Institute for Research on Poverty
Discussion Paper no. 1296-05

An Age-Period-Cohort Analysis of the Rise in the Prevalence of the U.S. Population Overweight and/or Obese

Andrew Cook
Ph.D. Graduate Student
H. John Heinz III School of Public Policy and Management
Carnegie Mellon University
E-mail: ajcook@andrew.cmu.edu

Beth Osborne Daponte, Ph.D.
Senior Research Scholar
Institution for Social and Policy Studies
Yale University
E-mail: beth.daponte@yale.edu

April 2005

We thank the Institute for Research on Poverty for funding this research under the IRP-USDA Small Grants Program. We are grateful to Mel Stephens and Marty Gaynor for their insightful comments.

Abstract

Using data from the National Health Interview Survey for years spanning 1976 to 2001, this paper presents an age-period-cohort analysis of weight gain throughout the life cycle. We find that while all ages experienced an increase in the proportion overweight and/or obese (PO&O), the PO&O of young adults has grown at a faster rate than that of older age groups. We find that the increases in Body Mass Index are primarily due to period effects, not cohort or age effects. From the ordered logistical regression analyses, we find that protective influence of factors such as education, income, and age on an individual's Body Mass Index have decreased over time. The analyses suggest that the increase in PO&O is a phenomenon that all demographic groups in the United States have experienced.

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I. INTRODUCTION

Over the past forty years, the proportion of individuals who are overweight and/or obese (hereafter PO&O) has risen dramatically in the United States, and the most dramatic growth has occurred over the last twenty-five years (Flegal et al. 1998; Hedley et al. 2004; Ogden et al. 2002). While there exist many theories about causes for the increase in Americans' weight, little research has examined the increase in weight between and among cohorts, genders, and races/ethnicities.

Research on PO&O has generally taken two forms: examination of specific practices and policy interventions on PO&O, and examination of the impact of being overweight and/or obese on individuals, health systems, and economic costs. By considering the PO&O of the U.S. population in a broad historical light and using an age-period-cohort analysis, the research presented in this paper contributes to a broader understanding of the increase in PO&O. This study examines:

1. Whether the increases in PO&O are associated with specific age groups, birth cohorts, and races/ethnicities; and
2. Changes in PO&O over the life course of birth cohorts.

We present two analyses of PO&O. The first analysis considers the age, period, and cohort aspects of the changes in the distribution of Body Mass Index (hereafter BMI) during the late twentieth century.

The first analysis considers these questions:

- Was there a specific period when dramatic changes in PO&O occurred?
- Have specific age groups been most afflicted by increases in PO&O?
- Over time, has the trajectory of being overweight and/or obese over the life course fundamentally changed?

In addition to supporting previous research, our results provide new insights into the increase in PO&O. We find that the U.S. adult population has increased its BMI in every five-year period between 1976 and 2001. Males, females, African Americans, Hispanics and non-Hispanic whites have contributed to this trend. We find that the youngest age groups (those 18-32 years) have shown the greatest increases in both their body mass indices and their probabilities of being obese. While adults of all ages show an increase in PO&O, the PO&O of young adults is growing at a faster rate than that of older age groups.

The second analysis examines the probability of being of normal weight, as opposed to overweight or obese, given a set of individual characteristics. It considers these questions:

- Which characteristics are associated with a greater chance of being overweight and/or obese?
- Have the influence of characteristics remained constant over time?

Using ordered logit models and controlling for demographic and socioeconomic characteristics, we find that the probability of having a BMI in excess of normal range has increased significantly between 1976 and 2001. Further, the propensity for Americans to be overweight or obese rather than of normal weight has accelerated.

In the remainder of this paper, we first discuss previous studies that have examined the relationship of overweight and obesity with various economic, social, and environmental influences. Section III discusses the data used in the analyses, measurement issues, and BMI. Section IV presents descriptive statistics, and Section V includes an age-period-cohort analysis. The ordered logit models are then presented. Section VII discusses the growth in the price of food relative to other goods and services. We conclude with policy implications, further discussion, and future research implications.

II. LITERATURE REVIEW

There exists an extensive literature on overweight and obesity. We restrict our review to studies directly relevant to the research at hand—research on the health impact and costs of excess weight, and research on possible societal explanations for the increase in PO&O.

Descriptive Statistics and Health Concerns Related to Obesity

Recent studies show a tremendous increase in PO&O. National Health and Nutrition Examination Survey data from the 1976-1980 and 1999-2002 periods indicate that the age-adjusted prevalence rate of overweight[1] adults 20-74 years of age has increased from 47 percent to 65 percent, and the proportion of the population considered obese (BMI > 30.0) has increased from 15 percent to 30 percent (Hedley et al. 2004; U.S. Department of Health and Human Services 2001:10). The same NHANES data indicate that the prevalence of children 6-19 years of age who are overweight has increased from 6 percent to 16 percent (Hedley et al. 2004, p. 11). To accentuate this growing problem even more, McTigue, Garrett, and Popkin (2002) show that with each later birth cohort, obese young adults have experienced an earlier onset of obesity.

The increased PO&O in the U.S. population is of great concern, in part due to the increased health risks faced by those who are overweight and/or obese (hereafter O&O). O&O adults suffer from an increased susceptibility to such ailments as respiratory restrictions, back pain, and overall physical functional limitations (Lean, Han, and Seidell 1999). The increased prevalence of poor health is exacerbated by an increased probability of further developing chronic health problems, such as Type II diabetes, respiratory disease, and cancers (Calle et al. 2003; Mokdad et al. 2003). O&O children have a greater propensity for functional limitations, and a greater likelihood for becoming O&O adults. Further, O&O often adversely impacts children's mental health (often manifested in the form of low self-esteem) (Friedlander et al. 2003; Neumark-Sztainer and Hannan 2000).

Increased health risks for O&O adults often lead to an increased risk of mortality. In 2000, mortality due to poor diet and physical inactivity reached 400,000, second only to the 435,000 deaths resulting from tobacco (Mokdad et al. 2004). The morbidity impact of O&O is similar to that presented

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[1]Among adults (age≥18), overweight is defined as a BMI greater than or equal to 25.0.

by poverty, smoking, and problem drinking (Sturm and Wells 2001). Young O&O adults are especially susceptible to these effects (Fontaine et al. 2003; Stevens et al. 1998).

American medical expenditures on O&O individuals reached approximately $75 billion in 2003, and one-half of these costs were publicly financed by Medicare and Medicaid (Finkelstein, Fiebelkorn, and Wong 2004). These costs can be attributed to increased expenditures on inpatient and outpatient treatment (36 percent greater for obese over healthy weights[2]), and medications (77 percent greater for obese over healthy weights) (Sturm 2002). Relative to expenditures on adults of healthy weight, total health care costs[3] are 25 percent greater for obese individuals with a BMI between 30.0 and 34.9 and 44 percent greater for adults with a BMI of at least 35.0 (Quesenberry, Caan, and Jacobson 1998). The total cost of O&O to U.S. society, both through increased health care expenditures ($51.5 billion in 1995 to $75 billion in 2003) and decreased economic/labor output, has risen dramatically in recent years (from $99.2 billion in 1995 to $117 billion in 2000), and continues to rise (Finkelstein et al. 2004; U.S Department of Health and Human Services 2001:10; Wolf and Colditz 1998).

The rise in obesity as an economic and health concern is not solely a U.S. problem, although the U.S. leads in rates of O&O among industrialized countries. The World Health Organization recognizes obesity as one of the top ten global health problems (Kelner and Helmuth 2003). Thirty-seven percent of U.S. children and adolescents are O&O, in contrast to 20 percent of their European counterparts (Nash 2003). Between 1985 and 1998, Canada's prevalence of adult obesity increased from 5.6 percent to 14.8 percent, reportedly accounting for $1.8 billion, or 2.4 percent, of total direct medical costs in 1997 (Katzmarzyk 2002).

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[2]Adult healthy weight is defined as a BMI between 18.5 and 24.9, inclusive.

[3]In order not to overestimate total health care costs, it may be more accurate to include the increased mortality among obese people when making calculations (Allison, Zannolli, and Narayan 1999).

Causes of O&O

A number of causes for O&O at a societal level have been introduced in the literature. We present them here, and in the conclusions, revisit them.

Technological Change

In recent years, economists have considered the impact of technological change on PO&O. This strain of research (Cutler, Glaeser, and Shapiro 2003; Lakdawalla and Philipson 2002; Philipson and Posner 1999) supports a theory of increased PO&O resulting from escalating caloric consumption and declining energy expenditures. As technology has become more adept at speeding up food preparation and facilitating consumption, individuals spend more time eating and less time expending energy preparing food. Cutler et al. (2003) further hypothesize that increased caloric intake also has resulted from more meals eaten as opposed to more calories per meal being consumed. Frazao (1999) has shown that daily energy intake has risen over a twenty-year period, but does not offer conclusions as to why.

Technology has allowed people to decrease their physical activity both at home and work. Ewing, Schieber, and Zegeer (2003) find that adults who live in sprawling counties have a higher likelihood of obesity than their urban counterparts, indicating that an increased reliance on machines (e.g., driving instead of walking) reduces caloric expenditures. Caloric expenditures at work have decreased as the nature of work has shifted from being physically taxing to being sedentary. Thus, PO&O is an outcome of broad societal shifts, and although policies might be introduced that could negate the impacts of technological changes, no specific policies have yet been proven successful (Connolly 2003).

Proliferation of Fast Food

Another contributor to the increase in O&O (which is really a corollary of the technological change argument) focuses on the increased consumption of food from “fast food“ establishments. For many, fast food provides an alternative to home meal preparation. Eric Schlosser (2001) depicts the fast food industry as a technological phenomenon that has revolutionized the daily American meal, and in doing so, has significantly contributed to the deterioration of the American diet.

Researchers (Chou, Grossman, and Saffer 2002; Jeffery and French 1998) have concluded that the increased U.S. reliance on fast food meals, which have higher caloric and fat content than meals prepared at home, has contributed to the rise in PO&O. While Jeffery and French (1998) found a marginal relationship between fast food consumption and increased PO&O, Chou et al. (2002) discovered that the increase in fast food and full-service restaurants has had a significantly positive influence on PO&O.

Role of the Food Industry

Food policy researchers have studied the relationship between the food industry and how it represents its products to the public. Nestle (2002) does not isolate the fast food industry in her critique of the declining health and nutritional contents of American meals. Rather, she explores such topics as the food industry's influence on government nutrition policies (i.e., dietary advice and promotion of diet supplements) and the food industry's efforts to promote products in a variety of settings.

Brownell and Horgen (2003) combine the critiques of both Schlosser (2001) and Nestle (2002) in their criticism of the food industry. They blame the food industry for creating what they term "a toxic environment" — an environment that all consumers, but especially children, must carefully navigate in order to eat a healthy diet.

Portion Sizes

Young and Nestle (2002) find that food portions have increased beyond federal standards, contributing to the increase in PO&O. However, Cutler et al. (2003) found that that increased caloric intake has partially resulted from more meals eaten as opposed to more calories consumed per meal.

Physical Activity

An important addendum to the technological innovation theory is how it affects physical activity levels. The sedentary activity of watching television is positively associated with an elevated risk of obesity in women and children (Gortmaker et al. 1996; Hu et al. 2003; Jeffery and French 1998; Robinson, 1999). Haapanen et al. (1997) find that overall physical inactivity is a risk factor for body mass gain and obesity, and Mokdad et al. (2001) conclude that 27 percent of adults do not engage in any physical activity, while another 28 percent are not regularly active. That is, approximately 55 percent of adults do not engage in regular physical activity.

Maternal Decisions

Economists and health professionals have also investigated the impact of maternal decisions on the PO&O among children. Economists have found a positive relationship between the number of hours worked by the mother and the probability of a child being O&O (Anderson, Butcher, and Levin 2002). However, the mechanisms by which this occurs are unknown. Health professionals have focused on how different attributes or decisions by mothers have affected their children's PO&O. One discovery is that maternal O&O is significantly related to a child's increased PO&O (Gortmaker et al. 1996; Strauss and Knight 1999). Daponte (2000) found that among low-income children, being in a two-parent family significantly decreases the probability of a child being an "anthropometric outlier."

Breastfeeding is a maternal decision that seems to affect PO&O. Von Kries et al. (1999) found that breastfeeding is a significant protective factor against PO&O in five- and six-year-olds, while Gillman et al. (2001) observed that adolescents who were breastfed longer had lower age-adjusted mean BMIs and lower rates of O&O.

Rational addiction models, used by economists to explain individuals' propensity to become O&O, were first introduced by Stigler and Becker (1977), and further developed by Becker and Murphy (1988) and Gruber and Koszegi (2001). In these models, individuals make their own decisions as to how much to consume of a good, based on their income and the price of the good. While individuals are aware of how their decisions affect their future health status, they sometimes behave in a way apparently contradictory to rational behavior, seemingly adhering to irrational consumption activities.

Behavioral models present addiction as a preferential choice, similar to models of consumer behavior. These models have interpreted such behaviors as nicotine addiction (Becker, Grossman, and

Murphy 1994), caffeine addiction (Olekalns and Pardsley 1996), and, drawing on a more general self-control model (O'Donoghue and Rabin 1999), overeating (Cawley 1999; Cutler et al. 2003).

The literature suggests a variety of reasons for the presence of O&O in a society. Some of the reasons, such as maternal breastfeeding decisions, would suggest that some cohorts might be affected more than others. Alternative explanations, such as technological change and living in a "toxic environment" suggest that all groups would be affected, but do not necessarily explain abrupt increases in O&O. Rational addiction models predict that the relative price of food would impact PO&O.

III. DATA CONSIDERATIONS

Body Mass Index[4]

Between 1942 and 2000, the definition of overweight has gone through many changes, evolving from weight-for-height standards to sex-specific population references, and eventually to a single measure, body mass index (BMI), defined as:

$$BMI = [(\text{weight in pounds})/(\text{height in inches})^2] \times 703$$

or

$$= [(\text{weight in kilograms})/(\text{height in meters})^2]$$

The advantages of using BMI over other anthropometric measures are that (1) BMI does not rely on age or a reference population, and (2) BMI's acceptance throughout the international community, allowing international comparisons.[5]

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[4]This analysis focuses solely on adults (age ≥ 18). For children, health care professionals use BMI-for-age gender specific charts, broken down into percentiles, to identify three categories: underweight (BMI-for-age ≤ 5th percentile), at risk of overweight (BMI-for age 85th percentile to 95th percentile), or overweight (BMI-for-age ≥ 95th percentile.

[5]Pre-1980, the primary weight standards were sex-specific weight-for-height tables, taken from actuarial data. Starting in 1980, specific reference intervals became more the norm. Over the past twenty-five years, these intervals have gone through many adjustments, eventually leading to BMI cutoff values that were embraced by both the United States and the World Health Organization (WHO). This agreement occurred in 1997, and represented a commonality in how the global community viewed weight and health risk.

The most significant criticism of BMI is that it relies on body weight, not body composition. Extra weight, regardless of whether it is fat or lean muscle, will increase one's BMI. Thus, relying solely on BMI could, in some cases, lead to an incorrect assessment of an individual's health.

Over time, the definition of "overweight" has changed. In this paper, we retrospectively apply the current definition of overweight and obese to historical data. Adults with a BMI between 18.5 and less than 25.0 are considered *normal weight*, between 25.0 and 30.0 are considered *overweight*, and with a BMI in excess of 30.0 are considered *obese.* Our analyses focus on overweight and obesity and do not consider other weight categories such as underweight (BMI<18.5), and severity of obesity (Class I is defined as 30.0≤BMI<35.0; Class II is defined as 35.0≤BMI<40.0; and Class III is defined as (BMI≥40.0).

Our analyses primarily rely upon the National Health Interview Study (NHIS). In addition, the NHANES data set is used to adjust the self-reported height and weight data provided by the NHIS.

<u>National Health Interview Survey</u>[6]

The NHIS, a nationally representative annual health survey conducted by the National Center for Health Statistics (NCHS), is a primary source of information on the health of the civilian, noninstitutionalized, household population in the United States. The NHIS, which administers face-to-face interviews, began in 1957.

Our analysis requires information on the height and weight of individuals over a long period of time. The NHIS started collecting self-reported height and weight for adults in 1976. Our analyses use NHIS data starting in 1976, and every five years hence. The core questionnaire items are revised every

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[6]U.S. Department of Health and Human Services, National Center for Health Statistics. *National Health Interview Survey, 2001* [Computer File]. ICPSR version. Hyattsville, MD.: U.S. Department of Health and Human Services, National Center for Health Statistics [producer], 2003. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 2003.

ten to fifteen years, with the last significant revisions occurring in 1982 and 1997. Thus, we use data from three different questionnaire alterations (1976/1981, 1986/1991/1996, and 2001).

The U.S. Census Bureau collects NHIS data through a personal household interview. The NHIS sample, in which low-income and minority households are oversampled, is redesigned every ten years to concur with census results. In the 1970s and 1980s, African Americans were oversampled, and in more recent years, both African and Hispanic Americans have been oversampled. Weighting the data allows one to arrive at U.S. population characteristics. Unfortunately, starting in 1996, the number of adult interviews that included information on height and weight was reduced. Thus, our sample sizes for 1996 and 2001 are considerably smaller than in the earlier years.

Since our analyses focus on BMI, we remove all observations with missing height and/or weight values, and with outlier values of height and/or weight (height>90 inches and weight>500 pounds).[7] The unknown/missing and removed groups represent 3 percent of the total sample.

With survey data spanning the course of 25 years, various concerns arise related to changes in the survey instrument and the validity and reliability of the data collected. One concern is whether the meanings of variables and their categories have changed over time. In particular, we are concerned about the definition of race, and how this definition changes throughout the 25 years of the survey. The actual composition of the group called Hispanic, which comprises five groups (Cuban, Mexican, Puerto Rican, South/Central American, or other Hispanic) has shifted over time (Bean and Tienda 1991). Between 1990 and 2000, the Hispanic population grew by 58 percent, and the proportion of Hispanics who are "other Hispanic" increased from 23 percent to 28 percent. During this time, the proportion of Hispanics who are

[7]For those individuals with missing or unknown values of height and weight, females are disproportionately more likely to possess unknown weight, black males and other males are disproportionately more likely to possess unknown height and weight, black females are disproportionately more likely to possess unknown height, and Hispanic males and females are more disproportionately more likely to possess unknown height and weight (only for 1996 and 2001). Information is available upon request.

of Mexican, Cuban, or Puerto Rican origin decreased somewhat (Saenz 2004: Table 1). To some extent, Hispanics measured in 1976 are not the same demographic group as those measured in 2001.

Further, measurement error, always of concern when using survey data, is especially of concern when using self-reported height and weight data. Niedhammer et al. (2000) find that self-reported weight and height can be biased by five factors: overweight status and end-digit preference, which interact with age, educational level, and occupation.

Another measurement issue surrounds the use of the floors and ceilings on the height and weight collected by the NHIS. In the first four surveys used (1976, 1981, 1986, and 1991), the minimum height accepted was three feet, and the maximum height accepted was seven feet in 1976 and 1981, and eight feet, two inches in 1986 and 1991. In 1996, the minimum height allowed became four feet 10 inches, which increased to four feet 11 inches in 2001. Considering the floor and ceiling of weight, from 1976 to 1991, the minimum weight accepted was 50 pounds. In 1996, that minimum increased to 97 pounds, and in 2001 it increased to 99 pounds. The weight ceiling grew from 300 pounds in 1976 to 400 pounds in 1981, and then to 500 pounds in 1986, where in stayed in 1991. For some unknown reason, the NHIS then set the weight ceiling in 1996 at 290 pounds, and decreased it to 285 pounds in 2001. People who exceed the ceilings or are below the floors for height and weight are recorded at the ceiling or floor.

The changes in the ceilings and floor tend to downwardly bias the BMIs in 1996 and 2001, but affect mostly the tails of the BMI distribution. It is for this reason that we focus on the medians rather than the means, and examine the data in terms of shifts in weight categories.

Another reason for using the median BMI rather than the mean is that while height tends to be close to normally distributed, weight, and as a result, BMI, are skewed to the right. Thus, since the mean value of BMI would also be biased, we decided to use the median value, which will provide a more accurate middle value of the distribution.

All data in the NHIS, including height and weight, are self-reported. Bound, Brown, and Mathiowitz (1999) and Cawley (2000) have shown that self-reported height and weight are fraught with measurement error and bias. Essentially, they have found that people tend to report themselves as both taller and thinner than they actually measure. Thus, we utilize methodology developed by Bound et al. (1999), and later used explicitly by Cawley (2000), to correct for these errors. To adjust the height and weight, one needs a data set that contains both self-reported and measured height and weight. The National Health and Nutrition Examination Survey (NHANES) provides that link.

National Health and Nutrition Examination Survey III[8]

NHANES aims to obtain nationally representative information on both the health and nutritional status in the United States through interviews and physical examinations. NHANES III is the seventh survey in this series, which began in 1960 as the National Heath Examination Survey (NHES). NHANES III was conducted between 1988 and 1994, and similar to previous surveys in this series, it is based on a multi-stage, stratified, clustered sample of civilian noninstitutionalized populations. It was conducted in two phases, 10/1988-10/1991 and 10/1991-10/1994. A total of 39,695 individuals were sampled, aged two months and older.

We use NHANES data only on adults with both self-reported and measured height and weight information, for whom both gender and race are known. Of those sampled, 20,050 had the opportunity to be both interviewed and examined and 91 percent complied with both.

Adjusting Self-Reported BMI

According to Cawley and Bound et al., having data which contain both measured and reported height and weight allows one to regress the measured value of the variable on its biased reported value.

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[8]U.S. Department of Health and Human Services, National Center for Health Statistics, *National Health and Nutrition Examination Survey III, 1988-1994* [Computer File]. ICPSR version. Washington, D.C.: U.S. Department of Health and Human Services, National Center for Health Statistics [producer], 1996. Ann Arbor, MI: Inter-university Consortium for Political and Social Research [distributor], 1998.

The resulting Ordinary Least Squares (OLS) coefficient on the reported value can then be used in the primary dataset, which in this case would be the NHIS data.[9]

Using the same population for the NHANES III that will be analyzed in the NHIS data, we regress measured weight on reported weight and the square of reported weight (with the mean of the squared reported weight removed to avoid multicollinearity with reported weight):[10]

$$M_{irg} = \alpha + \beta_1 R_{irg} + \beta_2[(R_{irg})^2 - (\overline{R_{rg}\hat{}2})] + \varepsilon_{irg} \qquad [1]^{11}$$

where:

i indexes individuals,

r indexes the four possible races;

g indexes the two genders;

M is the measured weight;

$(R_{irg})^2$ is the square of the reported weight;

$\overline{R_{rg}\hat{}2}$ is the mean of the square reported weight; and

ε is the error term.

The coefficients from these eight regressions are then applied to the self-reported NHIS data to adjust weight, using the following formula:

$$\hat{W}_{irg} = \hat{\alpha} + (S_{irg} \text{ x } \hat{\beta}_1) + [((S_{irg})^2 - (\overline{S_{rg}\hat{}2})) \text{ x } \hat{\beta}_2] \qquad [2]$$

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[9]Cawley (2000) notes that in order to accomplish this adjustment, one has to assume "transportability," which he defines as the relationship between measured and reported values being the same in both the NHIS and the NHANES III. This "transportability" has been verified, and is available upon request.

[10]We estimate the regression by race and gender: non-Hispanic white male, non-Hispanic white female, non-Hispanic black male, non-Hispanic black female, Hispanic male, Hispanic female, other male, and other female. The race defined as "other" consists of individuals who are not white, black or Hispanic, and primarily includes Native Americans, Asians/Pacific Islanders, and Eskimos.

[11]We attempted to include the 14 different age groups (see Table 2A) when estimating the regression, but the sample sizes became too small, leading to lower correlations between self-reported height/weight and adjusted height/weight.

Equation 2 is a straightforward calculation that uses certain values gathered from Equation 1 (denoted by "^"). In this equation,

$\hat{W}$ is the adjusted weight, $\hat{\alpha}$ is the intercept from equation 1;

S is the NHIS reported weight;

$\hat{\beta}_1$ the coefficient on NHANES reported weight from equation 1;

$\overline{S_{rg}\hat{}2}$ is the mean of the square NHIS reported weight; and

$\hat{\beta}_2$ is the coefficient on the NHANES square of reported weight.

We perform the same set of analyses and calculations for self-reported height. We then calculate the adjusted BMI using these new values for height and weight.

In almost every case, both the mean and median adjusted values of BMI, overweight, and obese (disaggregated by race and gender) exceed those values calculated from self-reported weight and height.[12] We run simple correlations in order to compare the similarities between adjusted and unadjusted values, and obtain results similar to Chou et al. (2002). The simple correlation coefficient between adjusted and unadjusted BMI is greater than 0.99. The simple correlation coefficient between the adjusted and unadjusted overweight indicator is 0.88, and between the adjusted and unadjusted obesity indicator is 0.84. Thus, for each indicator, the correlation is considerable. Comparing the BMIs we obtained with work done by Flegal et al. (1998) and Hedley et al. (2004), we find that our statistics are similar.

IV. INITIAL STATISTICS AND TRENDS

Table 1A presents summary statistics gleaned from the NHIS. The data presented represent the aggregation of the surveys for the years 1976, 1981, 1986, 1991, 1996, and 2001, with an aggregated

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[12]This information is available upon request. Adjusted values are lower then self-reported values only for non-Hispanic black male BMI and percent at least overweight. The aggregated U.S. adult population BMI mean increased from 24.97 to 25.68 (2.8 percent), while the median increased from 24.33 to 24.92 (2.4 percent).

Table 1A
Summary Statistics from the NHIS

Variable	Sample %	Median BMI	% At Least Overweight	% Obese
At Least Overweight (BMI>=25.0)	49.2%	28.3	100.0%	34.0%
At Least Obese (BMI>=30.0)	16.7	32.9	100.0	100.0
Females	53.4	24.1	43.4	17.7
Males	46.6	25.6	55.7	15.6
Non-Hispanic Black	11.6	25.7	55.8	23.9
Hispanic	7.5	26.8	66.3	26.5
Other	3.5	24.1	41.2	12.9
Non-Hispanic White	77.4	24.7	46.9	14.9
Year=1976	21.5	24.1	40.4	11.2
Year=1981	21.3	24.2	42.0	12.7
Year=1986	12.4	24.7	47.5	15.4
Year=1991	24.0	25.3	52.9	18.3
Year=1996	12.3	26.0	59.3	23.1
Year= 2001	8.5	27.0	66.6	28.9
Educ.: Less Than High School	25.7	25.7	55.5	21.3
Education: High School	36.7	24.8	48.5	16.7
Education: Some College	19.1	24.6	46.5	15.3
Educ.: At Least Bachelor's Deg.	17.5	24.4	44.1	11.6
Education: Unknown	1.0	24.8	48.5	15.5
Marital Status: Married or Union	64.4	25.2	51.9	16.9
Marital Status: Sep. or Divorced	9.3	25.2	51.7	20.6
Marital Status: Never Married	18.4	23.6	36.8	12.6
Marital Status: Widowed	7.7	25.0	53.2	20.2
Marital Status: Unknown	0.2	25.4	49.8	17.4
Poverty Income Ratio: 0.00-0.49	3.1	24.7	47.6	20.8
Poverty Income Ratio: 0.50-0.99	7.8	25.4	52.7	22.6
Poverty Income Ratio: 1.00-1.29	5.8	25.3	52.1	19.6
Poverty Income Ratio: 1.30-1.84	8.9	25.3	52.9	20.0
Poverty Income Ratio: 1.85-2.49	13.8	24.9	49.4	16.8
Poverty Income Ratio: 2.50-3.99	28.9	24.7	46.8	14.5
Poverty Income Ratio: 4.00+	18.2	24.8	48.3	14.2
Poverty Income Ratio: Unknown	12.4	25.0	49.9	16.9
Nonrural Location	73.9	24.9	48.8	16.4
Rural Location	26.1	25.0	50.3	17.6
Region: Midwest	25.1	25.0	49.6	16.9
Region: Northeast	21.6	24.9	49.3	15.9
Region: South	33.2	25.0	50.1	18.1
Region: West	20.1	24.7	47.0	15.1
Major Activity: Working	59.8	25.1	50.6	16.4
Major Activity: Retired	3.2	24.7	46.7	10.4
Major Activity: Other	37.0	24.6	47.0	17.8

(table continues)

Table 1A, continued

Variable	Sample %	Median BMI	% At Least Overweight	% Obese
Age= 18-22	10.5	22.6	26.9	7.5
Age= 23-27	10.9	23.6	36.8	11.5
Age= 28-32	11.1	24.4	44.4	14.8
Age= 33-37	10.4	25.0	49.7	17.1
Age= 38-42	9.4	25.5	54.3	19.5
Age= 43-47	8.4	25.7	56.8	20.7
Age= 48-52	7.6	26.0	59.5	22.1
Age= 53-57	7.0	26.1	59.9	21.4
Age= 58-62	6.3	26.0	59.9	21.2
Age= 63-67	5.7	26.0	59.0	20.5
Age=: 68-72	4.8	25.7	56.9	18.9
Age= 73-77	3.6	25.3	53.3	16.4
Age= 78-82	2.4	24.7	47.2	12.8
Age= 83+	1.8	23.7	37.4	9.0
15 Year Age Group: 18-32	32.5	23.5	36.2	11.4
15 Year Age Group: 33-47	28.2	25.4	53.4	19.0
15 Year Age Group: 48-62	21.0	26.0	59.7	21.6
15 Year Age Group: 63-77	14.1	25.7	56.8	18.9
15 Year Age Group: 78 up	4.2	24.3	42.9	11.1

Notes: Number of total observations in the sample is 352,760 (1976 - 75,822; 1981 - 75,250; 1986 - 43,747; 1991 - 84,507; 1996 - 43,395; and 2001 - 30,039). All BMI results are based on adjusted values of height and weight. Overweight is defined as a BMI >= 25.0; obese is defined as a BMI >= 30.0.

number of individuals of 352,760. The sample size for each of the utilized survey years ranges from 30,039 in 2001 to 84,507 in 1991. All BMIs considered here are adjusted. The table displays three aspects of the BMI—median BMI, the percentage at least overweight, and the percentage obese. The table shows that the median BMI has increased between each five-year period, with the greatest absolute increase occurring between 1996 and 2001. During this later period, the median BMI grew by 1.0, resulting in a median BMI in 2001 of 27.0, well above the overweight threshold of 25.0.

The BMI summary statistics differ between women and men, women being less likely to be overweight but more likely to be obese. Considering race/ethnicity, non-Hispanic whites and “other” races display median BMIs below 25.0, whereas non-Hispanic blacks and Hispanics have a median BMI well above 25.0. BMI is inversely related to educational level, measured categorically. BMI also is inversely related to household income, measured as an individual’s household income relative to its poverty threshold.

People who were ever married display a higher BMI than those who have never been married (median BMI in excess of 25.2 versus 23.6, respectively). Considering region of the country, compared with Midwesterners and Southerners, those who live in the West and Northeast show a lower BMI. People who work display a higher BMI than those who do not work. Considering age, those 18-32 have the lowest BMI, which peaks at the age of 48-62, and then decreases in old age.

We further disaggregate young adults by survey year. Table 1B shows that between 1976 and 2001, the median BMI of young adults grew from 22.8 to 25.8, with 40 percent of the growth occurring in the first 15 years (1976 – 22.8 to 1991 – 24.0), and the remaining 60 percent occurring over the final 10 years (1991 – 24.0 to 2001 – 25.8). The proportion overweight doubled in 25 years, and the proportion obese more than tripled. Not only has being overweight greatly increased in prevalence, but given that one is overweight, there is a higher chance that one is obese. In 1976, 26 percent of those who were overweight were obese, and by 2001, this proportion grew to 41 percent. This is particularly worrisome because one’s BMI trajectory is determined, in part, by the weight at which one is earlier in life. Similar to the study by McTigue et al. (2002), our results show that later birth cohorts of U.S. adults are

Table 1B
Statistics on the 18-32 Age Group, by Survey Year

Survey Year	Sample %	Median BMI	% At Least Overweight	% At Least Obese
1976	35.5%	22.8	28.1%	7.4%
1981	35.6	22.9	28.9	7.9
1986	34.0	23.4	34.4	10.0
1991	30.4	24.0	40.7	13.0
1996	28.9	24.9	48.9	17.8
2001	26.1	25.8	57.4	23.5

Notes: Number of total observations in the sample is 352,760 (1976 - 75,822; 1981 - 75,250; 1986 - 43,747; 1991 - 84,507; 1996 - 43,395; and 2001 - 30,039). All BMI results are based on adjusted values of height and weight.

experiencing earlier onset of obesity We now turn to considering BMI trajectories by doing an age-period-cohort analysis of the data.

V. AGE-PERIOD-COHORT ANALYSIS

To consider the impact of age versus cohort versus period effects, we start by exploiting information on the BMIs of age groups by year. Figure 1 displays the median BMI for five-year birth cohorts, and draws connections between five-year age groups. From this figure, one can see how the median BMI changed as a cohort ages through the life cycle. The data available allow us to consider data for nineteen five-year birth cohorts, starting with the BMI of people born before 1883 and ending with the data for the 1979-1983 birth cohort. Because of censoring, the number of data points available for each birth cohort ranges from one to six.

Amazingly, none of the lines cross. Without exception, each subsequent birth cohort shows a similar pattern throughout the life cycle, but with a higher intercept. Also, there seems to be a clear pattern to the BMI: BMI is at a minimum in young adulthood, peaks in late middle age, and then decreases steadily into old age. The graph shows that the 1954-1958 birth cohort entered adulthood with a median BMI of 22.0 (age 18-22), whereas the 1979-1983 birth cohort entered adulthood with a median BMI of approximately 24.6.

Figure 2 displays the percentage of those at least obese by five-year birth cohorts. Here, one observes that the age pattern of obesity naturally is similar to that of the median BMI (Figure 1), but that the slope between the ages seems to be increasing with the most recent birth cohorts.

Another way of examining the data is to use a synthetic cohort approach, where one essentially ages people through the life cycle using a period’s age-specific rates. Figure 3 presents the age pattern of the median BMI by survey year. Again, the lines never cross and the median BMI increases with time for every age group. Figure 4 presents analogous results, but for the percentage obese. Striking aspects include the tremendous increase in obesity among people entering adulthood (the rate has increased from

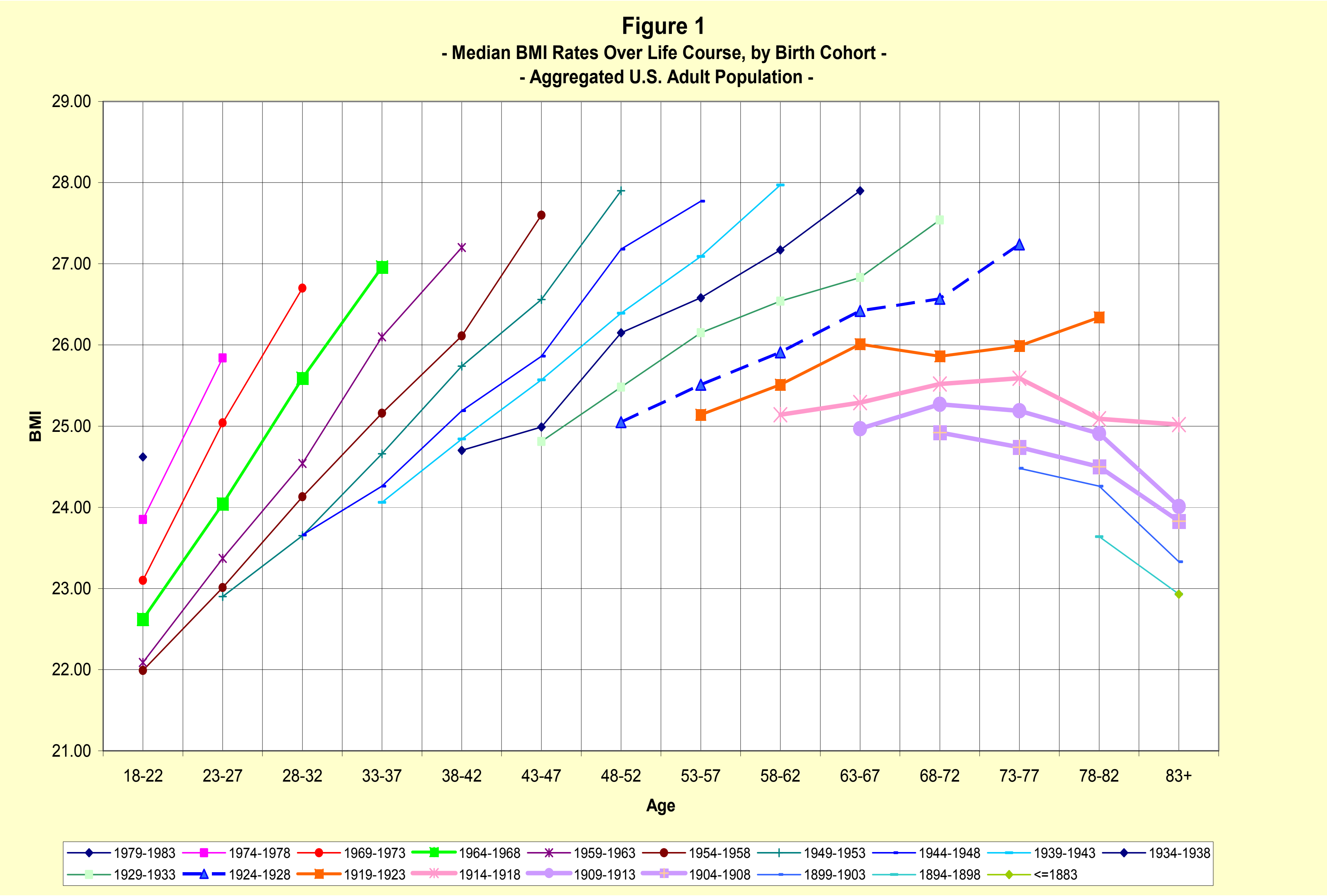


Figure 1
- Median BMI Rates Over Life Course, by Birth Cohort -
- Aggregated U.S. Adult Population -
29.00
28.00
27.00
26.00
25.00
24.00
23.00
22.00
21.00
BMI
18-22
23-27
28-32
33-37
38-42
43-47
48-52
53-57
58-62
63-67
68-72
73-77
78-82
83+
Age
1979-1983
1974-1978
1969-1973
1964-1968
1959-1963
1954-1958
1949-1953
1944-1948
1939-1943
1934-1938
1929-1933
1924-1928
1919-1923
1914-1918
1909-1913
1904-1908
1899-1903
1894-1898
<=1883

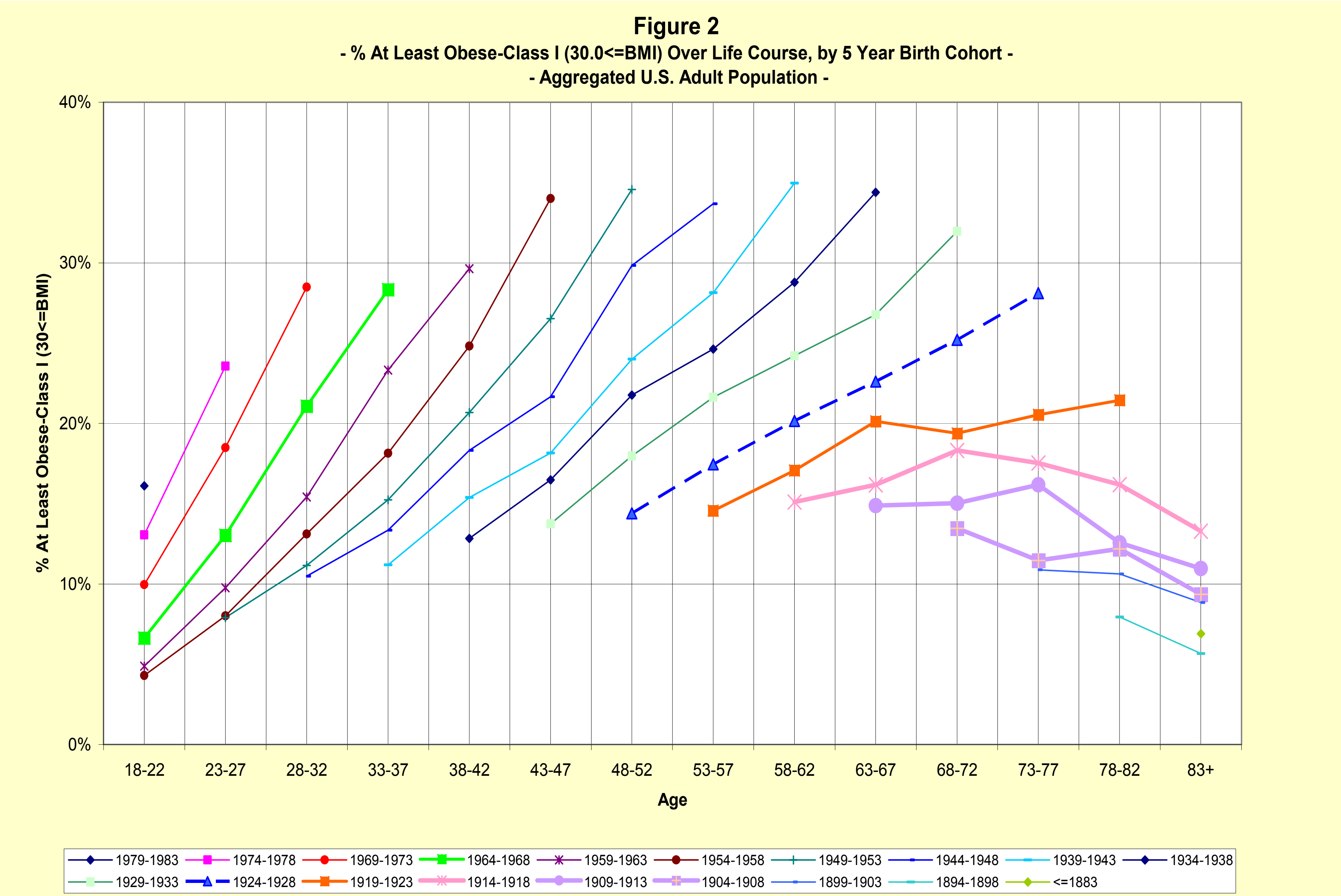


Figure 2
- % At Least Obese-Class I (30.0<=BMI) Over Life Course, by 5 Year Birth Cohort -
- Aggregated U.S. Adult Population -
% At Least Obese-Class I (30<=BMI)
40%
30%
20%
10%
0%
18-22
23-27
28-32
33-37
38-42
43-47
48-52
53-57
58-62
63-67
68-72
73-77
78-82
83+
Age
1979-1983
1974-1978
1969-1973
1964-1968
1959-1963
1954-1958
1949-1953
1944-1948
1939-1943
1934-1938
1929-1933
1924-1928
1919-1923
1914-1918
1909-1913
1904-1908
1899-1903
1894-1898
<=1883

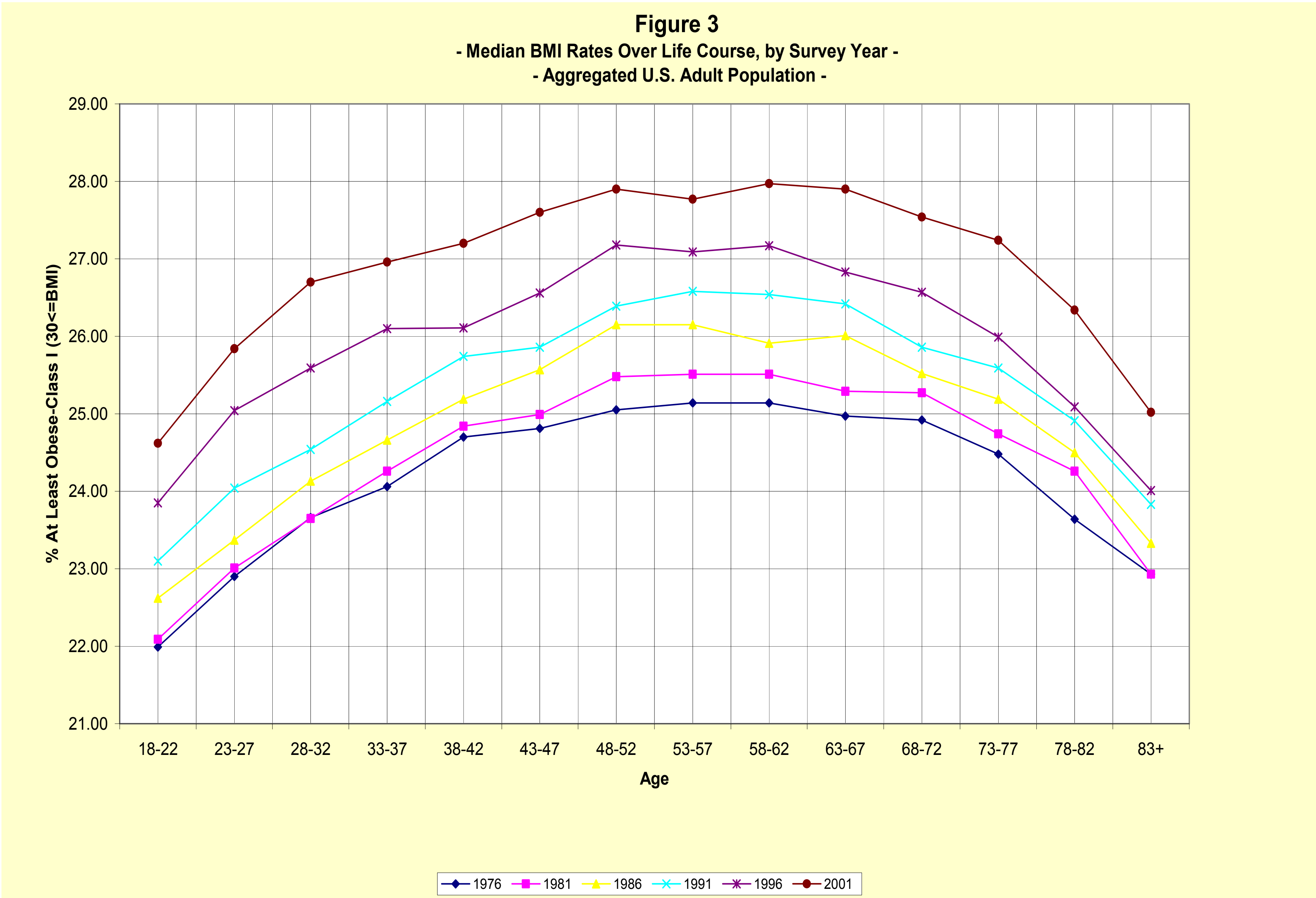
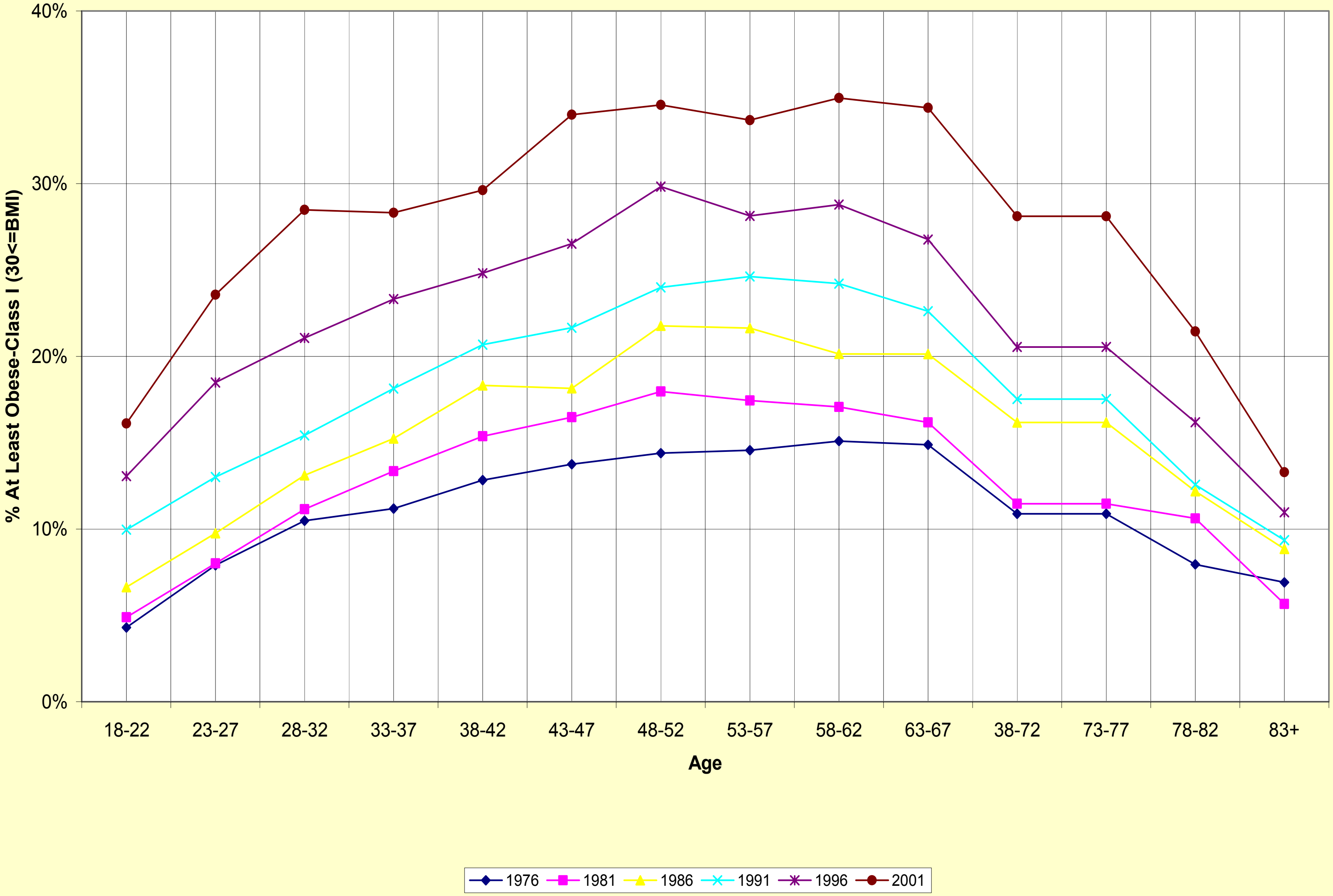


Figure 3
- Median BMI Rates Over Life Course, by Survey Year -
- Aggregated U.S. Adult Population -
29.00
28.00
27.00
26.00
25.00
24.00
23.00
22.00
21.00
% At Least Obese-Class I (30<=BMI)
18-22
23-27
28-32
33-37
38-42
43-47
48-52
53-57
58-62
63-67
68-72
73-77
78-82
83+
Age
1976
1981
1986
1991
1996
2001

Figure 4

- % At Least Obese-Class I (30.0<=BMI) Over Life Course, by Survey Year -

- Aggregated U.S. Adult Population -



4.5 percent to 17.0 percent in 25 years), and an age pattern of obesity that shows peaks among those aged 48-62 years.

We next use Preston and van de Walle's (1978) approach to examining age-period-cohort effects, starting with an initial age-period-cohort matrix that consists of BMI statistics for six five-year intervals, starting in 1976 (the earliest survey year that collected height and weight). Table 2A displays the median BMI for each age group, by period. By examining the O&O rates of a cohort (along the diagonal of the matrix), one can observe these rates as birth cohorts age over time (cohort effects). Alternatively, examining changes across a row shows how an age group has changed (period effects). Considering the BMI within columns demonstrates age effects.

Table 2B displays the median BMI by age for 1976. Then, for subsequent years, the columns display (Median BMI $\text{Age}_{x,\text{year}}$/Median BMI $\text{Age}_{x,\ 1976}$), reflecting the change in an age group's BMI relative to the age group's earliest recorded BMI (1976). If cohort effects dominated the change in BMI, one would observe the number that appears along the diagonals to be more similar than the number that appears in each column. If there was a change in the age pattern, then dissimilarities would appear within columns. Differences between columns are indicative of period changes. Examining Table 2B, we draw two important conclusions:

1. The age pattern of O&O throughout the life course seems to have remained relatively constant since 1976.
2. The largest changes in the median BMI seem to be between periods, not within years or between cohorts.

One can reject the idea that the recent rise in O&O is an artifact of a rise that happened some time ago, which may have caused certain birth cohorts to shift their intercept of O&O but to continue on the same trajectory. What one sees instead is an increase in O&O between five-year intervals, across all age groups. We suspect that if we had analyzed annual data, we would have observed more gradual increases in O&O.

We performed a similar analysis (not shown) separately for each gender and separately for whites and nonwhites. We find that the increases appear to be across survey years and affect every age group.

Table 2A
Median BMI by Age and Year, 1976-2001

Age	1976	1981	1986	1991	1996	2001
18-22	21.99	22.09	22.62	23.10	23.85	24.62
23-27	22.90	23.01	23.37	24.04	25.04	25.84
28-32	23.66	23.65	24.13	24.54	25.59	26.70
33-37	24.06	24.26	24.66	25.16	26.10	26.96
38-42	24.70	24.84	25.19	25.74	26.11	27.20
43-47	24.81	24.99	25.57	25.86	26.56	27.60
48-52	25.05	25.48	26.15	26.39	27.18	27.90
53-57	25.14	25.51	26.15	26.58	27.09	27.77
58-62	25.14	25.51	25.91	26.54	27.17	27.97
63-67	24.97	25.29	26.01	26.42	26.83	27.90
68-72	24.92	25.27	25.52	25.86	26.57	27.54
73-77	24.48	24.74	25.19	25.59	25.99	27.24
78-82	23.64	24.26	24.50	24.91	25.09	26.34
83+	22.93	22.93	23.33	23.83	24.01	25.02

Table 2B
Indices of Change from Median BMI by Age and Year, 1976–2001

Age	1976 Median BMI=(a)	Med. BMI 1981/(a)	Med. BMI 1986/(a)	Med. BMI 1991/(a)	Med BMI 1996/(a)	Med. BMI 2001/(a)
18–22	21.99	1.00	1.03	1.05	1.08	1.12
23–27	22.90	1.00	1.02	1.05	1.09	1.13
28–32	23.66	1.00	1.02	1.04	1.08	1.13
33–37	24.06	1.01	1.02	1.05	1.08	1.12
38–42	24.70	1.01	1.02	1.04	1.06	1.10
43–47	24.81	1.01	1.03	1.04	1.07	1.11
48–52	25.05	1.02	1.04	1.05	1.09	1.11
53–57	25.14	1.01	1.04	1.06	1.08	1.10
58–62	25.14	1.01	1.03	1.06	1.08	1.11
63–67	24.97	1.01	1.04	1.06	1.07	1.12
68–72	24.92	1.01	1.02	1.04	1.07	1.11
73–77	24.48	1.01	1.03	1.05	1.06	1.11
78–82	23.64	1.03	1.04	1.05	1.06	1.11
83+	22.93	1.00	1.02	1.04	1.05	1.09

Notes: Data are described in text. An index of change of 1.0 indicates that the median BMI for a particular age in a particular year did does not differ from the median BMI in 1976 for the respective age group. Indices above 1.0 indicate an increase in the median BMI.

We find no evidence that increases in BMI are the result of a sudden shift that might have happened some time ago, and the aging of people through the life course.

VI. ORDERED LOGIT MODELS

We use individual-level data from the NHIS to examine the probability of an individual being either of normal weight, overweight, or obese. Because the dependent variable is an inherent continuous latent variable having three categories and two threshold points,[13] we use an ordered logit model. The general form of the model is:

$$P(y=m|x) = F(\tau_m - x\beta) - F(\tau_{m-1} - x\beta)$$

where x represents various characteristics and τ represents the threshold point between the categories. This model considers the probability of moving to the category away from normal weight, or the probability of moving up a weight category. The categorical independent variables (x) include survey year (1976 omitted), age (ages 48-62 omitted), gender (males omitted), race (non-Hispanic whites omitted), education (high school omitted), marital status (never married omitted), urbanicity (nonrural omitted), region (East omitted), and working status (working omitted).

Table 3A[14] displays two models—one with only the main effects of the considered variables, and the other with the main effects plus interactions. The greater the coefficient, the more likely the group is to be in the higher BMI category than the next lower BMI category (e.g., obese vs. overweight; or overweight vs. normal weight).

We find that after controlling for all other factors, the variables which seem to have the most impact on the probability of moving to a higher BMI category are the ones that indicate survey year. Further, the coefficients of the survey year variables suggest that the probability of being obese or

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[13]The threshold between normal weight and overweight is BMI = 25.0, while the threshold between overweight and obese is BMI = 30.0.

[14]Odds ratios are available upon request.

Table 3A
Ordered Logistic Regression for Estimating the Probability of an Individual Being Overweight or Obese

Dependent Variable: Overweight/Obese	Main Effects Model		Main Effects + Survey Year Interactions	
Individual Characteristics	Estimate	Std. Error	Estimate	Std. Error
Intercept 1	-0.162**	0.016	-0.192**	0.020
Intercept 2	-1.866**	0.016	-1.900**	0.020
Survey Year: 1981	0.105**	0.010	0.183**	0.022
Survey Year: 1986	0.350**	0.012	0.431**	0.027
Survey Year: 1991	0.572**	0.010	0.637**	0.022
Survey Year: 1996	0.800**	0.012	0.797**	0.027
Survey Year: 2001	1.124**	0.014	1.009**	0.030
Age: 18–32	-0.836**	0.010	-0.825**	0.020
Age: 33–47	-0.261**	0.009	-0.217**	0.020
Age: 63–77	-0.160**	0.012	-0.114**	0.024
Age: 78+	-0.785**	0.019	-0.647**	0.042
Non-Hispanic Black	0.422**	0.011	0.381**	0.026
Hispanic	0.667**	0.013	0.485**	0.034
Other	-0.161**	0.019	0.434**	0.040
Gender: Female	-0.382**	0.007	-0.388**	0.015
Education: Less Than High School	0.186**	0.009	0.182**	0.009
Education: Some College	-0.085**	0.009	-0.086**	0.009
Education: At Least Bachelor's	-0.319**	0.010	-0.318**	0.010
Education: Unknown	-0.080*	0.034	-0.086*	0.034
Marital Status: Ever Married	0.344**	0.010	0.346**	0.011
Poverty Income Ratio: 0.00–0.99	0.153**	0.012	0.151**	0.012
Poverty Income Ratio: 1.00–1.84	0.100**	0.010	0.100**	0.010
Poverty Income Ratio: Unknown	-0.054**	0.011	-0.055**	0.011
Location: Rural	0.133**	0.008	0.132**	0.008
Region: Midwest	0.027**	0.010	0.027**	0.010
Region: South	-0.079**	0.009	-0.078**	0.009
Region: West	-0.172**	0.010	-0.168**	0.010
Working Status: Not Working	-0.072**	0.008	-0.069**	0.008
1981*Age18–32	-------	-------	-0.106**	0.028
1981*Age33–47	-------	-------	-0.055	0.028
1981*Age63–77	-------	-------	-0.061	0.033
1981*Age78+	-------	-------	-0.054	0.058
1986*Age18–32	-------	-------	-0.082*	0.033
1986*Age33–47	-------	-------	-0.066*	0.033
1986*Age63–77	-------	-------	-0.040	0.049
1986*Age78+	-------	-------	-0.130*	0.066

(table continues)

Table 3A, continued

Dependent Variable: Overweight/Obese	Main Effects Model		Main Effects + Survey Year Interactions	
Individual Characteristics	Estimate	Std. Error	Estimate	Std. Error
1991*Age18–32	--------	--------	-0.011	0.028
1991*Age33–47	--------	--------	-0.061*	0.027
1991*Age78+	-------	-------	-0.174**	0.054
1996*Age18–32	-------	-------	0.052	0.033
1996*Age33–47	-------	-------	-0.076*	0.032
1996*Age63–77	-------	-------	-0.112**	0.039
1996*Age 78+	-------	-------	-0.303**	0.064
2001*Age18–32	-------	-------	0.184**	0.038
2001*Age33–47	-------	-------	-0.001	0.036
2001*Age63–77	-------	-------	0.017	0.043
2001*Age78+	-------	-------	-0.174**	0.064
1981*Non-Hispanic Black	-------	-------	-0.041	0.037
1981*Hispanic	-------	-------	0.134**	0.046
1981*Other	-------	-------	-0.655**	0.064
1986*Non-Hispanic Black	-------	-------	-0.024	0.038
1986*Hispanic	-------	-------	0.127*	0.052
1986*Other	-------	-------	-0.526**	0.069
1991*Non-Hispanic Black	-------	-------	0.110**	0.033
1991*Hispanic	-------	-------	0.221**	0.042
1991*Other	-------	-------	-0.849**	0.054
1996*Non-Hispanic Black	-------	-------	0.149**	0.039
1996*Hispanic	-------	-------	0.161**	0.042
1996*Other	-------	-------	-0.903**	0.063
2001*Non-Hispanic Black	-------	-------	0.020	0.044
2001*Hispanic	-------	-------	0.313**	0.044
2001*Other	-------	-------	-0.590**	0.068
1981*Female	-------	-------	-0.007	0.021
1986*Female	-------	-------	-0.024	0.024
1991*Female	-------	-------	-0.051**	0.020
1996*Female	-------	-------	0.092**	0.023
2001*Female	-------	-------	0.108**	0.026
Degrees of Freedom	26		66	
- 2 Log Likelihood	673,641		672,989	
McFadden's-R^2 =	0.053		0.054	

Notes:
*= significant at P=.05, **=significant at P=.01.
N=352,760
Omitted categories are survey year=1976; age group= 48-62; non-Hispanic white; males; high school education; never married; income to poverty ratio>185%; urban; region=Northeast; working status=working.

overweight, rather than of normal weight, has increased steadily over time. The odds ratios of the coefficients suggest that after controlling for other factors, the likelihood of moving up a weight category in 2001 was triple that of 1976.

Considering age, the model reinforces the findings from the age-period-cohort analysis. After controlling for other characteristics, young adults are most likely to be of normal weight. The probability of moving to a higher BMI category increases with age, peaking at ages 48-62. The probability then decreases into old age.

With respect to the control variables, females are less likely than males to move to higher BMI categories. Of all of the race/ethnicity groups, Hispanics have the highest likelihood of moving to a higher BMI category. With respect to education, the probability of moving to a higher BMI category decreases as education increases. Those ever married are less likely to be of normal weight, as are those who live in the Midwest. Surprisingly, after controlling for other characteristics, those that live in the South and the West are more likely to be of normal weight.

To the main effects model, we added interactions reflecting the interaction between survey year and age. Here, we find that the advantage of being young has decreased with time. Starting in 1996, the coefficient of the interaction between survey year and age 18-32 became positive and significant.

Considering race/ethnicity, we find that not only are Hispanics most likely to move to a higher BMI category, but their likelihood has increased with each survey year. Considering gender, starting in 1996, the advantage that females once held over males with respect to BMI started to decrease.

To see whether the impacts of variables have changed over time, we ran the main effects model separately for each year (Table 3B[15]). Here, we observe that between 1996 and 2001, the probability differential of moving to a higher BMI category among the age groups seems to have flattened somewhat. Since 1991, women are losing the advantage that they have held over men in this respect. Considering

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[15]Odds ratios are available upon request.

Table 3B
Results of Ordered Logit, Considered Separately for Each Year

Variable	1976 Coeff.	1976 Std. Error	1981 Coeff.	1981 Std. Error	1986 Coeff.	1986 Std. Error	1991 Coeff.	1991 Std. Error	1996 Coeff.	1996 Std. Error	2001 Coeff.	2001 Std. Error
Intercept 1	-0.268**	0.033	-0.116**	0.033	0.255**	0.042	0.511**	0.030	0.626**	0.041	0.851**	0.049
Intercept 2	-2.040**	0.034	-1.817**	0.034	-1.438**	0.042	-1.194**	0.031	-1.044**	0.041	-0.829**	0.049
Age: 18-32	-0.776**	0.022	-0.874**	0.022	-0.914**	0.029	-0.878**	0.021	-0.804**	0.029	-0.678**	0.034
Age: 33-47	-0.210**	0.020	-0.260**	0.021	-0.279**	0.027	-0.288**	0.019	-0.307**	0.025	-0.226**	0.030
Age: 63-77	-0.126**	0.025	-0.185**	0.025	-0.169**	0.033	-0.184**	0.024	-0.201**	0.033	-0.080*	0.039
Age: 78+	-0.674**	0.044	-0.721**	0.043	-0.794**	0.054	-0.813**	0.036	-0.906**	0.051	-0.769**	0.052
Non-Hispanic Black	0.388**	0.027	0.334**	0.028	0.358**	0.030	0.475**	0.022	0.512**	0.030	0.425**	0.036
Hispanic	0.467**	0.035	0.608**	0.033	0.610**	0.042	0.705**	0.027	0.646**	0.028	0.870**	0.033
Other	0.425**	0.041	-0.200**	0.050	-0.103	0.056	-0.422**	0.037	-0.478**	0.048	-0.137*	0.055
Female	-0.388**	0.016	-0.399**	0.016	-0.416**	0.019	-0.440**	0.014	-0.293**	0.019	-0.267**	0.022
Educ: < HS	0.268**	0.019	0.245**	0.019	0.170**	0.026	0.124**	0.019	0.060*	0.027	0.065	0.034
Educ: Some College	-0.130**	0.023	-0.119**	0.022	-0.110**	0.027	-0.091**	0.018	-0.034	0.025	-0.050	0.029
Educ: BA +	-0.217**	0.024	-0.351**	0.022	-0.306**	0.027	-0.336**	0.018	-0.313**	0.025	-0.381**	0.031
Educ: Unknown	-0.017	0.067	0.030	0.078	-0.113	0.100	-0.147*	0.072	-0.139	0.085	-0.174	0.127
Ever Married	0.470**	0.025	0.473**	0.024	0.316**	0.030	0.261**	0.021	0.284**	0.028	0.229**	0.031
< 100% poverty	0.160**	0.028	0.142**	0.026	0.162**	0.037	0.216**	0.027	0.215**	0.035	-0.033	0.036
1.0-1.84% poverty	0.119**	0.022	0.136**	0.023	0.112**	0.029	0.118**	0.021	0.163**	0.028	-0.092**	0.028
Income Unknown	-0.015	0.027	-0.066*	0.027	-0.022	0.028	-0.056**	0.018	-0.028	0.026	-0.213**	0.047
Location: Rural	0.117**	0.017	0.116**	0.017	0.129**	0.023	0.154**	0.016	0.123**	0.024	0.155**	0.028
Region: Midwest	-0.049*	0.021	0.036	0.021	0.042	0.027	0.036	0.019	0.007	0.028	0.176**	0.034
Region: South	-0.186**	0.021	-0.109**	0.021	-0.102**	0.026	-0.028	0.019	-0.023	0.026	0.056	0.031
Region: West	-0.240**	0.023	-0.242**	0.023	-0.149**	0.029	-0.131**	0.021	-0.110**	0.028	-0.032	0.034
Working Status: Not Working	-0.089**	0.018	-0.082**	0.018	-0.039	0.024	-0.070**	0.017	-0.084**	0.023	-0.016	0.028
Degrees of Freedom	21		21		21		21		21		21	
- 2 Log Likelihood	132,953		134,867		83,644		167,917		89,880		63,497	
McFadden's-R^2	0.040		0.045		0.038		0.038		0.034		0.033	

Notes: See Table 1B for sample sizes by year; *=significant at P=.05; **=significant at P=.01; Omitted categories: age 48-62, males, non-Hispanic white, high school education, never married, >185% poverty, urban, Northeast, and working.

education, in the early years, education was clearly inversely related to the probability of moving to a higher BMI category. Later, though, this pattern is not as pronounced. Similarly, the large difference in the probability of moving to a higher BMI category between those who were ever married versus never married has been decreasing with time. Until 1996, one observed a pattern of an increased probability of moving to a higher BMI category among the poor. By 2001, this pattern disappeared.

Examining minority status, what stands out is that the probability of Hispanics moving to a higher BMI category has increased with each year. That finding is the only exception to the general trend of a flattening of the patterns between groups.

VII. PRICE OF FOOD

The growth in BMI, which affects nearly all age groups, led us to examine whether one plausible explanation could be that the price of food relative to nonfood items decreased during the period, leading people to choose to consume more food. To consider the increase in the price of food relative to nonfood items, we created a ratio of the seasonally adjusted Consumer Price Index for Food for urban consumers to the seasonally adjusted CPI for nonfood items.

Theory suggests that as food becomes cheaper, people will consume more of it. Figure 5 shows that the median BMI of all groups increased in the 1976-1981 period, even though, compared with nonfood prices, the price of food grew at a higher rate. But the difference between the rate of growth of food and nonfood items narrowed. The growth in the price of food relative to nonfood items declined from a high of 1.15 in 1980 down to parity around 1983. During this period, the median BMI increased. In the period 1986-1991, the price of food grew at a rate faster than nonfood items, and BMI increased. Since 1992, growth in the price of food has grown at a rate slower than nonfood items, and, as theory predicts, BMI has increased. That is, the median BMI has increased throughout the 1976-2001 period, both in periods where food was becoming relatively more expensive, and in periods where food was becoming relatively less expensive.

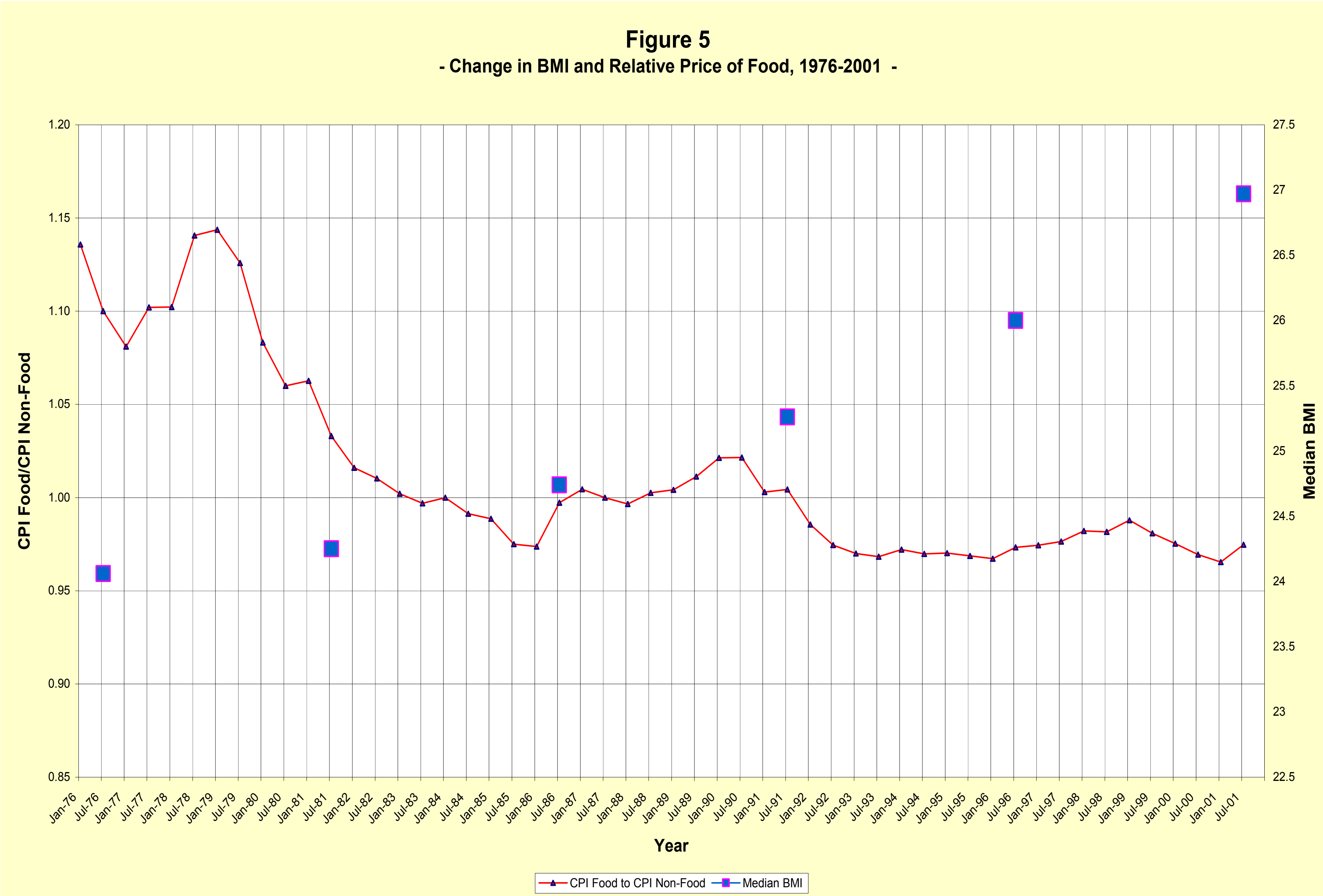

Figure 5
- Change in BMI and Relative Price of Food, 1976-2001 -
CPI Food/CPI Non-Food
Median BMI
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
27.5
27
26.5
26
25.5
25
24.5
24
23.5
23
22.5
Jan-76
Jul-76
Jan-77
Jul-77
Jan-78
Jul-78
Jan-79
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Jan-01
Jul-01
Year
CPI Food to CPI Non-Food
Median BMI

VIII. DISCUSSION

For every age group and for every birth cohort, current BMIs are larger than a previous period's BMI. Further, the growth in PO&O seems to be accelerating with time. Taking into account the characteristics of the population does not mitigate the effect of period on Americans' increased girth.

Since every birth cohort and age group has participated in the increase in BMI, explanations of reasons for the increase in BMI that focus on specific subpopulations miss the big picture. The big picture is that no group has been immune to the increases.

We had expected that one could isolate a particular time period, age group, or cohort that one could note as being the forerunner or forerunning period of the BMI increase. If we had, then one could target policy interventions and design appropriate policy interventions that could help mitigate the situation. We find that period effects dominate. The PO&O increases with every time period, without exception.

This leaves unexplained the question of why Americans' BMI has increased. The reason for the increase may lie somewhere in the American "culture." We reflected back particularly on the 1996-2001 period, when there was an acceleration in the rate of increase in BMI. We thought of President Clinton's morning jogs to McDonald's. We thought of the ubiquitous fast food industry, which not only targets children, but also offers low-cost "supersizing" to make their products seem cheaper in the short term. We thought of family life styles, where the amount of time spent sharing family meals has decreased. But then we asked whether there was really anything different about this time period from previous periods in terms of culture.

Our analysis has provided some new insights into this growing problem of O&O. The U.S. adult population has increased its BMI in every five-year period between 1976 and 2001. While all demographic groups have participated in the increase, there are some groups that showed greater growth than others. One interesting result is that the fastest rising subpopulation in the United States, Hispanics, is also the fastest increasing subpopulation in terms of BMI.

One limitation of our research and the data available is that we have only examined adults. Certainly, many young adults are entering adulthood already overweight or obese, an artifact of their childhood.

The ordered logit models showed that the probability of being obese versus overweight, and overweight versus normal weight, has decreased in every five-year period, after controlling for a host of factors. Between 1976 and 2001, the probability of the U.S. adult population being obese has tripled. Much of this analysis provides support to our earlier results. For instance, women are closing in on men in terms of possessing similar probabilities of being obese. Black and Hispanic females possess the highest probabilities of being obese, with black women leading in this respect. Hispanics hold the top spot for men. When we disaggregate by year, the results yield further support to an important result: the youngest age groups are increasing their likelihood of being obese at the fastest rates.

With respect to policy recommendations, one can compare the obesity problem with deaths on highways in the 1960s. In the 1960s, because of alarm over highway deaths, society adopted a number of interventions that attacked different possible contributors to the problem—e.g., safety belts, children's car seats, speed limits, drunk driving penalties, etc.

One could do the same with PO&O. There could be interventions adopted that attack the problem in various ways—e.g., disallowing food advertising targeted to children, the development of state-sponsored athletic facilities, such as the ones that Fairfax County, Virginia has developed; increasing incentives for green grocers to operate in areas where there are none, etc. The point is that a number of things could be done that would attack the problem on a number of fronts.

This study provides some important insights into the age-period-cohort effects of PO&O. Future research might concentrate on the aspects of American culture that result in eating behavior that yields O&O, how the American lifestyle seems to be at odds with expending energy, and how public policies might stop the PO&O trend in the United States.

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