards and have greater difficulties in delaying gratification for food (Bonato and Boland, 1983; Weller et al., 2008), but they discount greatly the long-run benefits of nutritious meals and exercise (Epstein et al., 2010; Weller et al., 2008). Ruhm (2012) develops a dual model, including a utility-maximizing deliberative system and an affective system that responds impulsively and ignores the long-term consequences, to examine the coexistence of overeating and excess weight. The affective system is consistent with the present-bias effect, which leads to food overconsumption and procrastination of healthy eating and exercise behaviors.

Previous studies support a positive relationship between body mass index (BMI) and present-biased preference (Borghans and Golsteyn, 2006; Ikeda, Kang and Ohtake, 2010; Komlos, Smith and Bogin, 2004; Smith, Bogin and Bishai, 2005; Zhang and Rashad, 2008). Except Ikeda, Kang and Ohtake (2010) where time preference is constructed based on the respondents' answers to the survey questions, the above mentioned studies use various proxies for the present-biased preference such as saving rates. Based on experiment data Richards, Patterson and Tegene (2007) find that obesity and discount rates are positively related and that individuals' inter-temporal choices over food consumption exhibit present bias.

To the best of our knowledge, this study is the first in the obesity literature to empirically test the difference of self-control capability between normal-weight and obese individuals and investigate the association between self-control and eating/excise behaviors and weight outcomes using a nationally representative data set.

Patterns of Eating and Exercise Behaviors and Weight-loss Intention

We adopt the standard BMI classification by the World Health Organization (WHO): normal weight defined as BMI between 18.5 and 25, overweight as BMI is between 25 and 30, and obese as BMI is over 30. Morbidly obese (BMI $\geq$ 40) is examined as a separate group for certain analyses.

Food Consumption and Energy/Nutrient Intake

We investigate the association between the BMI classes and food consumption from two different perspectives: (1) the probability of meeting the federal recommended levels[3] of fruit and vegetable consumption using the BRFSS 2001-2003 data, and (2) energy and nutrient intakes using the NHANES 2000-2010 data. The BRFSS is a survey of health and risk behaviors in non-institutionalized civilian individuals aged 18 years and older. The NHANES is designed to assess the health and

[3] Approximately 17 and 22 percent of the BRFSS respondents meet the recommended consumption levels of fruits and vegetables established by the 2010 Dietary Guidelines for Americans (USDA-USDHHS, 2010), respectively.

nutritional status of adults and children in the United States. BMI is self-reported in the BRFSS and measured in the NHANES. For both data sets, we drop underweight individuals, pregnant women, and individuals under 25 years of age from the sample.[4] Stratification and sampling weights for each data set are used to produce correct estimates and corresponding standard errors.

Based on the BRFSS 2001-2003 data, we create two dummy variables indicating whether the respondent meets the recommended levels of fruit and vegetable consumption during the week prior to the survey – ate vegetables at least three times per day (Veg3) and ate fruits at least twice per day (Fruit2). Each dummy variable equals one if the respondent met the recommended level and zero otherwise. We run a probit model using each food consumption indicator as the dependent variable and BMI classifications as independent variables. For each model we control for demographic characteristics such as age, gender, race and ethnicity backgrounds, marital status, educational level, employment status, household income, household size, and number of children less than 18 years old in the household. We also incorporate health related variables such as self-reported health condition, whether an individual has any type of health insurance in the past year, whether an individual was told by health professionals that he/she had diabetes, high blood pressure, or high blood cholesterol. A set of year dummies is also included.

Table 1 presents the marginal effects of the probit estimations. As shown in column 1 of table 1, relative to normal-weight individuals, overweight, class I&II obese, and morbidly obese individuals are respectively 6, 11, and 20 percent[5] less likely to meet the recommended fruit consumption level. Although smaller, overweight or obese individuals are 5-7 percent less likely to meet the recommended consumption level of vegetables (column 2 of table 1).

[4] Since young people might still attend school when surveyed, we drop them from the sample as we control for both education and employment in all analyses.

[5] The percentage changes are calculated by dividing changes in percentage points by the baseline percentages. For example, the percentage change is equal to 100%*0.0134/0.2164=6% for overweight individuals.

An alternative measure of eating habits is energy and nutrient intake. Approximately 11 percent of the daily calories are from saturated fat among U.S. adults in 2003-2006. This share is higher than the recommended level (10 percent) by the 2010 Dietary Guidelines for American. The average daily sodium intake of U.S. adults is more than double of the adequate intake set by the Institute of Medicine (IOM) of the National Academies. Americans on average consume 15 gram of dietary fiber a day that is significantly less than the recommended level by the IOM.[6]

Based on dietary intake recall data from the NHANES 2000-2010 we construct five variables to measure daily energy and nutrient intakes: percent of calories from fat and saturated fat, total sodium (milligram), total calories, and total fiber (gram). We convert fat and saturated fat to calories based on the transfer formulas by USDA[7] and then calculate the percentage of calories from fat and saturated fat by dividing the total calories. We find that U.S. adults under-consume dietary fiber (16 grams per day) and over-consume sodium (3,489 milligrams per day) and saturated fat (more than 11 percent of daily calories).

We estimate the relationship between BMI classes and energy/nutrients intake by regressing each of these five outcome variables on BMI classes. In addition to the interview day of the week and year dummies, each regression controls for a rich set of demographic information, including gender, age, race, a dummy variable for being born in the U.S., family income, family income to the federal poverty ratio, and educational level. We run the estimation on two samples: full sample and a subsample excluding overweight/obese individuals who either do not perceive themselves as overweight or do not want to lose weight. The baseline group is normal-weight individuals. The results of OLS regressions are presented in table 2.

Columns 1&2 of table 2 show that overweight/obese individuals have a greater proportion of

[6] IOM recommends 38 and 25 grams for men and women aged 50 or younger per day and 20 and 21 for men and women over 50 per day, respectively.
[7] http://healthymeals.nal.usda.gov/hsmrs/HUSSC/Formulas%20for%20Calculations.pdf.

daily calories from fat and saturated fat than normal-weight ones. Given the normal-weight baseline (the bottom row of table 2), the share of calories intake from fat increases by 7 percent for morbidly obese individuals in the full sample. Although smaller, a significant increase in the fat contribution to daily calories intake is also observed among both class I&II obese (5 percent) and overweight individuals (2 percent). Overweight, class I&II obese and morbidly obese individuals also have a 2, 7 and 8 percent increase respectively in the energy share from saturated fat. In the case of daily sodium intake, no statistical difference is found between normal and overweight individuals. However, compared with normal-weight individuals, the sodium intake is 5 and 11 percent higher, respectively, for class I&II obese and morbidly obese ones. We do not find a statistical difference of total calorie intake by BMI classes. In the case of dietary fiber, overweight and class I&II obese individuals consume 2 and 4 percent less respectively than normal-weight ones.

We would expect individuals in the subsample excluding those who do not perceive themselves as overweight or do not desire to lose weight are more motivated to improve their energy and nutrient intake as they presumably have a stronger desire to do so. However, such expectations are not supported by the results in panel B of table 2. We find that among this particular subsample, overweight, class I&II obese and morbidly obese individuals still have a statistically higher proportion of daily calories from fat and saturated fat, higher daily sodium intake, and lower intake of daily dietary fiber. The only exception is total daily calorie intake. That is, overweight individuals consume 3 percent less calories than normal-weight ones do.

We summarize the patterns on food consumption and energy and nutrient intakes below:

Finding 1: *Relative to their normal-weight counterparts, overweight/obese individuals are characterized by poor eating habits as they are less likely to meet the recommended levels of fruit and vegetable consumption and nutrient and energy intakes.*

Physical Activity

Physical activity have health benefits and should be considered when addressing weight management (USDA-USDHHS, 2010); but less than half of U.S. adults (44%) meet the recommended level of physical activity based on the *Healthy People 2020*.[8] Based on the BRFSS 2001-2003 data, we create two dummy variables, PhMod, and PhVig, to indicate whether the respondent met the recommendation for either moderate or vigorous physical activity.[9] PhVig takes the value one if the respondent had reported participating in vigorous activity for at least 20 minutes per day for at least three days per week. PhMod takes the value one if the respondent had reported participating in moderate physical activity for at least 30 minutes per day for at least five days per week.

We run a probit model using each physical activity indicator as the dependent variable and BMI classes as independent variables in addition to the same set of control variables as for the food consumption discussed above. Columns 3&4 of table 1 present the marginal effects of BMI classes. Relative to normal-weight individuals, overweight and Class I&II obese ones are less likely to meet the recommendations for moderate and vigorous physical activity. The same pattern is found for morbidly obese individuals with much larger differences — a 31 (41) percent lower probability to meet the recommendation for moderate (vigorous) physical activity. These results can be summarized below:

Finding 2: *Overweight and obese individuals are less likely to meet the recommended level of physical activity than their normal-weight counterparts.*

Dynamic Relationship between Weight Statuses and Eating and Exercise Behaviors

To exam the dynamic relationship between weight status and eating/exercise behaviors, we explore a panel data set, the NLSY97, from which we observe individual's behavior over time. The NLSY97 panel is a national representative sample of 8,984 youth aged 12–16 years by December 31, 1996.

[8] http://www.healthypeople.gov/2020/default.aspx.

[9] The definition of PhMod and PhVig not exactly the same as that by the 2008 Physical Activity Guidelines for Americans. However, such definitions have been widely used in literature and public health surveys/interventions.

Compared with the BRFSS definitions discussed in the previous sections, the recommended levels of fruit and vegetable consumption are the same, but the definition of the recommended level of physical activity is slightly different as engaging in exercise that lasts at least 30 minutes for at least five days during a typical week. To examine whether or not the change in weight status improves the probability of meeting the recommended levels of fruit and vegetable consumption or physical activity, we estimate the following linear probability model:

$$\Delta Y_i = \alpha \Delta OS_{1i} + \beta \Delta OS_{2i} + \gamma \Delta OS_{3i} + X_i * \delta + \Delta SE_i * \delta + \varepsilon_i$$

The first three dependent variables, ΔY_i, are binary variables with one indicating a change from failing to meet the recommended level in 2002 to meeting the recommend level in 2007 in terms of fruit and vegetable consumption or physical activity, and zero otherwise. In other words, the dependent variable, ΔY_i, equals one if an individual *i* improved his/her eating and exercise habits during the period from 2002 through 2007 and zero if no improvement was observed. The fourth dependent variable is a binary indicator with 1 indicating a change from not desiring to lose weight in 2002 to desiring to lose weight in 2007, 0 otherwise. We also create four variables indicating four types of change in obesity status in the same time period. They are ΔOS_{1i} indicating a non-obese individual *i* in 2002 became obese in 2007, ΔOS_{2i} indicating individual *i* being obese in both years, ΔOS_{3i} indicating an obese individual *i* in 2002 became non-obese in 2007 and ΔOS_{4i} indicating individual *i* being non-obese in both years. We use the fourth group as our base group. The vector, *X*, includes time-invariant characteristics: gender, ethnic background, age in 2002 and a depression indicator.[10] The vector, ΔSE_i, includes changes in health status, job status, rural-urban residence and poverty status. Sampling weights of the NLSY1997 are used to produce correct estimates and corresponding standard errors.

[10] Question on depression was only asked in the first year of the survey (1997).

As shown in table 3, compared with individuals who maintained a non-obese status, those who became obese did not increase the probability of meeting the recommended levels of fruit and vegetable consumption (see columns 1&2). None of the coefficients associated with three types of change in obesity status is statistically significant. As for physical activity, we find that the probability of meeting the recommended level of physical activity decreased by 11 percentage points for individuals who became obese compared with those who maintained a non-obese status (column 3). These results can be summarized below:

Finding 3: *Compared with individuals who maintain a non-obese status, a change from non-obese to obese does not improve an individual's probability of meeting the recommended levels of fruit and vegetable consumption and physical activity.*

Discrepancies between Weight-loss Intentions and Eating and Exercise Behaviors

Findings 1-3 show that compared with normal-weight individuals, overweight/obese individuals have poor eating and exercise behaviors and even a status change from normal weight to obese does not improve their behaviors. We then take one step further to examine the discrepancies between weight-loss intention and eating/exercise behaviors using the BRFSS 2001-2003 data and the NLSY97 data.

Based on the BRFSS data we create three weight-loss intention variables indicating whether the respondent tried to lose weight (Losewt) and whether the respondent specifically did so through eating less food and fewer calories (Fewercal) or exercise (Phyact) during the past 30 days. The NLSY97 respondents were asked to report whether they had an intention to lose weight. As shown in columns 5-7 of table 1, we find that compared with normal-weight individuals, the intention to lose weight for overweight/obese ones is more than doubled (increased by 101 percent for overweight individuals, 149 percent for class I&II obese ones, and 135 percent for morbidly obese ones). We also find that respondents have a statistically stronger intention to lose weight if they become obese (column 4 of table 3). We summarize the results on weight-loss intention below:

Finding 4: *Overweight and obese individuals have a much stronger intention to lose weight than normal-weight ones.*

Combining what we find so far, overweight/obese individuals on average have a greater intention to lose weight either through healthy eating or physical activity or both than normal-weight ones (**Finding 4**). However, they were less likely to meet the recommended levels of fruit and vegetable consumptions (**Finding 1**), energy and nutrient intake (**Finding 1**), and moderate and vigorous physical activity (**Finding 2**). These results show significant discrepancies between the weight-loss intention and actual eating and exercise behaviors (**Finding 4** vs. **Finding 1** and **Finding 2**). Furthermore, a status change from non-obese to obese does not improve eating and exercise habits even though the change in obese status causes a stronger intention to lose weight than those who maintain normal-weight status (**Finding 3**). Such discrepancies are further supported by the second analysis using the NHANE 2000-2010 data. As shown in panel B of table 2, even though overweight/obese individuals correctly perceive themselves as overweight or had indicated their desire to lose weight, their energy and nutrient intake is not improved compared with normal-weight ones. Thus, we conclude Finding 5 below:

Finding 5. *Overweight and obese individuals exhibit significant discrepancies between their weight-loss intention and actual eating and exercise behaviors.*

Self-Control and Weight-loss Behaviors

Weight-loss intention can be viewed as one immediate antecedent of an actual weight reduction. Yet, there is a psychological conflict between desire and willpower (self-control used to overcome desire) (Hoch and Loewenstein, 1991). The degree of success to eat healthy and stay physically active depends not only on one's intention, but more on one's control over eating and exercise behaviors. Indeed, findings 1-5 suggest that obese individuals lack self-control to achieve their weight-loss goals. Self-control capability has been linked with important life outcomes such as health and longevity (Rosengren et al., 2004; Stürmer, Hasselbach and Amelang, 2006), labor market participation

(DellaVigna and Paserman, 2005), and social and risk behaviors (Burger, 1984; Nunn, 1988). We link self-control with individuals' eating and exercise behaviors and weight outcomes.

According to the literature of behavioral economics, obese individuals with self-control problems could be naïve or sophisticated. Naïve individuals, who do not fully understand their lack of self-control, may overeat and/or exercise less today because they expect to diet and/or become physically active tomorrow. They procrastinate healthy eating and exercise habits and overestimate their self-control capability in the future. Sophisticated individuals realize self-control problems and may employ commitment devices to increase their probabilities of "good" behaviors. However, an effective commitment device is hard to come by. A well-documented literature on infamously ill-fated New Year's resolutions proves that lack of the willpower/self-control can easily break a well-orchestrated plan (Bryan, Karlan and Nelson, 2010). We expect that self-control capability differs between normal-weight and obese individuals and that a lack of self-control might have adverse effects on eating and exercise behaviors.

Self-Control Measures

Self-control is measured by the difference between the inter-temporal allocation viewed as optimal and the allocation that would be actually chosen (Ameriks et al., 2004).[11] This study uses the Rotter locus of control in the NLSY79 to measure self-control capability. Rotter (1966)'s locus of control refers to the extent to which individuals believe that they can control their lives through self-motivation or self-determination (internal control) as opposed to the extent that the environment controls their lives (external control).

[11] The literature uses behaviors such as substance uses to gauge individual self-control ability (DellaVigna and Paserman, 2005) or use questionnaire and experiment techniques to estimate self-control ability/problems, while the latter techniques have different directions. One direction is to take the time-versus-money approach – asking survey respondents to state how much money he/she would require at various future dates to give up a fixed immediate monetary rewards (Thaler and Shefrin, 1981). The implied high discount rates are used as evidence that the respondent has a self-control problem due to discounting of the present and preference for the future. Another type is to create a scenario involving possible temptation and ask respondents to reflect on their ability to resist the temptation.

The NLSY79 cohort is a nationally representative sample of youth aged 14-22 in 1979. The survey was conducted annually from 1979 to 1994 and biennially since 1996. We use the NSLY79 panel from 1985 to 2010 since BMI was not available before 1985. The 1980 interview contained a series of questions about the Rotter internal versus external locus of control (see Appendix B3). For each of four Rotter Scale questions, the respondents chose a Likter scale ranging from one to four with a lower number indicating a stronger self-control. The scores for each question are then summed. The maximum score is 16, indicating the greatest external control, while the minimum score is four, indicating the greatest internal control.

Figure 1 shows that relative to normal-weight individuals, obese ones had a higher average Rotter score in every survey year between 1985 and 2010 and the differences are statistically significant. The finding is summarized below:

Finding 5*: Overweight or obese individuals have a lower degree of self-control capability than normal-weight ones.*

Does Self-Control Ability Affect Eating and Exercise Behaviors and Weight Status?

We construct six dependent variables based on the NSLY79 data to investigate the effects of self-control capability on weight status and weight-related behaviors. The first two are BMI and obese status of the respondents. We also create two binary variables for exercise behaviors in the past week indicating whether the respondents participated in vigorous activity for at least 10 minutes that caused heavy sweating or large increases in breathing or heart rate (*Vigor*) or strength training activities for at least 10 minutes (*Strength*) for at least three days. Two variables characterizing respondents' eating behaviors are times eating food from a fast food restaurant such as McDonalds, Kentucky Fried Chicken, Pizza Hut, or Taco Bell (*Fast Food*) and times having a soft drink or soda that contained sugar (*soft drink*) in the past seven days. The control variables include gender, age, income, racial and ethnic backgrounds, education levels, and whether living in an urban area or not. We pool the data from different survey years and control for year and individual fixed-effects.

As shown in columns 1&2 in table 4, the Rotter score is positively associated with BMI ad obesity risk. As far as exercise is concerned, the Rotter score is negatively associated with the probability of engaging in vigorous physical activity or strength training (columns 3&4). We also find that the Rotter score is positively associated with a greater frequency of fast food consumption and sugared soft drinks. Thus, as summarized in Finding 6 below, self-control capability measured by the Rotter score is an important determining factor of individuals' eating and exercise behaviors -- a lower degree of self-control is associated with poor eating and exercise behaviors. A lower degree of self-control capability is also associated with an elevated BMI or a higher risk of being obese.

Finding 6*: Individuals who have a lower degree of self-control capability are more likely to be obese and have poorer eating and exercise habits.*

What can be done to Bridge the Gap between Weight-loss Intention and Eating/Exercise Behaviors?

Can Weight-related Counseling from Health Care Professionals Help?

Weight-related counseling provided by health care professionals may help overweight/obese individuals better understand costs and benefits of healthy eating and staying physically active. Patients who are advised by their health care providers, especially physicians, to modify their behaviors are generally more confident and motivated to engage in lifestyle modifications such as dietary changes and increased physical activity (Galuska et al., 1999; Huang et al., 2004; Kreuter, Chheda and Bull, 2000).

Using the BRFSS 2001-2003 data we run probit models to assess the effectiveness of the doctor's advice to lose weight on improving healthy eating and physical activity. In addition to the same set of control variables in table 1, we also include a dummy variable indicating whether the respondents reported that they had received a doctor's advice to lose weight and control for individuals' BMI so that the doctor's advice does not capture the effect of BMI. We run the probit model on two

subsamples independently: the obese sample and the obese sample who desire to lose weight. Individuals who desire to lose weight are those whose desired weight is lower than their reported weight.

Columns 5-7 of table 4 show that the doctor's advice to lose weight is associated with statistically significant, greater intention to lose weight for obese individuals; but the effect is smaller in magnitude for those who desire to lose weight. Columns 1&2 of table 4 show that the doctor's advice to lose weight help obese individuals meet the recommended consumption levels of fruits and vegetables, regardless of whether they had indicated a desire to lose weight or not -- the probability of meeting the recommended consumption level increased by approximately 6-10 percent. However, we do not find a statistically significant, positive effect of the doctor's advice on the probability of meeting the recommended levels of moderate and vigorous physical activity in both samples (see columns 3&4 of table 4). The differences in the effect of the doctor's advice between healthy eating and physical activity could be due to several factors. Engaging in physical activity may be more costly and require more self-control than eating more fruits and vegetables. Physicians are more capable of providing diet counseling than exercise counseling (Bleich, Pickett-Blakely and Cooper, 2011). Nevertheless, the fact that the doctor's advice increases the weight-loss intention through physical activity, but not the probability of meeting the recommended levels of moderate and vigorous physical activity, suggests that overweight/obese individuals may face a greater challenge when trying to become more physically active.

The effectiveness of a doctor's advice on food consumption and weight-loss intention suggests that health care professionals are uniquely positioned to impact obesity care and prevention. The U.S. Preventive Services Task Force recommends that clinician screen all adult patients for obesity and offer intensive counseling to promote sustained weight loss (Berg, 2003). However, most obese patients do not receive an obesity diagnosis or weight-related counseling (Bleich, Pickett-Blakely and

Cooper, 2011). Among 209,000 overweight/obese respondents of the BRFSS 2001-2003 who were asked to report whether they received any weight-related advice from health care professionals, only 24% reported that they had such counseling.

Can Improving Food Environments and Neighborhood Physical Activity Facilities Help?

Several field studies have shown that minor changes in food environments can successfully nudge consumers who lack self-control towards healthy food choices. For example, moving the salad bar from against the wall to the middle of the room in a middle school cafeteria boosts the sales of salad (Just and Wansink, 2009). Hanks, Just and Wansink (2013) provide an extensive formats of nudging used to encourage junior-senior high school students to eat more fruits and vegetables by making these foods more convenient (e.g., fresh fruits located next to the cash register), more attractive (e.g., fresh fruits displayed in nice bowls or tiered stands), and normative (verbal prompt by cafeteria staffs on the selection of fruits and vegetables). To a large extent, nudging reduces searching costs as fruits and vegetables nicely stand out in the food arrangement and decreases time cost as the selection of healthy foods are rewarded by convenience. Nudging expands the gain and/or utility from consuming fruits and vegetables as these food items become more attractive. As a result, individuals who lack self-control such as school students purchase and consume more fruits and vegetables though they would have not done so in a food environment without nudging. More importantly, changes in food environments can be a win-win situation for both consumers and food marketers if designed properly (Just and Payne, 2009; Just and Wansink, 2009), which makes nudging practically attractive.

Our results show that it is more difficult to motivate overweight/obese individuals to engage in more physical activity compared with fruit and vegetable consumption. One practical channel is to provide neighborhood amenities and improve the quality of such amenities so that costs of engaging in physical activity will be reduced and benefits of utilizing such amenities will increase. The literature documents rich evidences supporting a strong association between access to neighborhood amenities

(i.e. playgrounds, parks, trails) and increased outdoor physical activity (Bedimo-Rung, Mowen and Cohen, 2005; Roemmich et al., 2006). Fan and Jin (2013) find that adding a park/playground to a neighborhood significantly reduces the prevalence of childhood obesity, especially for young cohorts and poor neighborhoods. Furthermore, changing social norms on physical activity (Cohen, Scribner and Farley, 2000) and promote a culture of healthy activity habits in childhood (Zimmerman, 2009) can have sustainable and broad impacts on obesity.

Can Anti-obesity Commitment Devices Help?

To battle self–control problems associated with the time–inconsistent preference, sophisticated individuals may employ commitment devices to protect long-term goals from short–term unhealthy temptations. Lacking self-control is mostly likely driven by individual's time-inconsistent preferences. Commitment devices such as financial incentives should help them restrain their short-term impulses and materialize their weight-loss intention by eating healthy and keeping physically active. Financial incentives have been shown to be effective in battling addictive behaviors such as smoking and substance abuse (Dallery et al., 2001; Giné, Karlan and Zinman, 2010; Lussier et al., 2006). It might also play an important role in tackling obesity. Charness and Gneezy (2009) conduct experiments among college students and find that simply informing people about the benefits of exercise had little effect; but paying people to go to the gym is successful in creating a positive habit of exercising more.

The efficacy of financial incentives can be affected by the size of financial incentives and it may differ in the short run and long run. Wing and Jeffery (2001) find that paying participants of weight-loss programs $25 per week for achieving and maintaining their weight loss goal has no effect on weight outcomes. Volpp et al. (2008) and John et al. (2011) find that financial incentives result in a significant weight loss during the intervention period; but the weight loss is not sustained in the long term. Individuals still need practical mechanisms to leverage financial incentives. Burger and Lynham (2010) analyze a weight loss betting market in the UK using a data set from a bookmaker William Hill

from 1993 to 2006. The authors find that approximately 80% of bettors, who spend money to bet on their own behaviors with a hope to control their short-term craving for foods and lose weight, end up losing their bets despite of payoffs as high as $7,350. The authors conclude that individuals in this market are aware of their need for commitment devices to improve their self-control capability, but they are unable to design appropriate practical mechanisms even with a significant high payoff if they succeed. DellaVigna and Malmendier (2006) collected data from three health clubs in New England and analyze the patrons' contract choice and their day-to-day attendance. They find that monthly attendance is only 4.69 for those who purchased annual contracts. One of their interpretations is that some patrons use the annual club membership as a commitment device to attempt to increase their future attendance but lacking self-control eventually invalidates the commitment device. These studies highlight a phenomenon that individuals who understand and use a commitment device still faces self-control problems and often fail to carry out their well-orchestrated plan. This raises an important question about behavioral interventions: how can the intervention make the targeted people "committed" to commitment devices? Interventions aiming to help individuals who lack self-control may also face a difficult ethical question: when an individual has time-inconsistent preference, whose side do we take: the forward-looking self or the myopic self? Read (2006) noted that, with regard to other people, we usually take sides based on our own perception of what is best for them. Nevertheless, in many cases, our judgment is not a valid substitute for the preferences of the individual we attempt to help. To avoid this ethical quagmire, policymakers may limit their efforts to the provision of commitment devices that will help individuals construct strategies to achieve their goals.

Conclusions

Using four nationally representative data sets (BRFSS 2001-2003, NHANES 2000-2010, NLSY79, and NLSY97), we find that overweight/obese individuals in the U.S. are characterized by poor eating and exercise behaviors compared with normal-weight ones. Compared with normal-weight individuals,

although overweight/obese individuals have a much greater intention to lose weight, but are less likely to meet the recommendations for fruit and vegetable consumption, energy and nutrient intakes, and physical activity. Even a weight status change from non-obese to obese is not associated with improvement in eating and exercise behaviors. The findings can be explained by heterogeneous levels of self-control capability. We find that obese individuals have a lower degree of self-control capability and that lack of self-control capability is associated with poor eating and exercise behaviors and an increase in obesity risk and BMI.

We discussed three strategies that could potentially bridge the gap between the weight-loss intention and behaviors. We find that the doctor's advice to lose weight increases the probability of meeting the recommended levels of fruit and vegetable consumption among overweight or obese individuals, but less effective in inducing more physical activity. The improvement in built environment of food and neighborhood amenities could induce healthy weight-related behaviors. Commitment devices, though frequently employed by obese individuals to lose weight, face challenges to be effective.

We are aware of one main caveat in this study that calls for cautious interpretations of our results. We make an implicit assumption that all individuals have an access to and can afford healthy foods and physical facilities and amenities. However, low income population who have a disproportionally high obese prevalence are likely to face more challenges to engage in healthy eating and physical activity. For example, they might have limited access to healthy foods and physical facilities/amenities. Or they have little time to engage in more physical activities due to long working hours. Furthermore, they might have no access to weight-related physician counseling due to lack of health insurance and limited coverage. Therefore, the discrepancies between weight-loss intention and behaviors and the role of self-control might be overstated.

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Please also help edit the table titles and notes.

Table 1. Marginal effects of BMI classes on fruit and vegetable consumption, physical activity, and weight-loss intention (RRFSS 2001-2003)

	Food Consumption		Physical Activity		Weight-loss Intention		
Variable	Fruit2	Veg3	PhyMod	PhyVig	Losewt	Fewercal	Phyact
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Overweight	-0.0134***	-0.0136***	-0.0356***	-0.0309***	0.315***	0.288***	0.257***
(25≤BMI<30)	(0.0046)	(0.0049)	(0.0060)	(0.0052)	(0.0055)	(0.006)	(0.006)
Obese	-0.0243***	-0.0151***	-0.0881***	-0.0798***	0.465***	0.444***	0.3640***
(30≤BMI<40)	(0.0052)	(0.0057)	(0.0069)	(0.0058)	(0.0049)	(0.00570)	(0.0065)
Morbidly Obese	-0.0434***	-0.0188	-0.1690***	-0.138***	0.420***	0.448***	0.333***
(BMI≥40)	(0.0095)	(0.0116)	(0.0134)	(0.0105)	(0.0049)	(0.00745)	(0.0124)
Normal-weight							
Baseline	0.2164	0.2777	0.5368	0.3400	0.31164	0.2636	0.2561

Notes: Each column represents a probit model estimation in which the dependent variable is a dummy variable indicating whether the respondent met the recommendation for fruits consumption (Fruit2), vegetable consumption (Veg3), moderate physical activity (PhyMod), or vigorous physical activity (PhyVig), or whether the respondent reported that he/she had tried to lose weight (Losewt), through consuming fewer calories and/or less fat (Fewercal) or physical activity (Phyact). A rich set of demographic factors and health-related variables are included as control variables in addition to year fixed-effects. Each model has 138,982 observations. Asterisks, ***, ** and *, indicate the 1%, 5% and 10% significance level, respectively. Standard errors of marginal effects are in parenthesis.

Table 2. Effects of BMI classes on daily intake of energy and nutrients (NHANES 2000-2010)

	% of Calorie from		Total	Total	Total
	Fat	Saturated Fat	Sodium (mg)	Calorie	Fiber (gm)
	(1)	(2)	(3)	(4)	(5)
Panel A: Full Sample (No. of observations = 22,718)					
Overweight	0.578***	0.254***	-6.159	-12.392	-0.384*
(25≤BMI<30)	(0.177)	(0.063)	(39.406)	(19.911)	(0.220)
Obese (30≤BMI<40)	1.725***	0.720***	161.435***	-11.847	-0.754***
	(0.238)	(0.098)	(42.644)	(20.235)	(0.201)
Morbidly Obese	2.123***	0.833***	370.063***	53.271	-0.338
(BMI≥40)	(0.440)	(0.172)	(61.274)	(32.499)	(0.283)
R-squared	0.045	0.042	0.159	0.225	0.078
Panel B: Subsample excluding overweight/obese individuals who either did not perceive themselves being overweight or did not want to lose weight (No. of observations = 17,759)					
Overweight	0.672***	0.259***	-45.008	-55.638***	-0.606**
(25≤BMI<30)	(0.209)	(0.072)	(43.306)	(21.110)	(0.255)
Obese (30≤BMI<40)	1.806***	0.729***	151.956***	-18.693	-0.806***
	(0.254)	(0.103)	(43.594)	(20.541)	(0.206)
Morbidly Obese	2.110***	0.808***	382.882***	62.309*	-0.249
(BMI≥40)	(0.440)	(0.170)	(64.146)	(33.217)	(0.290)
R-squared	0.043	0.040	0.157	0.219	0.083
Normal-weight Baseline	32.577	10.637	3482.220	2209.200	16.286

Notes: Each column represents a regression model in which a rich set of demographic factors are controlled for. Asterisks, ***, ** and *, indicate the 1%, 5% and 10% significance level, respectively. Standard errors are in parenthesis.

Table 3. Effects of the change in obesity status on the change of eating/exercise behavior and weight-loss intention (NLSY1997)

	Change from 2002 to 2007			
	Probability of Meeting the Recommended Level of			
	Fruit Consumption	Vegetable Consumption	Physical Activity	Weight-loss Intention
	(1)	(2)	(3)	(4)
From Non-obese to Obese	-0.0400	-0.0073	-0.1111**	0.0743*
	(0.0343)	(0.0260)	(0.0442)	(0.0405)
From Obese to Obese	0.0196	-0.0042	-0.0422	-0.0596
	(0.0247)	(0.0195)	(0.0387)	(0.0378)
From Obese to Non-obese	0.0158	-0.0230	0.0158	-0.1532
	(0.0618)	(0.0189)	(0.0639)	(0.0937)
# of Observations	2,069	2,069	2,069	2,069

Notes: The dependent variables in columns 1-3 are binary indicators with 1 indicating a change from not meeting recommended levels of fruit/vegetable consumption or physical activity in 2002 to meeting the recommended levels in 2007, 0 otherwise. The dependent variable in columns 4 is a binary indicator with 1 indicating a change from not desiring to lose weight in 2002 to desiring to lose weight in 2007, 0 otherwise. The respondents are divided into four groups based on the change of their obesity status from 2002 through 2007: non-obese to non-obese, non-obese to obese, obese to obese and obese to non-obese. The non-obese to non-obese group is our base group. Control variables include gender, ethnic background, age, depression indicator, health status change, job change, urban residence status change and poverty status change. Asterisks, ***, **, and *, indicate the 1%, 5%, and 10% significance level, respectively. Standard errors are in parenthesis.

Table 4. The effect of the Rotter scale on weight status and eating and exercise behaviors (NLSY79)

	Weight Status		Physical Activity		Food Consumption	
	BMI	Obesity risk	Vigor	Strength	Fast Food	Soft drink
	(1)	(2)	(3)	(4)	(5)	(6)
Rotter Scale	0.079***	0.004**	-0.004**	-0.005***	0.021*	0.096**
	(0.007)	(0.002)	(0.002)	(0.002)	(0.011)	(0.043)
Region Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	98,491	98,491	25,695	28,694	11,218	11,209
R-squared	0.137	0.069	0.039	0.030	0.034	0.053

Notes: The dependent variables are BMI, an obese indicator, a binary variable indicating having vigorous physical activities or sports for at least 10 minutes for at least 3 days per week, a binary variable indicting participating in strength training activities for at least 10 minutes a day for at least 3 days per week, times ate food from a fast food restaurant in the past 7 days, and times drank a soft drink or soda in the past 7 days. The control variables are gender, age, income, racial and ethnic backgrounds, education levels, and whether living in an urban area or not. Asterisks, ***, **, and *, indicate the 1%, 5%, and 10% significance level, respectively**.** Robust standard errors are in parenthesis and clustered on individual level.

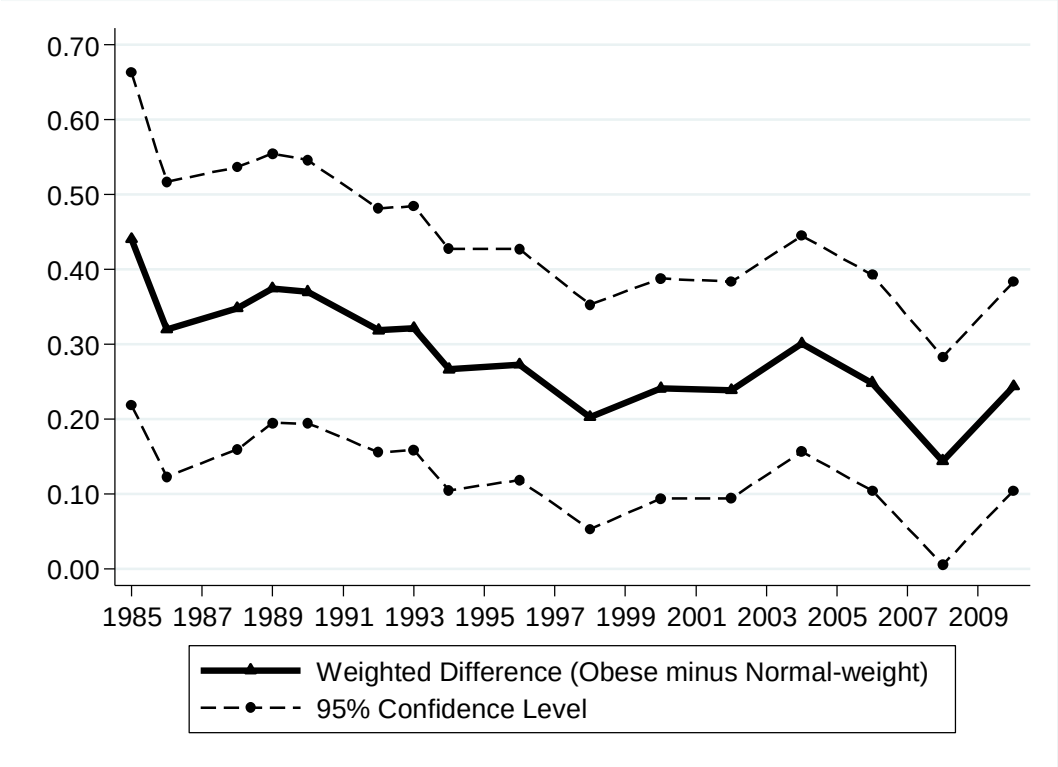
Table 5. Marginal effects of the doctor's advice on weight-loss intention, fruit and vegetable consumption and physical activity (BRFSS 2001-2003)

	Food Consumption		Physical Activity		Weight-loss Intention		
	Fruit2	Veg3	PhyMod	PhyVig	Losewt	Fewercal	Phyact
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Obese Sample (No. of observations = 39,196)						
	0.0154**	0.0141*	-0.0194**	-0.0057	0.1600***	0.158***	0.126***
Doctor's Advice	(0.0076)	(0.0085)	(0.0098)	(0.0079)	(0.0076)	(0.0088)	(0.0100)
Baseline[a]	0.1565	0.2201	0.4236	0.2373	0.7023	0.6015	0.4976
	Obese Sample Excluding Those Who do not Want to Lose Weight (No. of observations = 37,952)						
	0.0147*	0.0130	-0.0195**	-0.0029	0.1390***	0.140***	0.111***
Doctor's Advice	(0.0077)	(0.0086)	(0.0100)	(0.0080)	(0.0075)	(0.0088)	(0.0010)
Baseline[a]	0.1548	0.2187	0.4227	0.2342	0.7333	0.6295	0.5193

Notes: Each entry represents a separate probit estimation. The dependent variables and control variables are the same as in table 1. Asterisks, ***, ** and *, indicate the 1%, 5% and 10% significance level, respectively**.** Standard errors of marginal effects are in parenthesis.

[a] The base value is the estimated probability of meeting the recommended levels of fruit and vegetable consumption, meeting the recommended levels of moderate and vigorous physical activity, or the weight-loss intention for the respondents in the same estimation sample but did not receive the doctor's advice to lose weight.

Figure 1. Difference in the Rotter Score between Obese and Normal-weight Individuals (NLSY79)



OBESITY AND SELF-CONTROL: FOOD CONSUMPTION, PHYSICAL ACTIVITY AND WEIGHT-LOSS INTENTION

Appendix A: Supplemental Tables

Table A1. Difference in Rotter Score between Obese and Normal-weight Individuals (NLSY79)

Year	Obese	S.D.	Obs.	Normal	S.D.	Obs.	Difference	P-value
1985	8.92	2.38	760	8.51	2.4	9710	0.44	0
1986	8.81	2.29	893	8.52	2.39	9304	0.32	0
1988	8.84	2.39	1122	8.53	2.39	9182	0.35	0
1989	8.84	2.41	1260	8.51	2.39	9610	0.37	0
1990	8.84	2.43	1392	8.51	2.38	9219	0.37	0
1992	8.82	2.42	1551	8.55	2.4	8117	0.32	0
1993	8.8	2.44	1576	8.53	2.4	8066	0.32	0
1994	8.75	2.49	1700	8.53	2.4	7989	0.27	0
1996	8.75	2.44	1837	8.54	2.4	7799	0.27	0
1998	8.7	2.44	1978	8.54	2.39	7529	0.2	0
2000	8.72	2.46	2191	8.54	2.39	7262	0.24	0
2002	8.72	2.41	2198	8.54	2.4	7052	0.24	0
2004	8.76	2.39	2270	8.54	2.41	7006	0.3	0
2006	8.72	2.43	2409	8.55	2.41	6998	0.25	0
2008	8.66	2.38	2598	8.57	2.4	7090	0.14	0.02
2010	8.72	2.41	2678	8.56	2.4	6911	0.24	0

Table A2 (Augmented Table 3 in the paper) Effects of the change in obesity status on the change of eating/exercise behavior and weight-loss intention (NLSY1997)

	Change from 2002 to 2007			
	Probability of Meeting the Recommended Level			Weight-loss Intention
	Fruit Consumption	Vegetable Consumption	Physical Activity	
	Model 1			
From Non-obese to Obese	-0.0400	-0.0073	-0.1111**	0.0743*
	(0.0343)	(0.0260)	(0.0442)	(0.0405)
From Obese to Obese	0.0196	-0.0042	-0.0422	-0.0596
	(0.0247)	(0.0195)	(0.0387)	(0.0378)
From Obese to Non-obese	0.0158	-0.0230	0.0158	-0.1532
	(0.0618)	(0.0189)	(0.0639)	(0.0937)
	Model 2			
Change of BMI	0.0018	-0.0002	-0.0083***	0.0260***
	(0.0029)	(0.0022)	(0.0031)	(0.0034)
# of Observations	2,069	2,069	2,069	2,069

Notes: The dependent variables in columns 1-3 are binary indicators with 1 indicating a change from not meeting recommended levels of fruit/vegetable consumption or physical activity in 2002 to meeting the recommended levels in 2007, 0 otherwise. The dependent variable in columns 4 is a binary indicator with 1 indicating a change from not desiring to lose weight in 2002 to desiring to lose weight in 2007, 0 otherwise. The respondents are divided into four groups based on the change of their obesity status from 2002 through 2007: non-obese to non-obese, non-obese to obese, obese to obese and obese to non-obese. The non-obese to non-obese group is our base group. Control variables include gender, ethnic background, age, depression indicator, health status change, job change, urban residence status change and poverty status change. Asterisks, ***, **, and *, indicate the 1%, 5%, and 10% significance level, respectively. Standard errors are in parenthesis.

Table A3 (Augmented Table 4 in the paper). The effect of the Rotter scale on weight status and eating and exercise behaviors (NLSY79)

	Weight Status		Physical Activity		Food Consumption	
	BMI	Obesity risk	Vigor	Strength	Fast Food	Soft drink
	(1)	(2)	(3)	(4)	(5)	(6)
Rotter Scale	0.079***	0.004**	-0.004**	-0.005***	0.021*	0.096**
	(0.007)	(0.002)	(0.002)	(0.002)	(0.011)	(0.043)
Female	-0.854***	-0.013	-0.081***	-0.056***	-0.363***	-1.417***
	(0.034)	(0.008)	(0.010)	(0.008)	(0.051)	(0.202)
Age (years)	0.119***	0.006***	-0.005**	-0.005***	-0.033***	-0.081*
	(0.008)	(0.002)	(0.002)	(0.002)	(0.011)	(0.042)
Income ($1,000)	-0.007***	-0.000***	0.001***	0.001***	-0.001**	-0.015***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)	(0.002)
Married	0.172***	0.005	0.019*	0.003	0.008	-0.722***
	(0.036)	(0.007)	(0.010)	(0.008)	(0.055)	(0.221)
Race/ethnicity (base = White)						
Hispanic	1.522***	0.078***	-0.052***	-0.007	0.127*	-0.125
	(0.050)	(0.011)	(0.013)	(0.011)	(0.069)	(0.261)
Black	1.882***	0.102***	-0.060***	0.013	0.127*	-0.003
	(0.044)	(0.010)	(0.011)	(0.009)	(0.065)	(0.266)
Highest Education Attained (base=high school graduate)						
Less than High School	0.068	0.011	-0.036***	-0.045***	-0.027	1.428***
	(0.049)	(0.012)	(0.013)	(0.012)	(0.078)	(0.260)
College or Above	-0.652***	-0.051***	0.042***	0.050***	-0.198**	-0.890***
	(0.055)	(0.012)	(0.015)	(0.013)	(0.080)	(0.220)
Urban (=1)	-0.428***	-0.024***	0.017	0.022**	0.169***	0.041
	(0.043)	(0.008)	(0.011)	(0.009)	(0.059)	(0.226)
Constant	20.545***	-0.087*	0.708***	0.502***	2.504***	7.464***
	(0.220)	(0.051)	(0.098)	(0.096)	(0.582)	(2.081)
Region Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	98,491	98,491	25,695	28,694	11,218	11,209
R-squared	0.137	0.069	0.039	0.030	0.034	0.053

Notes: Robust standard errors are clustered on individual level. Having vigorous physical activities or sports for at least 10 minutes for at least 3 days per week. Participating in strength training activities for at least 10 minutes a day for at least 3 days per week. Times ate food from a fast food restaurant in the past 7 days. Times drank a soft drink or soda in the past 7 days.

Table A4 (Augmented Table 5 in the paper). Marginal effects of the doctor's advice on weight-loss intention, fruit and vegetable consumption and physical activity (BRFSS 2001-2003)

	Food Consumption		Physical Activity		Weight-loss Intention		
	Fruit2	Veg3	PhyMod	PhyVig	Losewt	Fewercal	Phyact
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Overweight Sample (No. of observations = 54,824)						
	0.0328***	0.0488***	-0.0126	-0.0416***	0.2740***	0.245***	0.208***
Doctor's Advice	(0.0112)	(0.0104)	(0.0125)	(0.0101)	(0.0113)	(0.0123)	(0.0129)
Baseline[a]	0.1637	0.2146	0.4917	0.3149	0.5211	0.4400	0.4084
	Overweight Sample Excluding Those Who do not Want to Lose Weight (No. of observations = 47,120)						
	0.0332***	0.0443***	0.0000	-0.0301***	0.2180***	0.2000***	0.171**
Doctor's Advice	(0.0114)	(0.0103)	(0.0127)	(0.0103)	(0.0105)	(0.0121)	(0.0127)
Baseline[a]	0.1629	0.2163	0.4849	0.3049	0.6090	0.5154	0.4773
	Obese Sample (No. of observations = 39,196)						
	0.0154**	0.0141*	-0.0194**	-0.0057	0.1600***	0.158***	0.126***
Doctor's Advice	(0.0076)	(0.0085)	(0.0098)	(0.0079)	(0.0076)	(0.0088)	(0.0100)
Baseline[a]	0.1565	0.2201	0.4236	0.2373	0.7023	0.6015	0.4976
	Obese Sample Excluding Those Who do not Want to Lose Weight (No. of observations = 37,952)						
	0.0147*	0.0130	-0.0195**	-0.0029	0.1390***	0.140***	0.111***
Doctor's Advice	(0.0077)	(0.0086)	(0.0100)	(0.0080)	(0.0075)	(0.0088)	(0.0010)
Baseline[a]	0.1548	0.2187	0.4227	0.2342	0.7333	0.6295	0.5193

Appendix B: Questionnaires of Four Data Sets

B1. BRFSS Questionnaire

We list the most relevant questions in the survey below. The complete questionnaire and coodbook can be found at http://www.cdc.gov/brfss/annual_data/annual_data.htm.

Weight management:

Question: Are you now trying to lose weight?
Yes
No

Question: Are you now trying to maintain you current weight, that is to keep from gaining weight?
Yes
No

Question: Are you eating either fewer calories or less fat to lose weight or keep from gaining weight
Yes, fewer calories
Yes, less fat
Yes, fewer calories
No

Question: Are you using physical activity or exercise to...lose weight or keep from gaining weight?
Yes
No

Question: In the past 12 months, has a doctor, nurse or other health professional given you advice about your weight?
Yes, lose weight
Yes, gain weight
Yes, maintain current weight
No

Fruit and vegetable consumption:

Question: Not counting juice, how often do you eat fruit?

Per day
Per week
Per month
Per year
Never

Question: How often do you eat green salad?

Per day
Per week
Per month
Per year
Never

Question: How often do you eat carrots?
Per day
Per week
Per month
Per year
Never

Question: Not counting carrots, potatoes, or salad, how many servings of vegetables do you usually eat? [Example: A serving of vegetables at both lunch and dinner would be two servings.]
Per day
Per week
Per month
Per year
Never

Physical activity:

Question: Exercise in Past 30 Days
Section: 3.01 Exercise
Column: 83
Prologue:
Description: During the past month, other than your regular job, did you participate in any physical activities or exercises such as running, calisthenics, golf, gardening, or walking for exercise?
Yes
No

Question: Now, thinking about the moderate physical activities you do. In a usual week, do you do moderate activities for at least 10 minutes at a time, such as brisk walking, bicycling, vacuuming, gardening, or anything else that causes small increases in breathing or heart rate?
Yes
No

Question: How many days per week do you do these moderate activities for at least 10 minutes at a time?
Days per week

Question: On days when you do moderate activities for at least 10 minutes at a time, how much total time per day do you spend doing these activities?
Hours and minutes per day

Question: Now thinking about the vigorous physical activities you do. In a week, do you do vigorous activities for at least 10 minutes at a time, such as running, aerobics, heavy yard work, or anything else that causes large increases in breathing or heart rate?
Yes
No

Question: How many days per week do you do these vigorous activities for at least 10 minutes at a time?
Days per week

Question: On days when you do vigorous activities for at least 10 minutes at a time, how much total time per day do you spend doing these activities?
Hours and minutes per day

B2. NHANES Questionnaire

The objective of the dietary interview component is to obtain detailed dietary intake information from NHANES participants. The dietary intake data are used to estimate the types and amounts of foods and beverages (including all types of water) consumed during the 24-hour period prior to the interview (midnight to midnight), and to estimate intakes of energy, nutrients, and other food components from those foods and beverages. Following the dietary recall, participants are asked questions on salt use, whether the person's overall intake on the previous day was much more than usual, usual or much less than usual, and whether the respondent is on any type of special diet. We list the most relevant questions in the survey below. The complete questionnaire and codebook can be found at http://www.cdc.gov/nchs/nhanes/nhanes_questionnaires.htm.

Question: Dietary fiber (gm)
0.25 to 12 Range of Values

Question: Total fat (gm)
0.2 to 29 Range of Values

Question: Total saturated fatty acids (gm)
0.05 to 3 Range of Values

Question: Total monounsaturated fatty acids (gm)

Question: Total monounsaturated fatty acids (gm)
0.076 to 6 Range of Values

Question: Total polyunsaturated fatty acids (gm)
0.06 to 20 Range of Values

Question: Energy (kcal)
1 to 270 Range of Values

Question: Sodium (mg)
1.14 to 230 Range of Values

B3. NLSY79 Questionnaire

We list the most relevant questions in the survey below. The complete questionnaire and coodbook can be found at http://www.bls.gov/nls/nlsy79.htm.

Question: Which of the following are you trying to do now about your weight?
1 Lose weight
2 Gain weight
3 Stay the same weight
4 Not trying to do anything about my weight

Question: In the past seven days, how many times did you eat food from a fast food restaurant such as McDonalds, Kentucky Fried Chicken, Pizza Hut, or Taco Bell?
# of times

Question: In the past seven days, how many times did you have a soft drink or soda that contained sugar? (Do not include diet soft drinks or sodas, or carbonated water.)
# of times

Question: How often do you do vigorous activities for at least 10 minutes that cause heavy sweating or large increases in breathing or heart rate?
# of times
Time unit:
1 Per day
2 Per week
3 Per month
4 Per year

Question: How often do you do physical activities specifically designed to strengthen your muscles such as lifting weights or doing calisthenics? (Include all such activities even if you have mentioned them before.)
# of times
Time unit:
1 Per day
2 Per week
3 Per month
4 Per year

Rotter Locus of Control Scale: The Rotter Internal-External Locus of Control Scale (R01530.-R01537.), collected as part of the 1979 round of the NLSY79, is a four-item abbreviated version of a 23-item forced choice questionnaire adapted from the 60-item Rotter Adult I-E scale developed by Rotter (1966). The scale was designed to measure the extent to which individuals believe they have control over their lives through self-motivation or self-determination (internal control) as opposed to the extent that the environment (that is, chance, fate, luck) controls their lives (external control). The scale is scored in the external direction-the higher the score, the more external the individual. In order to score the Rotter scale in the NLSY79, one has to generate a four-point scale for each of the paired items and then sum the scores. For example, the first pair has the following two statements:

1. What happens to me is my own doing. (internal control item)
2. Sometimes I feel that I don't have enough control over the direction my life is taking. (external control item)

Respondents were asked to select one of each of the paired statements and decide if the selected statement was much closer or slightly closer to their opinion of themselves. The following shows how the scale is constructed:

Internal Control Item		**External Control Item**	
Much closer	Slightly closer	Slightly closer	Much closer
1	2	3	4

Each of the four paired items is constructed in the same manner as the above example. The values for each item are then summed. The maximum possible score is 16, indicating high external control, while the minimum possible score is four, indicating high internal control. The summed score on the NLSY79 abbreviated version correlates well with self-esteem, education, and social class, but the internal consistency of the scale is quite low for the whole cohort (alpha: .36). Separate estimates by race and sex do not yield significantly higher reliability estimates.

B4. NLSY97 Questionnaire

We list the most relevant questions in the survey below. The complete questionnaire and coodbook can be found at http://www.bls.gov/nls/nlsy97.htm.

Question: Which of the following are you trying to do now about your weight?
1 Lose weight
2 Gain weight
3 Stay the same weight
4 Not trying to do anything about my weight

Question: In a typical week, how many times do you eat fruit? (Do not count fruit juice.)
I do not typically eat fruit
1 to 3 times
4 to 6 times
1 time per day
2 times per day
3 times per day
4 or more times per day

Question: In a typical week, how many times do you eat vegetables other than French fries or potato chips?
I do not typically eat vegetables
1 to 3 times
4 to 6 times
1 time per day
2 times per day
3 times per day
4 or more times per day

Question: In a typical week, how many days do you engage in exercise that lasts 30 minutes or more?
# of days