NBER WORKING PAPER SERIES

# THE SOCIO-ECONOMIC CAUSES OF OBESITY

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Working Paper 17423
http://www.nber.org/papers/w17423

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
September 2011

Financial support for this research has been generously provided by the Center for Consumer Freedom (CCF), although the opinions expressed in this paper are solely those of the authors. The views expressed herein are those of the authors and do not necessarily reflect the views of the National Bureau of Economic Research.

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NBER Working Paper No. 17423
September 2011
JEL No. I1,I12

**ABSTRACT**

An increasing number of Americans are obese, with a body mass index of 30 or more. In fact, the latest estimates indicate that about 30% of Americans are currently obese, which is roughly a 100% increase from 25 years ago. It is well accepted that weight gain is caused by caloric imbalance, where more calories are consumed than expended. Nevertheless, it is not clear why the prevalence of obesity has increased so dramatically over the last 30 years.

We simultaneously estimate the effects of the various socio-economic factors on weight status, considering in our analysis many of the socio-economic factors that have been identified by other researchers as important influences on caloric imbalance: employment, physical activity at work, food prices, the prevalence of restaurants, cigarette smoking, cigarette prices and taxes, food stamp receipt, and urbanization. We use 1979- and 1997-cohort National Longitudinal Survey of Youth (NLSY) data, which allows us to compare the prevalence of obesity between cohorts surveyed roughly 25 years apart. Using the traditional Blinder-Oaxaca decomposition technique, we find that cigarette smoking has the largest effect: the decline in cigarette smoking explains about 2% of the increase in the weight measures. The other significant factors explain less.

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## I. Introduction

More Americans are now obese than ever before, where obese is defined as having a body mass index (BMI) of 30 or more (BMI equals weight in kilograms divided by height in meters squared). The most recently-available estimates (from 2007-2008) indicate that 33.8% of Americans are obese, which is more than twice as many as were obese 30 years ago (Flegal et al., 2002; Ogden et al., 2006; Flegal et al., 2010). A similar increase is found for various demographic groups, including males, females, whites, African-Americans, and Hispanics. As a result of the dramatic increase in the prevalence of obesity, Americans are now more likely to be obese than to smoke: only 22.5% of Americans smoke cigarettes (Campaign for Tobacco-Free Kids, 2004).

It is well accepted that weight gain is caused by caloric imbalance, where more calories are consumed than expended. For example, a pound of weight gain results from consuming 3,500 calories. Nevertheless, it is not clear why the prevalence of obesity has increased so dramatically over the last 30 years. An increasing portion of Americans are exercising and dieting (though their lifestyles are not necessarily more active), Americans currently possess more knowledge of the consequences of obesity than ever before via government and medical awareness campaigns, biological factors though capable of explaining weight differences within a cohort should not have changed enough to explain differences in obesity over the last quarter-century, and weight is no longer a status symbol indicating prosperity (Philipson and Posner, 1999; Philipson, 2001). Yet, Americans are more likely to be obese now than ever before.

As a result, researchers have recently examined the effects of various socio-economic changes, which may have affected net calories consumed, on the prevalence of obesity.[1] For

[1] New working papers examine the effects of child care subsidies (Herbst and Tekin, 2009), health insurance (Bhattacharya et al., 2009), and food prices (Goldman, Lakdawalla, and Zheng, 2009) on

example, Baum (2007) examines changes in the racial and ethnic composition and age distribution in the U.S.; Philipson (2001), Philipson and Posner (1999), and Lakdawalla and Philipson (2007) examine employment and physical activity at work; Cutler et al. (2003), Chou, Grossman, and Saffer (2004), Rashad and Grossman (2004), and Rashad, Grossman, and Chou (2006) examine the prevalence of restaurants and food prices; Chou et al. (2004) and Gruber and Frakes (2006) examine cigarette prices and taxes; Gibson (2003), Chen, Yen, and Eastwood (2005), Meyerhoefer and Pylyphuck (2008), and Baum (2011) examine food stamp receipt; and Ewing et al. (2003) and Eid et al. (2006) examine urban sprawl.

We propose to build on the existing literature by simultaneously examining the effects of multiple socio-economic factors on the prevalence of obesity. We consider in our analysis many of the socio-economic factors that have been identified by other researchers as important influences on caloric imbalance. Specifically, we consider *(i)* employment, *(ii)* physical activity at work, *(iii)* food prices, *(iv)* the prevalence of restaurants, *(v)* cigarette smoking, *(vi)* cigarette prices and taxes, *(vii)* food stamp receipt, and *(viii)* urbanization (urban sprawl). We use 1979- and 1997-cohort National Longitudinal Survey of Youth (NLSY) data, which allows us to compare the prevalence of obesity between cohorts surveyed roughly 25 years apart (at a given age). The first portion of the analysis simultaneously estimates the effects of the various socio-economic factors on BMI, being overweight, and obesity using multivariate regression analysis. The second phase of the analysis uses the traditional Blinder-Oaxaca decomposition technique to approximate the contribution of each socio-economic factor to the increase in the weight measures over the past 25 years (Blinder 1973; Oaxaca

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body weight and obesity. A number of other papers examine the effects of various socio-economic factors, such eating school lunches versus lunches from home, exposure to junk food in schools, and physical education classes, on childhood and adolescent overweight (e.g., Gibson, 2004, 2006; Loureiro and Nayga, 2004; Cawley, Meyerhoefer, and Newhouse, 2005; Smith, Bogin, and Bishai, 2005; Anderson and Butcher, 2006; Whitmore, 2009).

1973). The only study particularly similar to ours is Chou et al.'s (2004), who also attempt to identify the portion of the increase in BMI and obesity that can be attributed to various socio-economic factors. We attempt to improve upon results from that study by controlling for time trends. Our specification changes ultimately produce different conclusions.

## II. Literature Review

To explain the increase in obesity that began in earnest roughly 25 to 30 years ago, researchers have sought to identify underlying socio-economic changes occurring concomitantly that could have influenced net caloric intake enough to support the corresponding increase in obesity.[2] The associated socio-economic changes do not necessarily need to be dramatic: Hill et al. (2003) show that today's obesity epidemic could be explained by a net increase of 50 to 100 calories per day, the amount of calories in an Oreo cookie.

Philipson and his colleagues argue that technological changes in the workplace have increased obesity (Philipson and Posner, 1999; Philipson, 2001; Lakdawalla and Philipson, 2007). In particular, technological advances have made jobs more sedentary, requiring less caloric expenditure. Secular shifts across industries have decreased the portion of workers employed in manufacturing and mining. Indeed, they find that spending 18 years in an occupation with one of the highest fitness demands (compared to an occupation with one of the lowest fitness demands) lowers BMI by a couple of index points for males (but not females), but spending 18 years in an occupation with one of the highest strength demands (relative to an occupation with one of the lowest strength demands) raises BMI by a couple of points for males. Relatedly, Anderson et al. (2003a, b) suggest changes in the composition of the labor force have increased obesity. Specifically, a larger portion of females have been participating in the labor force, and these mothers consequently have less time to prepare

[2] Finkelstein, Ruhm, and Kosa (2005) and Rosin (2008) review this literature.

healthy meals. Anderson et al. suggest that this has resulted in more eating away from home, where more calories are typically consumed. Certainly the labor force participation rate for mothers with a child under age 6 has increased, doubling from 30% to 62% between 1970 and 1999, but Anderson and her co-authors ultimately find that maternal employment only affects obesity for some socio-economic groups.

Cutler et al. (2003) suggest increased obesity is at least partially the result of technological changes making food more readily available and convenient. This, consequently, has made it easier for consumers who lack self-control to overeat. Chou et al. (2004), Rashad and Grossman, (2004), and Rashad, Grossman, and Chou (2006) agree that the quantity of food demanded will increase with decreases in food prices. Further, Cutler et al. (2003) suggest calorie-dense food has become less expensive relative to foods that are not mass produced. Chou et al. (2004), Rashad and Grossman, (2004), and Rashad, Grossman, and Chou, (2006) predict increases in the prevalence of restaurants have increased BMI and obesity. For example, they note that the number of fast-food restaurants per person doubled between 1972 and 1997 (Chou et al., 2004).

Chou et al. (2004) and Baum (2009) find that cigarette prices have exacerbated obesity, although Gruber and Frakes's (2006) results show that cigarette taxes are negatively associated with obesity. In 1964, the U. S. Surgeon General issued its first report relating smoking and health, and since that time, federal and state governments have increased cigarette taxes in a successful effort to reduce the prevalence of cigarette smoking (Grossman et al., 1993; Grossman, 2001). Because cigarette smoking and obesity seem to be inversely related, cigarette taxes may have simultaneously served to increase the prevalence of obesity. Cigarette smoking may affect weight by altering "insulin homeostasis, lipoprotein lipase activity, the activity of the sympathetic nervous system, physical activity, and preferences in food consumption" (Williamson et al., 1991; see also Wack and

Rodin, 1982, and Hofstetter et al., 1986). Further, cigarette smoking reputedly suppresses appetite and enjoyment of food (Stamford et al., 1986; Williamson et al., 1991). Certainly the prevalence of obesity has increased substantially as cigarette smoking has dramatically fallen (from about 45% to 22.5% since the early 1960s).

Gibson (2003), Chen, Yen, and Eastwood (2005), Meyerhoefer and Pylyphuck (2008), and Baum (2011) examine the role food stamps may have played increasing obesity, finding that food stamp program participation increases obesity among low-income women between 6.7% and 13.5%. Prior to the Food Stamp Act of 1964 (and other food assistance programs passed during the twentieth century), poverty was assumed to be associated with a decrease in food consumption. Various twentieth century government programs changed this by constructing a safety net that helps prevent those in poverty from starvation. The Food Stamp Act does this by guaranteeing an allotment of food for those below the poverty level and potentially increases obesity by increasing food consumption, resulting in excessive caloric intake. Food stamps potentially increase food consumption by making the monetary cost of food zero for eligible individuals up to their food stamp allotment (though since Food Stamp Program participation rates are well below 100 %, non-monetary costs such as stigma and the opportunity cost of applying and re-certifying for the benefits likely remain significant).[3]

Lastly, Ewing et al. (2003) find that urban sprawl has promoted weight gain, although Eid et al. (2006) do not concur.[4] Urban sprawl would exacerbate obesity if fewer destinations were

[3] A survey of the literature suggests a dollar of food stamps increases food consumption between $0.17 and $0.47, which is more than an equivalent amount of cash would (Fraker 1990). It is not surprising that this would be true for constrained households, but this also appears to be true for the other 85 to 95 % of food stamp households that are unconstrained (Fraker 1990).

within reasonable walking-distance. If so, then urban sprawl would be associated with decreased caloric expenditure.

In addition, demographic changes may also explain a portion of the increase in obesity. For example, the portion of the U.S. population that is black or Hispanic is increasing, and blacks and Hispanics are more likely to be obese (Flegal et al., 2002). Similarly, the U.S. population is aging (baby boomers are between the ages of 46 and 64 in 2010), and people tend to gain weight as they age. Baum (2007) finds that a small portion (no more than about 10%) of the increase in obesity is due to changes in the racial and ethnic composition and age distribution.

## III. Data

We use data from the 1979 and 1997 National Longitudinal Survey of Youth (NLSY) cohorts to estimate the effects of the various socio-economic factors on obesity. From 1979 through 1994, the NLSY79 annually interviewed a cohort of 12,686 respondents who were between the ages of 14 and 21 in 1979 (Center for Human Resource Research, 2004a). After the 1994 survey, the NLSY79 began interviewing biennially, and these respondents have since been re-interviewed on that basis. The original NLSY sample contained 6,283 females and an oversample of blacks, Hispanics, low-income whites, and military personnel. The military sample was dropped in 1984 and the low-income white sample was dropped in 1990. We exclude the military sample and the low-income white oversamples from our analysis because the NLSY97 does not contain comparable oversamples.

In each survey, the NLSY79 collects information on each respondent's individual and family background characteristics. In addition, questions about weight were asked in the 1981, 1982, 1985, 1986, 1987, 1989, 1990, 1992, 1993, 1994, 1996, 1998, 2000, 2002, 2004, 2006, and 2008 surveys, and questions about height were asked in the 1981, 1982, and 1985 surveys (The Center for Human Resource Research, 2004a). We assume that height does not change after the 1985 survey because

NLSY79 respondents are at least 20 years of age at that time. This enables us to calculate each respondent's Body Mass Index (BMI), which is defined as weight (in kilograms) divided by height (in meters) squared.

The NLSY97 began annually interviewing 8,984 youths who were aged 12 through 16 on January 1, 1997 and the survey remains in progress on that basis (Center for Human Resource Research, 2004b). The NLSY97 sample contains 6,748 cross-sectional observations and an oversample of 2,236 additional black and Hispanic observations. Much like the NLSY79, the NLSY97 collects weight and height information in each survey (specifically, in the 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, and 2008 waves). Using the methods described above, we calculate each NLSY97 respondent's BMI.

For most of the analysis, we use commonly-aged respondents from the 1979 and 1997 cohorts between the ages of 18 and 27.[5] For the 1979-cohort, this includes at least a portion of the respondents from the 1981 NLSY79 survey (the first survey in which weight was collected) through the 1992 survey. For the 1997 cohort, this begins with the 1999 survey, when the first respondents from the 1997 cohort became at least 18 years of age, and continues through the most recently-released 2008 survey, when 1997-cohort respondents were as old as 27.

To measure obesity, we first calculate each individual's BMI. Obesity is defined as a BMI of 30 or more (CDC, 2006). The CDC considers adults to be underweight if their BMI is less than 18.5 and overweight to be BMIs of 25 to 30. However, the Centers for Disease Control and Prevention's

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[5] We examine whether our age limits affect the results by re-estimating the models first including only those 20 to 27 years of age and then without upper age restrictions. When excluding those who are 18 and 19, the statistical significance of the socio-economic covariates changes in only three instances but the coefficient signs do not. When including respondents as old as 50 years of age, some of the socio-economic covariates become statistically significant at the 5% level (perhaps because the number of observations increases by about 80%), but the signs of these covariates are almost always the same as for the smaller samples.

(CDC) method for identifying "obesity" in those under age 21 is through age- and gender-specific BMI growth charts (rather than simply using greater than or equal to 30 as the cutoff). For consistency across respondents, we first use a cutoff of 30 for all respondents.

With both NLSY cohorts, we exclude pregnant females and new mothers (women who have given birth within a year) because their reported weight may not be representative of their non-pregnancy weight. These respondents' weight observations are ignored from survey years when pregnant (or recently after giving birth) as described above, but their prior and future non-pregnant weight observations (from other survey years) are included in the analysis.

The NLSY measures of weight and height are self-reported. Unfortunately, self-reported weight (and, to a lesser extent, self-reported height) is potentially measured with error. Fortunately, the National Health and Nutrition Examination Survey (NHANES) – NHANESIII (1988-1994) and then NHANES 1999-2006, in particular – contains both actual and reported weight. Cawley (2000) uses this data to determine the extent of measurement error in weight (and height) and finds that those who are overweight underestimate their weight and those who are underweight overestimate their weight. Though the NLSY only collects self-reported weight, Cawley, using NHANES data, is able to predict actual weight for NLSY respondents from their self-reported weight. He does this by regressing actual weight on self-reported weight (and its squared value) using NLSY-aged NHANES respondents.[6] Then, he uses gender- and race-specific NHANES results to adjust self-reported weight in NLSY79 data. We use his procedure to adjust our NLSY data.[7]

[6] We use NHANESIII (1984-1994) to adjust 1979-cohort NLSY data and NHANES 1999-2006 data to adjust 1997-cohort NLSY data.

[7] We re-estimate our models using unadjusted height and unadjusted weight to calculate BMI, overweight, and obesity. Compared to results with adjusted height and weight, none of the statistically significant coefficients for the socio-economic covariates change sign. In some cases, the level of statistical significance changes, but otherwise conclusions do not seem to hinge on whether we use adjusted or unadjusted height and weight.

Figure 1 presents reported and adjusted BMI for each NLSY79 and NLSY97 survey year in which weight was collected (with no age restrictions). BMI increases over time have been much steeper for the NLSY97 cohort, although between 1997 and 2008 BMI is higher for NLSY79 respondents, likely because they are older. The figure also indicates that reported BMI underestimates actual BMI. That is, adjusted BMI is higher than reported BMI in each year, except for 1997 with the NLSY97 cohort. This is likely because those who are underweight tend to overestimate their weight.

Figure 2 presents the reported and adjusted probabilities of being obese for NLSY79 and NLSY97 survey years (again, without age restrictions). As with BMI, the annual increase in obesity is larger for the NLSY97 cohort, but the probability of being obese during the 1997 to 2008 period is higher for the 1979 cohort. By 2008, over 35 % of NLSY79 respondents are obese, and about 28 % of NLSY97 respondents are obese even though they are substantially younger.

Figure 3 presents reported and adjusted BMI by age. When comparing common ages, BMI for the 1997 cohort is substantially higher than for the 1979 cohort. For example, at age 28, average BMI for the 1997 cohort is over 28, but BMI at that age for the 1979 cohort is about 25 on average. The BMI-age gradient is steeper for 1997 NLSY respondents as well.

Figure 4 presents corresponding statistics for the probability of being obese. As with BMI, the probability of being obese adjusted for age is substantially higher for the NLSY97 cohort than for the NLSY79 cohort. And, this gap widens with age. For example, the difference in the probability of being obese at age 18 for the two cohorts is about 7.5 percentage points; however, by age 28, this gap is 19 percentage points.

The NLSY surveys also collect much of the information required to create covariates representing the socio-economic factors. Both NLSY surveys collect information on employment, including each employed respondent's job occupation and industry classification codes required to measure physical activity at work, cigarette smoking, and food stamp receipt. In addition, the NLSY identifies each respondent's state and county of residence, which allows us to match with each respondent other socio-economic characteristics, such as the prevalence of restaurants, food prices, and cigarette taxes. We next describe in more detail how each key socio-economic covariate is created.

To measure physical activity at work, we follow Lakdawalla and Philipson (2007), who also use NLSY data, by constructing a measure of fitness required at work and a measure of occupational strength demands. Lakdawalla and Philipson (2007) suggest fitness demands at work, which require endurance and agility, will decrease weight, but strength demands, which require muscle, will increase weight. The fitness measure equals the number of the following activities required at work: climbing, reaching, stooping, kneeling, crouching, and crawling. The measure of strength demands is an ordinal ranking from one to five, where one indicates a sedentary occupation and five indicates very heavy strength demands. Both measures are based on occupation-specific information from the Dictionary of Occupation titles (DOT) from the revised fourth edition. However, the NLSY classifies occupations according to the Census taxonomy, which is different than that used by the DOT. We match NLSY census occupations with DOT occupations using a crosswalk provided by the Department of Labor's National Occupational Information Coordinating Committee (NOICC). The NOICC crosswalk uses 1970 Census occupation codes, but, unfortunately, the NLSY uses 1970 Census codes in only the 1979 through 2000 NLSY79 surveys. The 2002 through 2008 NLSY79 surveys and all NLSY97 surveys use 2000 Census codes, which are fundamentally different (at least partially because new occupations are incorporated). To convert 2000 Census occupation codes to 1970 Census occupation codes, we use a mapping scheme developed by Meyer and Osborne (2005) at the Department of Labor. Ultimately, each NLSY occupation is matched with a measure of fitness requirements and strength demands.

We use two state- and year-specific measures to proxy for food prices: the price of food-at-home and the price of fast food. Both of these food prices are created following Chou et al.'s (2004) methodology using American Chamber of Commerce Research Association (ACCRA) cost of living data provided by the Council for Community and Economic Research (C2ER) for more than 300 core-based statistical areas (CBMAs) quarterly from 1968 to the present (C2ER, 2010). State-specific prices are population-weighted averages for the CBMAs in each state, and year-specific prices are equally-weighted averages across the four quarters in each year. The food-at-home price is a weighted index based on the prices of 13 grocery food items, which include the price of a T-bone steak, ground beef, bacon, chicken, tuna, milk, eggs, margarine, cheese, potatoes, bananas, lettuce and bread.[8] The weights, which are fixed over time, are based on the portion of a typical consumer's budget spent on each item.[9] The fast-food price is an index comprised of the equally-weighted costs of a chicken meal from Kentucky Fried Chicken, a thin-crust cheese pizza from Pizza Hut, and a McDonald's quarter-pound cheeseburger. Both food prices are converted to year-2005 dollars for this analysis.

The number of restaurants equals the state-specific number of "eating and drinking places" as measured by the U.S. Census Bureau in their Census of Retail Trade (U.S. Census Bureau, 1977; 1982; 1987; 1992; 1997; 2002; 2007). In particular, every five years (in 1982, 1987, 1992, 1997,

[8] A full description of the methodology used to construct the food-at-home price and the fast-food price is available upon request (and additional details are also available in Chou et al., 2004).

[9] These weights are the same as those used by Chou et al. (2004).

2002, and 2007), the U.S. Census Bureau for every state tabulates the number eating and drinking places, defined as places that "prepare meals, snacks, and beverages to customer order for immediate on-premises and off-premises consumption." This includes places that provide "food and drink only…various combinations of seating space, (and) waiter/waitress services and incidental amenities, such as limited entertainment." For years not corresponding to a census date, we interpolate the state-specific number of restaurants.

The Census of Retail Trade used Standard Industrial Classification (SIC) codes for their 1977, 1982, 1987, and 1992 surveys (U.S. Census Bureau, 2010). Thereafter, the Census of Retail Trade has used the North American Industry Classification System (NAICS). SIC category 58, which is eating and drinking places, is reputedly quite comparable to NAICS category 722, which is food services and drinking places. For example, the number of establishments in SIC category 58 in 1992 is within 90% of the number of establishments in NAICS category 722 in 1997 (U.S. Census Bureau, 2010). Both classification systems contain sub-categories pertaining to eating and drinking places that, unfortunately, are substantially less comparable. In particular, the SIC's sub-categories for eating and drinking places include restaurants, cafeterias, refreshment places, other eating places, and drinking places, while the sub-categories for the NAICS's sub-categories for food services and drinking places include full-service restaurants, limited-service eating places, special foodservices, caterers, mobile food services, and drinking places. Using sub-categories would result in relatively large discontinuous jumps in the number of particular types of eating establishments between 1992 and 1997, so we use the total number of eating and drinking places in our analysis without attempting to identify separate effects for particular types of eating and drinking places.[10] We scale the prevalence of restaurants by population to produce the number of restaurants per 1,000 residents.

The NLSY79 collects information about smoking behavior in the 1984, 1992, 1994, and 1998 surveys for the 1979 cohort and in every NLSY97 survey. These surveys ask respondents whether they smoke daily, occasionally but not daily, or do not smoke. If respondents answer that they smoke daily, then the surveys identify the average number of cigarettes smoked. We create two cigarette smoking covariates: a dummy variable indicating whether the respondent smokes and a continuous variable that equals the number of cigarettes smoked per day. The continuous variable equals zero for non-smokers. NLSY79 observations from a survey that did not ask the cigarette smoking question are assigned covariate values from the first preceding survey that does contain the cigarette smoking questions. We add in the models an additional dummy variable that indicates whether the respondent's cigarette smoking information is obtained from the same survey as their weight information or from a prior survey.

To estimate the effects of cigarette costs on BMI and obesity, we need data on cigarette taxes and cigarette prices. The NLSY surveys do not collect such data; fortunately, this information is available from the Tobacco Institute (The Tobacco Institute, 2008), which reports the annual average price of cigarettes by state and separately identifies federal and state taxes (and the exact dates of tax changes). We explore the effects of using cigarette taxes and cigarette prices in the analysis because the literature has been unable to agree which is most appropriate. For example, Chou, Grossman, and Saffer (2006) argue that cigarette prices is the preferred measure because cigarette taxes fail to incorporate exogenous state variation in the cost of production (such as state-

[10] Chou et al. (2004) attempt to disaggregate types of eating and drinking places and find that the effects of different types of restaurants on weight are similar. For simplicity, they ultimately present regression results that use an aggregated measure for the number of restaurants.

specific transportation costs) and in market share. Conversely, Gruber and Frakes (2006) argue that cigarette taxes is the better measure because cigarette prices are potentially endogenous: cigarette prices are at least partially determined by cigarette demand, and states where cigarette demand is high may tend to invest less in health and have more obesity.[11]

Because NLSY data identifies each respondent's state and county of residence, we can link the Tobacco Institute's measures of local cigarette taxes and prices with each respondent.[12] Others have found that cigarette price variation between states is primarily due to variation in state excise taxes (Chaloupka, 1991; Becker, Grossman, and Murphy, 1994; Farrelly et al., 2001). For example, Farrelly et al. (2001) report that in 1993 the state cigarette tax in Virginia was only 2.5 cents, but in Washington D.C. the state cigarette tax was 65 cents. Data from the Tobacco Institute is used extensively in the economics literature to estimate the effects of cigarette prices on cigarette demand (Wasserman et al., 1991; Becker, Grossman, and Murphy, 1994; Evans and Ringel, 1999; Farrelly et al., 2001). All tax figures are adjusted for inflation with the Consumer Price Index (CPI) to year-2005 dollars. Often, state cigarette taxes change during the year. When this occurs, we use the cigarette tax rate at the time of the survey, which is identified in each questionnaire.

[11] Though taxes may be more exogenous than prices, they too may suffer from a degree of endogeneity.

[12] To avoid high cigarette costs (perhaps due to local excise taxes), smokers may leave their state of residence to purchase cigarettes in lower-taxed localities (Batalgi and Levin, 1986). If border crossing occurs, then the effects of "state of residence" cigarette costs will be biased toward zero (Chaloupka, 1991; DeCicca et al., 2002). To account for the effects of "casual smuggling," the literature often averages state of residence cigarette prices with the lowest cigarette price from a neighboring state. For example, Chaloupka's (1991) cigarette price is an equally weighted average of the local price and the "border price" of cigarettes, where the border price is the lowest cigarette price within 25 miles of the county of residence. Others use a different approach, excluding respondents who live within a reasonable distance (20 to 25 miles) from a low-price state line (Lewit et al., 1981; Lewit and Coate, 1982; Wasserman et al., 1991; Chaloupka and Wechsler, 1997). We explore the potential effects of border crossing using these methods as well but find that these adjustments have little impact on the results.

The NLSY surveys also collect information on government program participation, including food stamp receipt, identifying whether each respondent receives food stamp benefits in each month covered by the survey.[13] However, information on welfare program participation is not collected for NLSY79 respondents under the age of 18 who are not married, not in college, and without children. We only include person-year weight observations when respondents are at least 18 years of age so food stamp usage will not increase simply because youths cross the 18-year threshold. The food stamp covariate equals the number of months during the prior calendar year in which the respondent received food stamps.

Urban sprawl is created from data provided by the NLSY that was originally obtained from the U.S. City-County Database. In particular, we create a variable measuring urbanization, defined as the local population divided by square miles. Urban sprawl is intended to measure population movement out of urban areas, so urban sprawl is the inverse of urbanization: as urbanization (population divided by square miles) decreases, urban sprawl increases.

Table 1 presents descriptive statistics (weighted sample means and standard errors) for the key explanatory variables and for the standard demographic variables for NLSY79 respondents. Table 1 also presents sample means separately for obese NLSY79 respondents and non-obese NLSY79 respondents. Following that format, table 2 presents these descriptive statistics for NLSY97 respondents.

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[13] Food Stamp Program participation also may be misreported, with empirical evidence indicating that errors of omission are substantially more prevalent than errors of commission (Bollinger and David 1997; Bitler, Currie, and Scholz 2003). While we do not address misreporting empirically, others (Bollinger and David 1997, 2001, 2005) have shown that survey respondents seem to be predisposed to provide either accurate or inaccurate food stamp information and that reporting errors are less likely to be due to difficulty recalling whether participation occurred in a specific month.

Comparing sample means between the 1979 and 1997 cohorts, employment levels are similar, but occupational fitness and occupations strength demands are slightly lower for the 1997 cohort, as anticipated. Also as expected, most food prices (the food-at-home price and the fast-food price) are lower for the 1997 cohort. The prevalence of restaurants (per 1,000 residents) is greater for the 1997 cohort. Respondents from the two cohorts are almost equally likely to smoke cigarettes, although 1979-cohort respondents are likely to smoke more cigarettes per day. Real cigarette prices have more than doubled, from $1.73 to $3.76 between cohorts. Food stamp program participation is lower for the 1997 cohort, and urban sprawl has increased, with land-adjusted population decreasing over time.

NLSY79 respondents are less likely to be black or Hispanic. They are also a bit older on average, which may partially explain why NLSY79 respondents tend to have more education and weeks of work experience and are more likely to be married. NLSY79 respondents also have more biological children; however, respondents from the 1997 cohort have larger family sizes and have more individuals under the age of 18 (who are not necessarily biological children) present in the household. Real household income is higher for the 1997 cohort.

Examining the association of the key socio-economic factors, obese respondents in both cohorts have fewer occupational fitness demands but more occupational strength demands. The associations of food prices and the number of restaurants with obesity are either mixed are small. Surprisingly, obese 1979-cohort respondents are less likely to smoke and smoke fewer cigarettes than their non-obese counterparts, but obese respondents from the 1997 cohort are more likely to smoke and smoke more cigarettes. The association of cigarette prices with obesity also differs between cohorts. Food stamp receipt and urban sprawl are both positively associated with obesity for both cohorts.

For both the 1979 and the 1997 cohorts, females, blacks, and Hispanics are more likely to be overweight and obese than their counterparts (males and whites). Furthermore, for both cohorts, obesity is positively associated with age, being married, and the number of biological children. Education and household income are negatively associated with obesity for both cohorts. The association between obesity and work experience and family size differ between the two cohorts.

## IV. Empirical Methodology

The descriptive statistics presented thus far only identify correlation between the various socio-economic characteristics and weight. To identify causal effects, we estimate BMI, the probability of being overweight, and the probability of being obese using multivariate regression analysis. We will use OLS for continuous dependent variables (BMI) and the logit function form for dichotomous dependent variables (the probability of being overweight and the probability of being obese). In all models, we include a standard set of covariates to control for gender, race/ethnicity, age, education, income, work experience, marital status, and household composition (the number of family members, the number of members under the age of 18, and the number of biological children). Suppose measures of weight (W), such as BMI, the probability of being overweight, and the probability of being obese, for individual i in state s at time t can be specified as

$$W_{ist} = \alpha_0 + \alpha_1 \mathbf{X}_{ist} + \mu_{ist}, \qquad (1)$$

where **X** is a vector of observable individual-specific and region-, state-, or county-specific characteristics,[14] $\mu$ is the error term, and the $\alpha$s are parameters to be estimated. In the regression

[14] Food-at-home prices, fast-food prices, the number of restaurants, and cigarette prices are state-specific covariates, urbanization is a county-specific covariate, and the other key explanatory variables and all the demographic characteristics are individual-specific covariates.

analysis, we do not use sampling weights,[15] but we control for correlation among observations that come from the same state because such observations are not independent from one another (Bertrand, Duflo, and Mullainathan, 2004).[16] Otherwise, such correlation would lead to underestimated standard errors and overestimated significance levels. Because some NLSY respondents contribute multiple observations to the sample, regression estimates could still be overestimated or underestimated.

The effects of the explanatory variables could be correlated with time trends. For example, cigarette taxes and obesity have been increasing over time. Without controls for time trends, the cigarette tax covariate otherwise might pick up a portion of this trend. To control for time trends, we include in our models a set of year dummy variables (one for each survey year – minus one). Similarly, the effects of the explanatory variables could be correlated with state-specific characteristics. For example, cigarette smoking and obesity may be higher in southern states (or food prices and obesity might be negatively correlated in northern states). Without controls for state-specific effects, the cigarette smoking covariate (or the food price covariate) might otherwise pick up a portion of these state-specific characteristics. To control for state-specific effects, we include a set of state dummy variables (one for each state – minus one). Ultimately, our preferred regression specification is

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[15] We do not use sampling weights in our regression analysis, although we do use sampling weights when separately calculating sample means for the two cohorts, which are used for the decompositions. This is because we pool observations from the NLSY79 and NLSY97 and it is not clear that sampling weights for the two cohorts can be combined. Actually, it is not clear that the sampling weights, created in 1979 and 1997 for the initial samples, for either cohort are necessarily accurate for successive waves due to attrition.

To explore how sensitive our results are to sampling weights, we re-estimate the regression models using sampling weights (simply combining the two sets of sampling weights into a common measure). In most instances, the results are substantively unchanged.

[16] The literature seems to agree that state-level error clustering (instead of clustering at the individual level) accounts for both state-level correlation and correlation from respondents providing multiple observations (for example, see Bitler, Gelbach, and Hoynes, 2006).

$$W_{ist} = \alpha_0 + \alpha_1\mathbf{X}_{ist} + \alpha_2(\mathbf{state}_{it}) + \alpha_3(\mathbf{year}_{it}) + \mu_{ist}, \quad (2)$$

where **state** is a vector of state dummy variables ($\mathbf{state}_j$ equals one if individual i lives in state j in year t), **year** is a vector of year-specific dummy variables ($\mathbf{year}_t$ equals one if individual i is in year t), and W, **X**, μ, and the αs are as defined before.[17]

With each set of regression results, we decompose the increase in weight (BMI, being overweight, and obesity) attributable to each socio-economic factor using a version of the traditional Oaxaca-Blunder decomposition (Blinder 1973; Oaxaca 1973). That is, for each socio-economic factor, we first predict each weight measure (BMI, for example) with the socio-economic factor's value set to its weighted 1979-cohort mean (using 1979-cohort sampling weights) and with all other covariates at their actual weighted values. Then, we change the socio-economic covariate's value to its weighted 1997-cohort mean (using 1997-cohort sampling weights) and re-predict the weight measurements, recording the change. We used weighted changes in covariate values even when using coefficient estimates from unweighted regressions. We also identify the portion of the change in the weight measurement explained by the change in the socio-economic factor. If, for example, changing cigarette smoking from its 1979-cohort average to the 1997-cohort value increases BMI by 0.4 index points and the ultimate increase in BMI is 4 points, then 10% of the increase in BMI between the 1979 and 1997 NLSY cohorts would be attributed to changes in cigarette smoking. A portion of the weight increases will almost certainly remain unexplained (that is, not explained by the changes in the socio-economic factors).

For continuous weight measures (BMI), the decomposition results are independent of the values used for the other covariates. However, for non-linear models (the logits for the probability of

[17] We also estimate our models separately by gender to explore whether the various socio-economic factors affect weight for males and females differently. These results are presented in a longer companion paper, which is available upon request.

being overweight and the probability of being obese), the values used for the other covariates affect the portion of the increase attributable to each socio-economic factor. Although our results would change if we used different values for the other covariates, using actual values for the other covariates should provide an approximation between that which would be produced using either 1979-cohort or 1997-cohort averages.

## V. **Results**

We present results for the socio-economic and demographic covariates from unweighted regression models that use adjusted measures of height and weight and include state and year dummy variables. Table 3 presents regression results for BMI, the probability of being overweight, and the probability for being obese using the full sample. The next table (table 4) shows the portion of the increase in the weight measures attributable to each socio-economic and demographic factor.[18] In particular, the decomposition shows the change in the weight measures between the 1979 and 1997 cohorts resulting from the change in each socio-economic or demographic factor between cohorts (Δ) and the portion of the total change in the weight measures that the socio-economic change represents (%Δ). Decomposition results that correspond to statistically significant regression covariates (at the 5% level) are in bold for ease of interpretation.

Examining model 1 in table 3, occupational fitness demands and smoking cigarettes (both the discrete measure for being a smoker and the continuous measure for the number of cigarettes smoked) significantly decrease BMI, as does being employed and urbanization.

[18] We do not include changes in age in the decompositions because the NLSY97 cohort is slightly younger on average than the NLSY79 cohort (just the opposite, the population of the U.S. is aging), although we control for age in the regressions, and the range of ages included in the analysis from each cohort are identical.

Occupations strength demands and food stamp receipt significantly increase BMI. These results are as predicted. However, food-at-home and fast-food prices and the prevalence of restaurants do not have statistically significant effects. Cigarette prices also have statistically insignificant effects.

The effects of food prices and restaurants could be confounded because additional restaurants could lower food prices (specifically, more fast-food restaurants could lower fast-food prices). If restaurants affect weight through food prices, then we might not expect to find significant effects of restaurants on weight when holding food prices constant. Alternatively, if food prices affect weight through the number of restaurants (for example, if higher food-at-home prices increase the number of restaurants), then we might not expect to find significant effects of food prices on weight when holding the number of restaurants constant.

We further explore the effects of food prices and restaurants by first re-estimating our specifications including food prices but not the prevalence of restaurants in the regression models and then re-estimating the models including restaurants but not food prices. In both sets of models, the results, which are available upon request, are largely the same as those already presented. This may indicate that the relationship between restaurants and food prices is not particularly strong. Alternatively, it may be that food prices affect the prevalence of restaurants (or vice versa), but neither has a particularly meaningful effect on weight.

Most of the demographic characteristics have statistically significant effects. Increases in BMI are associated with being male, black, and Hispanic, age, and work experience. Education and income significantly decrease BMI. Evidence also suggests being married increases BMI, as does family size, but the number of biological children has a significant negative effect.

Results from the decompositions, presented in table 4, indicate none of these socio-economic factors can explain a large portion of the 1.685 index-point increase in BMI. The statistically significant socio-economic factor that explains the largest portion of the BMI increase (1.956% of the BMI increase) is the number of cigarettes smoked: cigarette smoking decreases BMI, and the number of cigarettes smoked decreased from 6.127 for the 1979 cohort to 3.525 for the 1997 cohort.[19] Changes in occupational fitness and urbanization explain less than 1% of the

[19] Cigarette prices likely affect weight primarily through cigarette smoking. If so (or if higher cigarette prices affect weight *exclusively* through reduced cigarette smoking) then we would not expect the effects of cigarette prices to be statistically significant when holding cigarette smoking constant. That is, the cigarette price covariate would not be expected to affect BMI, being overweight, and obesity when including covariates for cigarette smoking. Indeed, cigarette prices have statistically insignificant effects in many of the models.

To explore this possibility, we re-estimate our models (those models whose results are presented in tables 3, 4, and 5) first including controls for cigarette smoking but not cigarette prices and then including the cigarette price covariate but not controls for cigarette smoking. In both cases, the results, which are available upon request, are almost identical to those already presented. Again, perhaps it is not surprising that excluding cigarette prices does not alter the effects of cigarette smoking on weight since cigarette prices likely affect weight through cigarette smoking. However, that the effects of cigarette prices remain statistically insignificant in many cases when controls for cigarette smoking are excluded suggests even if cigarette smoking affects weight, cigarette prices do not have a particular large effect on cigarette smoking.

In the economics literature, studies show that the demand for cigarettes is relatively inelastic, with demand elasticities typically ranging from –0.75 to –0.10 (Lewit, Coate, and Grossman, 1981; Lewit and Coate, 1982; Becker, Grossman, and Murphy, 1991, 1994; Chaloupka, 1991; Wasserman et al., 1991; Grossman et al., 1993; Keeler, 1993; Chaloupka, Tauras, and Grossman, 1997; Chaloupka and Wechsler, 1997; Evans and Farrelly, 1998; Evans and Ringle, 1999; Chaloupka and Warner, 2000; Farrelly et al., 2001; Gruber and Koszegi, 2001). For example, Becker, Grossman, and Murphy (1991, 1994) find that a permanent 10% increase in cigarette prices reduces cigarette consumption by 4% initially and by 7.5% in the long run (generating elasticities of –0.4 and –0.75, respectively).

We also re-estimate our models using cigarette taxes instead of cigarette prices. Cigarette taxes have statistically insignificant effects on BMI, being overweight, and obesity, although the estimated coefficients are almost always positive (instead of negative, as seen in many of the models that use cigarette prices). This would suggest that as cigarette taxes increase, cigarette smoking decreases, increasing the various weight measurements. We also attempt to control for state border crossing (to buy cigarettes in lower-cost states) using the methods outlined earlier, but border crossing does not seem to be an issue. Since cigarette prices do not seem to substantively affect weight, it makes sense that border crossing is not important.

BMI increase. Changes in occupational strength and food stamp receipt have decreased BMI over time because strength requirements and food stamp program participation both decreased slightly between the 1979 and 1997 cohorts.

The increase in the proportion of black and Hispanic in the sample accounts for 1.127% and 5.010% of the BMI increase between cohorts. Changes in marital status have dampened the increase in BMI because marriage increases BMI and fewer from the 1997 cohort are married. Changes in family size and in the number of biological children account for 1.381% and 2.186% of the increase in BMI, because family size increases BMI and NLSY97 respondents have larger families, and children decrease BMI and NLSY97 respondents have fewer children. No other demographic covariate significantly explains more than 1% of the change in BMI.

Results for the probability of being overweight (table 3) are similar to those for BMI. The number of cigarettes smoked has the largest effect, with decreases in the number of cigarettes smoked increasing the probability of being overweight by 1.861% between the two cohorts (see table 4). None of the other socio-economic factors significantly explains more than 1% of the increase, and food-at-home and fast-food prices and the prevalence of restaurants continue to have statistically insignificant effects.

Almost all the demographic factors continue to have statistically significant effects in the model for the probability of being overweight, and the demographic factors that explain at least 1% of the change in the probability of being overweight are the same as those that explain at least 1% of the change in BMI with one exception: the number of biological children (which explains about 2% of the BMI increase) has a small and statistically insignificant effect on the probability of being overweight. The other demographic variables continue to explain only a small portion of the weight change.

In many ways, the results for the prevalence of obesity are similar: shown in table 3, occupational strength demands significantly increase obesity and occupational fitness demands significantly decrease obesity. Obesity is also significantly increasing in food stamp receipt and urban sprawl (decreasing in urbanization). Cigarette smoking significantly decreases obesity, but the effect of the number of cigarettes smoked is only marginally significant. Indicated in table 4, occupational strength demands have the largest effect that is statistically significant on obesity among the socio-economic factors, but since such demands increase obesity and such demands have decreased between the 1979 and 1997 cohorts, this serves to decrease the magnitude of the increase in obesity.

The demographic characteristic that makes the largest positive contribution to the increase in obesity is being Hispanic: the increase in the portion Hispanic explains about 3.5% of the increase in obesity. Otherwise, the demographic factors have effects similar to those for BMI and the probability of being overweight. For example, decreases in marital status mitigate increases in obesity between cohorts.

## VI. Discussion and Conclusions

Four of the more consistent findings for the socio-economic factors from this analysis are that *(i)* occupational fitness and strength demands significantly affect weight, *(ii)* cigarette smoking (and being a cigarette smoker) significantly decreases weight, *(iii)* food stamp receipt significantly increases weight, and *(iv)* urban sprawl significantly increases weight. This corroborates a host of medical studies on weight and cigarette smoking, as well as those studies by Gibson (2003), Ewing et al. (2003), Chen, Yen, and Eastwood (2005), Lakdawalla and Philipson (2007), Meyerhoefer and Pylyphuck (2008), and Baum (2011). However, none of these factors explain a noticeable increase in the weight measures. For example, the decline in cigarette smoking explains no more than about 2% of the increase in the weight measures. The other significant factors explain even less.

Occupational strength and fitness demands have expected effects, with strength demands increasing weight and fitness demands decreasing weight (Philipson, 2001; Philipson and Posner, 1999; Lakdawalla and Philipson, 2007). Although statistically significant, changes in physical demands at work never explain more than about 1% of the increase in the weight measures. Finkelstein et al. (2005) assert that occupational changes cannot be expected to explain a very large portion of the increase in obesity that has occurred over the last 25 years because the shift from manual employment to other sectors has been occurring gradually and began much earlier than the beginning of the increase in obesity.

The reason food stamp receipt does not seem to explain any of the increase in weight between cohorts is because between the two periods examined food stamp program participation actually *decreases*. This is somewhat of an anomalous artifact of the particular periods examined in this analysis. For much of the time since its 1964 inception, food stamp program participation has increased, reaching a high of about 27 million participants in 1994. After 1994, program participation declined until 2002, with the number of food stamp recipients not reaching 1994-levels until the most recent recession in 2008 (USDA, 2010). These results indicate that when food stamp receipt increases, as it has from 2002 through the current recession, it will increase weight and the various measures of being overweight and obese.

The effects of many of the demographic characteristics are as expected. Males have significantly higher BMIs and are significantly more likely to be overweight but significantly less likely to be obese. As anticipated, being black and Hispanic are significantly associated with higher BMI and higher probabilities of being overweight and obese (Ogden et al., 2006). Years of schooling significantly decrease the weight measures in each model, as expected and found often elsewhere (Mokdad et al., 2001). The measures of weight are rarely significantly affected by the number of household members under the age of 18, but they are typically increasing in family size and decreasing in the number of biological children. The portion Hispanic is the demographic characteristic that explains the largest fraction of the increase in the weight measures. For example, the increasing portion Hispanic explains about 5% of the rise in BMI.

Our conclusions—that these socio-economic factors have played a small role in the increase in obesity—are different than Chou et al.'s (2004) conclusions. Decompositions in Chou et al. indicate that the increase in the prevalence of restaurants explains 60 to 65% of the increase in BMI and obesity, increases in cigarette prices explain about 20% of the increase in BMI and obesity, and decreases in the various measures of food prices explain about 12% of the weight increases. One potential explanation for these differences is that Chou et al. examine older respondents (Behavioral Risk Factor Surveillance System respondents aged 18 and older, aged 43 on average) who may be affected differently by the socio-economic factors. Another explanation is that Chou et al.'s regression specifications do not control for time trends with a continuous year covariate or year dummy variables, essentially *forcing* the included covariates (such as the socio-economic variables) to explain the increase in obesity to fit the data. We suspect that if year dummy variables were included, then the socio-economic covariates would have explained a smaller portion of the increase in obesity.

Various policies have been proposed to address the increase in obesity. Some may be effective. For example, analysts have suggested the Food Stamp Program be revised to offer bonuses for purchasing healthy foods such as fruits and vegetables, and to expand nutrition education offered through the program (Gutherie et al., 2007a, 2007b; Ver Ploeg and Ralston, 2008; Alston et al., 2009).[20] The White House Task Force on Reducing Childhood Obesity (2010) recommends, among other things, making neighborhoods safer so that more children will walk or bike to school. Results in this study suggest these policies could have effects on weight, because the socio-economic factors these policies are associated with (food stamps and urban sprawl) have statistically significant effects. However, the direct effects of food stamps and urbanization are small, so the effects of these policy revisions will likely be small as well.

Other policies may be ineffective. For example, some have proposed using taxes to essentially raise the prices of unhealthy foods such as snack foods (Epstein et al., 2010) and sugar-sweetened beverages (Smith, Lin, and Lee, 2010), using zoning restrictions to limit or prohibit fast-food restaurants (CDC, 2010), and using tax credits to promote supermarkets in underserved areas (Morland, Diez Roux, and Wing, 2006; Rundle et al., 2009; Treuhaft and Karpyn, 2010). However, this analysis offers no evidence that food prices (either food-at-home prices or fast-food prices) and the prevalence of restaurants have statistically significant effects on weight.

Other policies would be counterproductive. No one recommends cigarette smoking (or higher cigarette taxes) as a means to combat obesity, although the cigarette smoking covariates have statistically significant effects in this study.

Ultimately, the socio-economic and demographic factors examined in this analysis, whether considered individually or collectively, explain a minority of the increase in BMI, overweight, and obesity. The unexplained increases in these weight measurements could potentially be due to other factors not examined in the analysis or to genes. However, genes likely cannot explain the rising trend in weight because they are not thought to change substantially over a period of just a few

[20] The USDA has not implemented any of these suggestions at this time, but California is in the process of funding a program to provide rebates when recipients use their food stamps to purchase fruits and vegetables.

decades, although genetic differences could still significantly explain differences in weight between individuals (cross-sectional differences) (Bouchard, 1994; Philipson, 2001). Alternatively, perhaps the socio-economic factors we examine have large effects on weight, but this analysis does not identify those effects because the covariates designed to measure these factors are imprecise. Certainly our analysis will be unlikely to estimate statistically significant effects on BMI, being overweight, and obesity if these socio-economic factors are not accurately represented by their corresponding covariates.

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**Table 1: Descriptive Statistics for NLSY79 Data**

| **Dependent Variables** | **Full Sample** | | **Obese** | **Non-Obese** |
|---|---|---|---|---|
| Body Mass Index (BMI=Weight/(Height$^2$)) | 24.129 | (0.069) | 33.885 | 23.094 |
| Prevalence of Overweight (BMI = 25+) | 0.336 | (0.006) | 1.000 | 0.265 |
| Prevalence of Obesity (BMI = 30+) | 0.096 | (0.004) | 1.000 | 0.000 |
| **Socio-Economic Factors** | | | | |
| Employed (=1 if employed within last year) | 0.916 | (0.005) | 0.883 | 0.919 |
| Occupational Strength (1 to 5 ordinal ranking) | 1.548 | (0.010) | 1.574 | 1.546 |
| Occupational Fitness (number of activities) | 0.561 | (0.007) | 0.556 | 0.562 |
| Food-at-Home Prices (in 2005 dollars) | 2.116 | (0.012) | 2.136 | 2.114 |
| Fast-Food Prices (in 2005 dollars) | 5.136 | (0.025) | 5.146 | 5.135 |
| Number of Restaurants (number per 1,000) | 1.606 | (0.023) | 1.602 | 1.606 |
| Smoked Cigarettes (=1 if smokes) | 0.404 | (0.007) | 0.362 | 0.408 |
| Cigarettes Smoked (cigarettes per day) | 6.127 | (0.163) | 5.574 | 6.186 |
| Cigarette Prices (per pack in 2005 dollars) | 1.733 | (0.010) | 1.794 | 1.727 |
| Food Stamp Receipt (during preceding year) | 0.537 | (0.041) | 1.024 | 0.485 |
| Urbanization (population/square miles) | 1.826 | (0.253) | 1.467 | 1.864 |
| **Demographic Characteristics** | | | | |
| Male (=1 if male) | 0.532 | (0.007) | 0.516 | 0.534 |
| Black (=1 if black) | 0.122 | (0.018) | 0.174 | 0.116 |
| Hispanic (=1 if Hispanic) | 0.057 | (0.010) | 0.080 | 0.055 |
| Age (in years) | 24.419 | (0.017) | 25.182 | 24.338 |
| Education (in years) | 12.918 | (0.061) | 12.380 | 12.976 |
| Household Income ($10,000s in 2005 dollars) | 5.169 | (0.179) | 4.621 | 5.228 |
| Experience (=weeks worked during year/52) | 0.760 | (0.006) | 0.750 | 0.761 |
| Marital Status (=1 if married) | 0.390 | (0.010) | 0.443 | 0.384 |
| Family Size (number in household) | 2.807 | (0.030) | 3.001 | 2.786 |
| Kids (number of children in Household) | 0.507 | (0.018) | 0.717 | 0.485 |
| Children (number of biological children) | 0.560 | (0.021) | 0.751 | 0.540 |
| Year (year of survey) | 1986.132 | (0.024) | 1986.903 | 1986.132 |

Sample means with standard errors in parentheses. There are 34,878 respondent-year observations.

**Table 2: Descriptive Statistics for NLSY97 Data**

| **Dependent Variables** | **Full Sample** | | **Obese** | **Non-Obese** |
|---|---|---|---|---|
| Body Mass Index (BMI=Weight/(Height$^2$)) | 25.814 | (0.103) | 35.683 | 23.553 |
| Prevalence of Overweight (BMI = 25+) | 0.451 | (0.008) | 1.000 | 0.325 |
| Prevalence of Obesity (BMI = 30+) | 0.186 | (0.006) | 1.000 | 0.000 |
| **Socio-Economic Factors** | | | | |
| Employed (=1 if employed within last year) | 0.928 | (0.004) | 0.919 | 0.930 |
| Occupational Strength (1 to 5 ordinal ranking) | 1.510 | (0.013) | 1.530 | 1.506 |
| Occupational Fitness (number of activities) | 0.492 | (0.007) | 0.479 | 0.495 |
| Food-at-Home Prices (in 2005 dollars) | 1.941 | (0.013) | 1.938 | 1.942 |
| Fast-Food Prices (in 2005 dollars) | 4.844 | (0.020) | 4.830 | 4.847 |
| Number of Restaurants (number per 1,000) | 1.832 | (0.021) | 1.818 | 1.836 |
| Smoked Cigarettes (=1 if smokes) | 0.401 | (0.008) | 0.407 | 0.400 |
| Cigarettes Smoked (cigarettes per day) | 3.525 | (0.149) | 3.583 | 3.512 |
| Cigarette Prices (per pack in 2005 dollars) | 3.762 | (0.221) | 3.540 | 3.813 |
| Food Stamp Receipt (during preceding year) | 0.425 | (0.030) | 0.796 | 0.340 |
| Urbanization (population/square miles) | 1.372 | (0.345) | 1.365 | 1.373 |
| **Demographic Characteristics** | | | | |
| Male (=1 if male) | 0.535 | (0.007) | 0.521 | 0.538 |
| Black (=1 if black) | 0.135 | (0.013) | 0.201 | 0.120 |
| Hispanic (=1 if Hispanic) | 0.119 | (0.018) | 0.151 | 0.111 |
| Age (in years) | 21.633 | (0.016) | 22.228 | 21.497 |
| Education (in years) | 12.878 | (0.059) | 12.708 | 12.917 |
| Household Income ($10,000s in 2005 dollars) | 6.224 | (0.197) | 5.419 | 6.408 |
| Experience (=weeks worked during year/52) | 0.738 | (0.005) | 0.761 | 0.733 |
| Marital Status (=1 if married) | 0.128 | (0.006) | 0.178 | 0.117 |
| Family Size (number in household) | 3.292 | (0.039) | 3.285 | 3.294 |
| Kids (number of children in Household) | 0.605 | (0.016) | 0.668 | 0.591 |
| Children (number of biological children) | 0.252 | (0.012) | 0.357 | 0.228 |
| Year (year of survey) | 2003.73 | (0.018) | 2004.220 | 2003.618 |

Sample means with standard errors in parentheses. There are 35,516 respondent-year observations.

**Table 3: The Effects of Socio-Economic Factors and Demographic Characteristics on Body Mass Index (BMI), the Probability of Being Overweight, and the Probability of Being Obese**

| **Estimates** | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| Socio-Economic Factors | | | | | | |
| Employed | -0.554*** | (0.101) | -0.224*** | (0.041) | -0.368*** | (0.055) |
| Occupational Strength | 0.246*** | (0.036) | 0.074*** | (0.015) | 0.135*** | (0.020) |
| Occupational Fitness | -0.208*** | (0.042) | -0.052*** | (0.017) | -0.106*** | (0.023) |
| Food-at-Home Prices | -0.292 | (0.202) | -0.120 | (0.080) | -0.036 | (0.110) |
| Fast-Food Prices | -0.010 | (0.107) | 0.013 | (0.043) | 0.006 | (0.060) |
| Restaurants | -0.492 | (0.309) | -0.142 | (0.126) | -0.207 | (0.179) |
| Cigarette Smoker | -0.309*** | (0.055) | -0.158*** | (0.022) | -0.078*** | (0.029) |
| Cigarettes Smoked | -0.013*** | (0.003) | -0.004*** | (0.001) | -0.004* | (0.002) |
| Cigarette Prices | -0.001 | (0.001) | -0.001 | (0.001) | -0.001 | (0.003) |
| Food Stamp Receipt | 0.120*** | (0.009) | 0.030*** | (0.004) | 0.046*** | (0.004) |
| Urbanization | -0.025*** | (0.004) | -0.009*** | (0.002) | -0.011*** | (0.003) |
| Demographic Characteristics | | | | | | |
| Male | 0.467*** | (0.113) | 0.311*** | (0.049) | -0.192*** | (0.058) |
| Black | 1.356*** | (0.122) | 0.370*** | (0.040) | 0.537*** | (0.052) |
| Hispanic | 1.384*** | (0.098) | 0.507*** | (0.046) | 0.458*** | (0.048) |
| Age | 0.280*** | (0.022) | 0.091*** | (0.009) | 0.107*** | (0.012) |
| Education | -0.140*** | (0.024) | -0.037*** | (0.008) | -0.066*** | (0.011) |
| Household Income | -0.009** | (0.004) | -0.004** | (0.002) | -0.012*** | (0.004) |
| Experience | 0.476*** | (0.101) | 0.172*** | (0.043) | 0.253*** | (0.048) |
| Marital Status | 0.391*** | (0.071) | 0.204*** | (0.026) | 0.202*** | (0.046) |
| Family Size | 0.048** | (0.022) | 0.019** | (0.008) | 0.048*** | (0.016) |
| Kids | -0.019 | (0.056) | 0.008 | (0.017) | -0.042 | (0.026) |
| Children | -0.119** | (0.047) | 0.003 | (0.022) | -0.063*** | (0.022) |
| Weight Measure | BMI | | Overweight | | Obese | |

Standard errors are in parentheses. *$p < 0.10$, **$p < 0.05$, and ***$p < 0.01$. There are 70,394 observations. The models also include state dummy variables and year dummy variables. R-squared values are 0.088 for BMI, 0.051 for the probability of being overweight, and 0.063 for the probability of being obese.

**Table 4: The Effects of Socio-Economic Factors and Demographic Characteristics on Body Mass Index (BMI), the Probability of Being Overweight, and the Probability of Being Obese**

| | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| **Decomposition** | Δ | %Δ | Δ | %Δ | Δ | %Δ |
| Weight Increase ($W_{97}$-$W_{79}$) | 1.685 | | 11.531 | | 9.049 | |
| Socio-Economic Factors | | | | | | |
| Employed | **-0.007** | **-0.394** | **-0.060** | **-0.516** | **-0.049** | **-0.545** |
| Occupational Strength | **-0.017** | **-1.006** | **-0.111** | **-0.963** | **-0.095** | **-1.048** |
| Occupational Fitness | **0.008** | **0.470** | **0.044** | **0.378** | **0.042** | **0.463** |
| Food-at-Home Prices | 0.051 | 3.030 | 0.468 | 4.059 | 0.071 | 0.782 |
| Fast-Food Prices | 0.003 | 0.172 | -0.085 | -0.741 | -0.020 | -0.224 |
| Restaurants | -0.111 | -6.602 | -0.710 | -6.161 | -0.524 | -5.785 |
| Cigarette Smoker | **0.001** | **0.055** | **0.011** | **0.091** | **0.003** | **0.029** |
| Cigarettes Smoked | **0.033** | **1.956** | **0.215** | **1.861** | 0.107 | 1.177 |
| Cigarette Prices | -0.001 | -0.021 | -0.022 | -0.191 | -0.009 | -0.101 |
| Food Stamp Receipt | **-0.013** | **-0.799** | **-0.074** | **-0.641** | **-0.058** | **-0.637** |
| Urbanization | **0.011** | **0.669** | **0.092** | **0.800** | **0.057** | **0.634** |
| Demographic Characteristics | | | | | | |
| Male | **0.001** | **0.083** | **0.021** | **0.180** | **-0.006** | **-0.071** |
| Black | **0.019** | **1.127** | **0.115** | **0.999** | **0.084** | **0.926** |
| Hispanic | **0.084** | **5.010** | **0.690** | **5.986** | **0.311** | **3.442** |
| Education | **0.006** | **0.340** | **0.034** | **0.291** | **0.030** | **0.333** |
| Household Income | **-0.009** | **-0.550** | **-0.084** | **-0.732** | **-0.138** | **-1.526** |
| Experience | **-0.010** | **-0.594** | **-0.080** | **-0.696** | **-0.059** | **-0.655** |
| Marital Status | **-0.102** | **-6.056** | **-1.184** | **-10.266** | **-0.587** | **-6.482** |
| Family Size | **0.023** | **1.381** | **0.204** | **1.772** | **0.260** | **2.869** |
| Kids | -0.002 | -0.111 | 0.017 | 0.144 | -0.046 | -0.504 |
| Children | **0.037** | **2.186** | -0.023 | -0.199 | **0.217** | **2.401** |
| Weight Measure | BMI | | Overweight | | Obesity | |

The decompositions correspond to coefficient estimates presented in table 3. There are 70,394 observations.

**Figure 1**

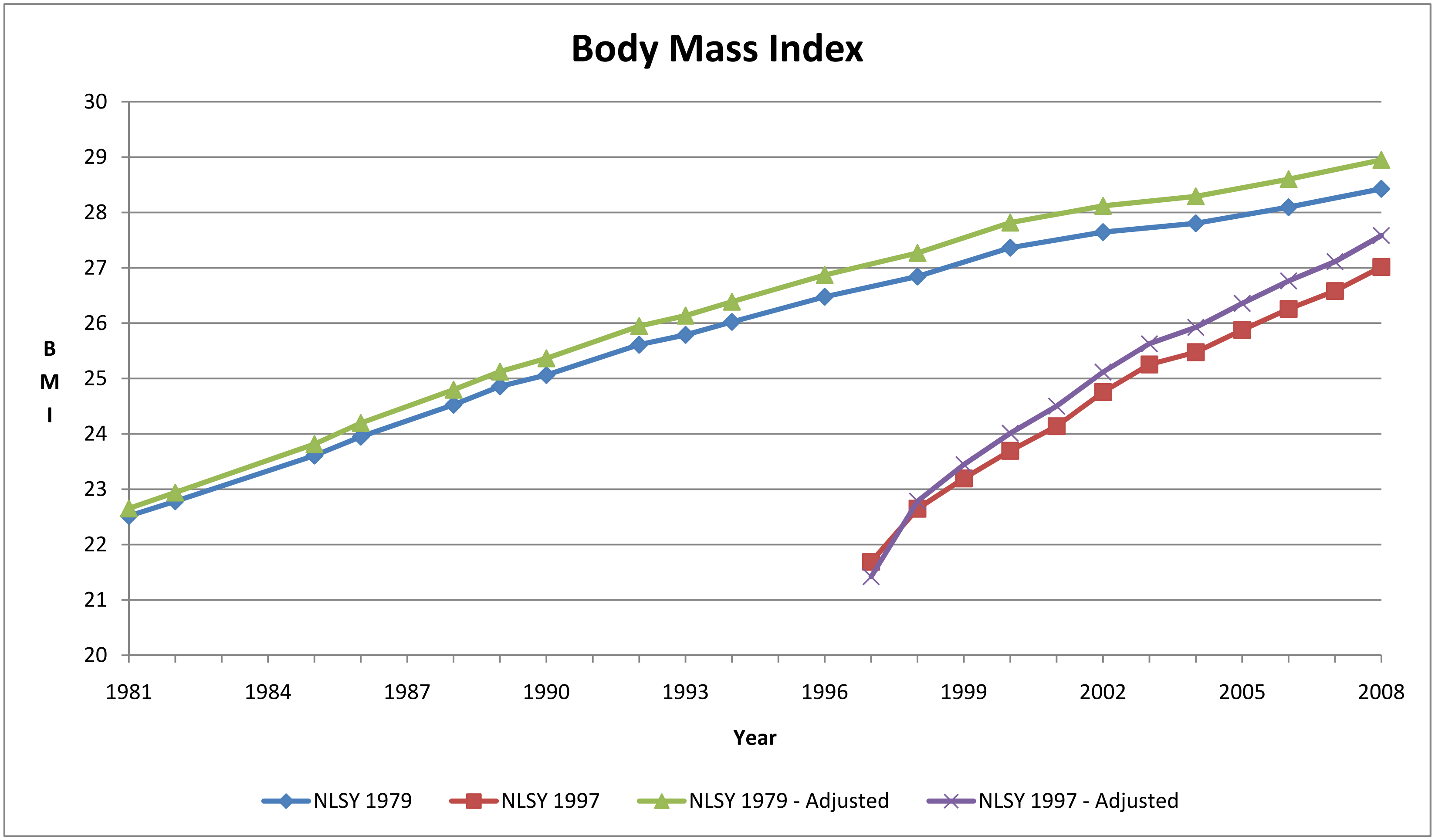
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**Figure 2**

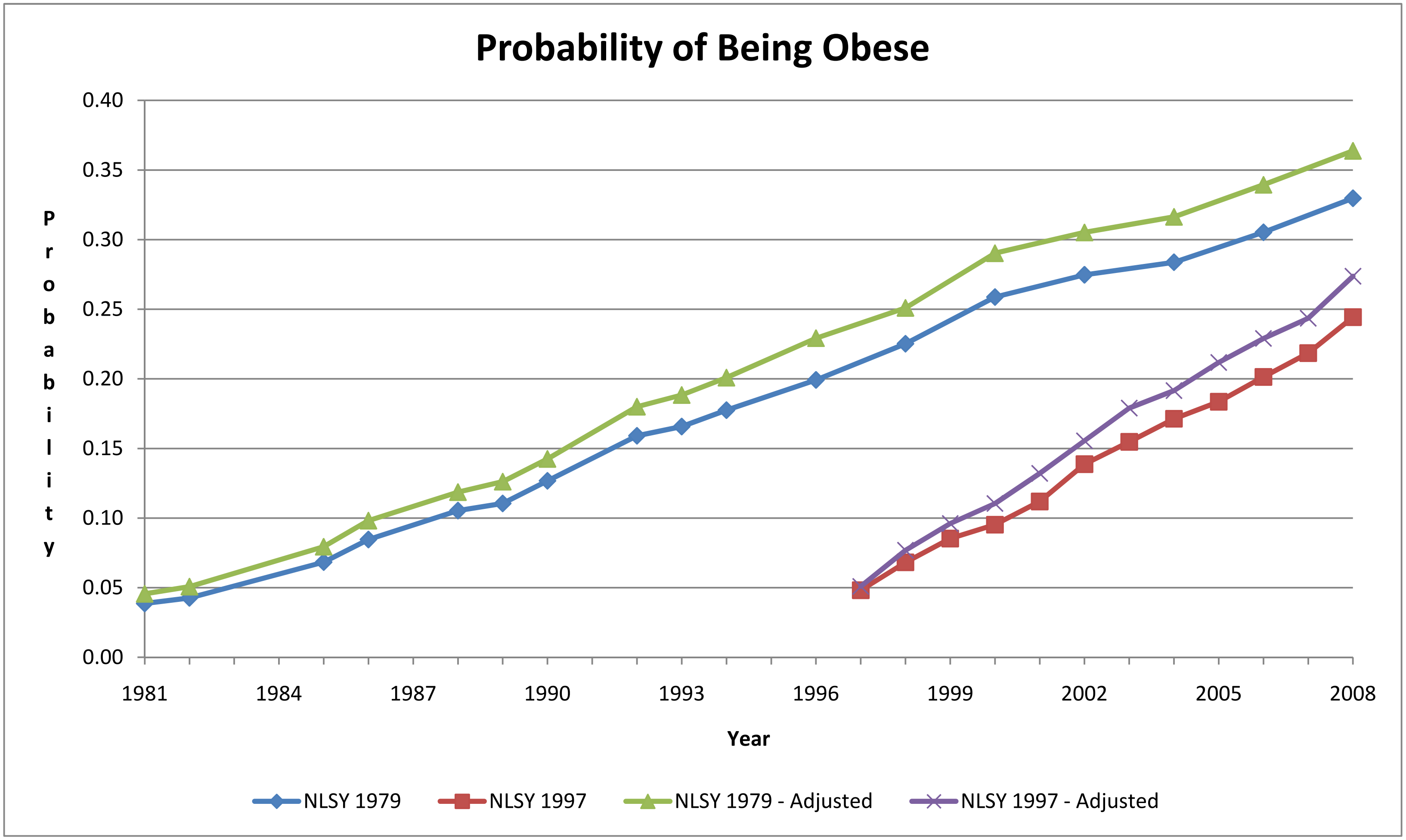
Probability of Being Obese
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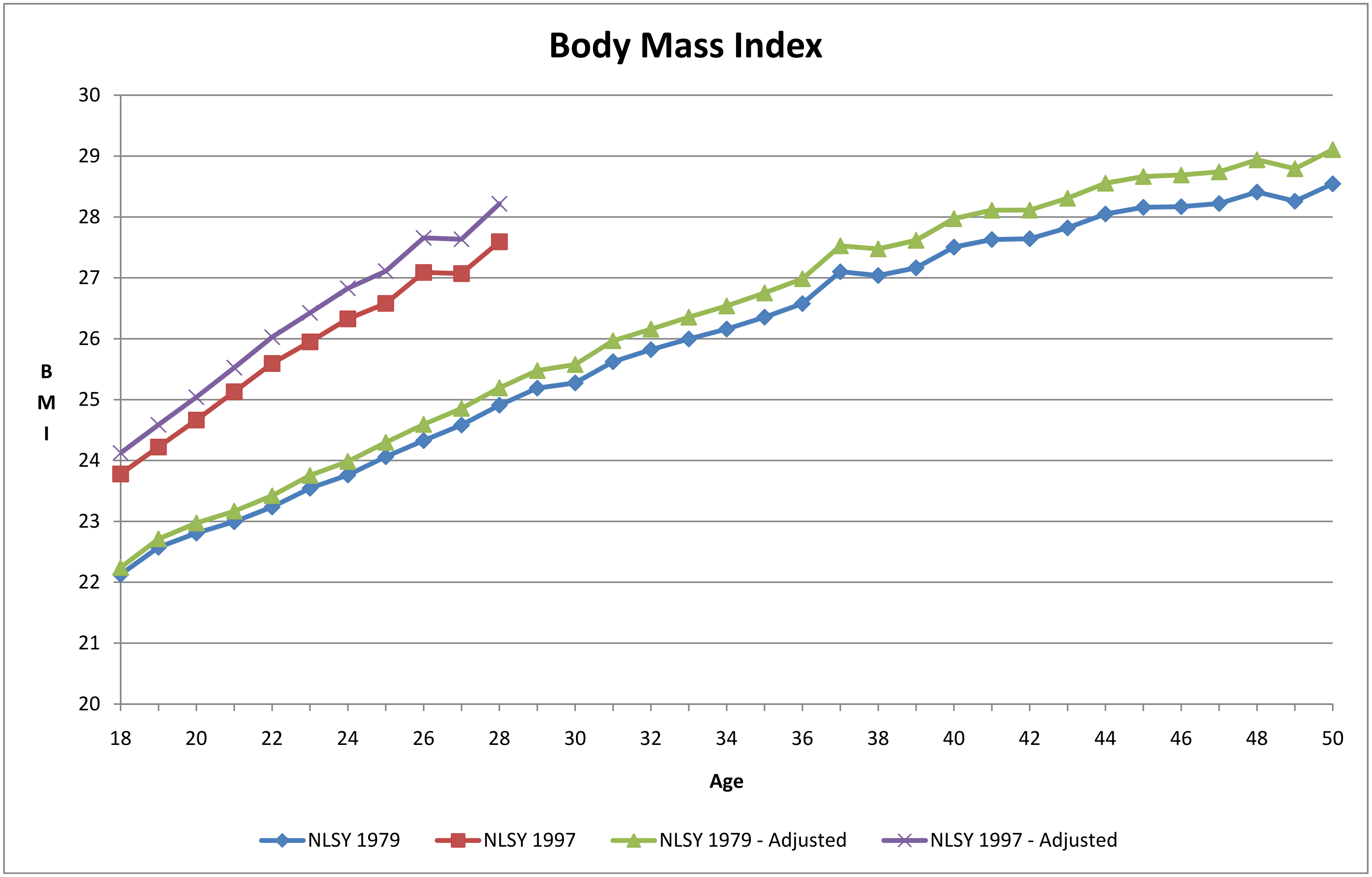
**Figure 3**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Age
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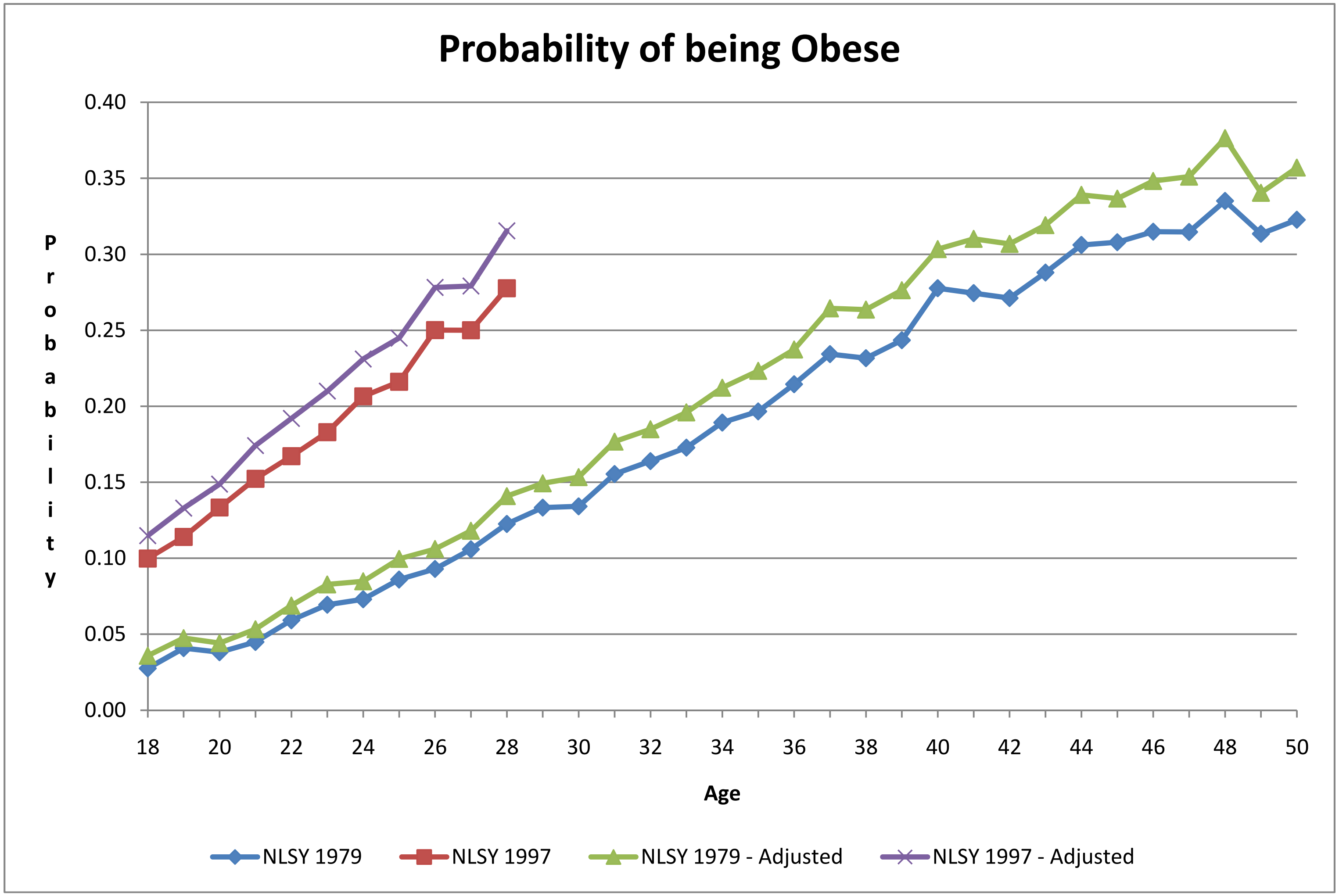
NLSY 1997
NLSY 1979 - Adjusted
NLSY 1997 - Adjusted

**Figure 4**



Probability of being Obese
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Age
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NLSY 1997
NLSY 1979 - Adjusted
NLSY 1997 - Adjusted