The Association of Obesity and Self-Rated Health Across Periods and Cohorts

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Abstract

In recent decades, the prevalence of obesity has increased dramatically; however, individual's ratings of their health have improved. We assess the association between individual weight status and self-rated health (SRH) across four decades (1970s-2000s) and four birth cohorts (G.I. Generation, Silent Generation, Baby Boomers, and Generation X) of NHANES data (N=30,454), while controlling for as many other health conditions as possible. We ask whether and among whom the obesity-SRH association has strengthened over time. Obesity is strongly associated with fair/poor SRH. This relationship has grown stronger among more recent birth cohorts but also weakened across time. More specifically, compared with normal weight peers, overweight and obese adults in younger cohorts are more likely to report fair/poor health than older cohorts. Simultaneously, the tendency of overweight and obese adults to report fair/poor health declined within cohorts over time. Overall, the results highlight the complex and dynamic association between SRH and obesity.

The Association of Obesity and Self-Rated Health Across Periods and Cohorts

In the United States, the prevalence of obesity (defined here as having a body mass index, BMI, at or above 30) has rapidly increased in the last 40 years for both genders, all race/ethnic groups, and all levels of socioeconomic status (Chang and Lauderdale 2005, Flegal, Caroll and Ogden 2010, Zhang and Wang 2004). Given the increase in prevalence across all groups, researchers and public health advocates have, in the past two decades, been sounding alarms of an impending obesity epidemic. Mounting evidence based on clinical and epidemiological research links obesity to many negative health and mortality outcomes (Bray 2004, Knight 2011, Must et al. 1999, Stein and Colditz 2004), and perhaps even a decline in life expectancy in the United States (Olshansky et al. 2005). Obesity is now depicted by health advocates and researchers as an "epidemic" of enormous significance. For example, a recent *Lancet* article states: "Unlike other major causes of preventable death and disability, such as tobacco use, injuries, and infectious diseases, there are no exemplar populations in which the obesity epidemic has been reversed by public health measures. This absence increases the "urgency" for action (Swinburn et al. 2011): 804).

Despite the dramatic increase in obesity, individual's ratings of their health have improved during this time period. In general, adults are less likely to report fair/poor health in more recent years[1] (e.g. 2000s vs. 1980s) (Liu and Hummer 2008, Martin et al. 2007). This is particularly true for the highly educated, non-Hispanic whites, men, and older adults (Goesling 2007, Martin et al. 2007, Salomon et al. 2009). This leads to a puzzling conclusion that the prevalence of obesity has increased at the same time as perceptions of health have become more favorable.

How can the prevalence of obesity increase contemporaneously with improved ratings of health? Changes in food contexts providing broad access to high calorie foods and reduced demands for physical activity most likely led to the rapid increase in obesity prevalence (Cutler, Glaeser and Shapiro 2003, Reither, Hauser and Yang 2009). On the other hand, the reductions in poor health ratings are partially attributable to declines in the prevalence of smoking (Centers for Disease Control and Prevention 1999) and drinking (Lakins, Williams and Yi 2006), increasing educational attainment (Newburger and Curry 2000), and the widespread availability of medical technology (Rublee 1994).

However, these explanations rely on expansive societal changes that have occurred over time periods and overlook changes that may be occurring across birth cohorts. Recent research indicates that both changes across periods and birth cohorts have contributed to the increasing prevalence of obesity (Reither, Hauser and Yang 2009) and substantial variation in self-rated health by birth cohort (Martin et al. 2007). We explore the extent to which obesity is associated with self-rated health across periods and birth cohorts. This is critically important because understanding of obesity-related health risks is likely to be associated with the effectiveness of prevention and treatment efforts (Link et al. 1998, Post et al. 2011). We assess the association between individual weight status and self-rated health (SRH) across four decades (1970s-2000s) and four birth cohorts (G.I. generation, Silent Generation, Baby Boomers, and Generation X), while controlling for as many other health conditions as possible. We ask whether and among whom the obesity-SRH association has strengthened over time.

Background

Obesity Trends in the United States by Period and Cohort

When considering changes in self-rated health and obesity, we focus particularly on period and cohort effects. In the case of the increase in obesity, period or secular effects are often blamed (Reither, Hauser and Yang 2009). A period effect is defined as change that occurs over time that affects all groups regardless of age (Ryder 1965, Yang and Land 2008). Period effects include broad historical and environmental changes such as wars, disease outbreaks, and technological advances that affect everyone in a society at that particular moment in time. Increasing rates of obesity provides an example of a period effect. For instance, the prevalence of obesity increased from 13.4% in the early 1970s to 33.0% in 2007-2008 among non-Hispanic white women and from 11.3% to 31.9% among non-Hispanic white men; a similar trend is found for other race/ethnic groups (Chang and Lauderdale 2005, Flegal, Caroll and Ogden 2010). Additionally, research assessing the unique contribution of periods and birth cohorts to the epidemic found period effects to be the major contributor to the rise in obesity (Reither, Hauser and Yang 2009).

Along with period effects, recent research has pointed to the role of cohort effects in the obesity epidemic (Ailshire and House 2011, Reither, Hauser and Yang 2009). Cohort effects are social and historical changes that affect a specific group who experienced an initial event, such as birth, around the same time (Reither, Hauser and Yang 2009, Ryder 1965, Yang and Land 2008). Birth cohorts likely share a social history and the stages of the life course during the same period of historical time (Alwin, McCammon and Hofer 2006). Cohort effects are often used to explain variation in obesity prevalence between ages and groups. For example, the child development and nutrition literature shows that people establish food preferences and dietary behaviors in early childhood (Davison and Birch 2002, Davison, Francis and Birch 2005, Fiorito et al. 2010). As children age, these preferences and behaviors become more difficult to change and may explain differences between birth cohorts in dietary behaviors and preferences. More

recent cohorts were born into and grew up in an increasingly obesogenic food environment that shaped these behaviors and preferences (Robinson et al. 2012).

Furthermore, individuals born in more recent cohorts are at increased risk of obesity and are most likely to be overweight. For instance, Baby Boomers (born between 1946-65) are more likely to be overweight and become overweight earlier than those born in the Silent Generation (1936-45) (Leveille, Wee and Iezzoni 2005). Even more concerning is that cohorts born after 1960 (e.g. Generation X) are more likely to be overweight compared to earlier generations (Allman-Farinelli et al. 2007, Jacobsen Bk 2001, Juhaeri et al. 2003) and those born in the 1980s are particularly susceptible to obesity and weight gain (Robinson et al. 2012).

Trends in Self-rated Health by Period and Cohort

While the literature on self-rated health trends across periods and cohorts is sparse, generally adults in the United States report more favorable health in recent periods. In the latest periods (i.e. 2000s), adults are less likely to rate their health as fair or poor compared to adults thirty years earlier (i.e. 1980s) (Liu and Hummer 2008, Martin et al. 2007). Fair or poor health ratings have declined over periods, more substantially among older adults than younger cohorts given the relatively low prevalence of fair or poor health among younger adults (Martin, Schoeni, Freedman, and Andreski 2007).

Self-rated health across cohorts reveals a more complex pattern. Among adults born in earlier cohorts, fair or poor ratings of health decline with age suggesting that their self-ratings of health have improved; yet, for more recent birth cohorts, as adults age, the percent reporting fair or poor health increases. For instance, Martin and colleagues (2007) find that as adults born in 1932 and ranging in age from their late 50s to early 70s, the percent reporting fair or poor health declines while the percent reporting fair or poor increases for adult born in 1952 as they age from

their early 40s to early 50s. Additional research confirms this pattern: a higher percentage of middle-aged adults in recent cohorts report fair or poor health compared to middle-aged adults in earlier cohorts (Yang and Lee 2009, Zack et al. 2004).

Linking Obesity and Self-rated Health

Despite what is known about trends in the prevalence of obesity and self-rated health independent of one another, little is known about how the association between obesity and self-rated health has changed across periods and birth cohorts. Health, as a multi-dimensional construct, taps into any of a number of factors. Prior research shows that self-rated health is associated with health behaviors, health conditions, functional limitations, and obesity (Ferraro and Yu 1995, Franks, Gold and Fiscella 2003, Manderbacka, Lundberg and Martikainen 1999, McGee et al. 1999), and is consistently and strongly associated with morbidity and mortality (Idler and Benyamini 1997). Results from the mid-1980s and the early 2000s suggest that overweight and obese adults are more likely to report fair or poor health and lower health-related quality-of-life (HRQL) compared to normal weight adults (Ferraro and Yu 1995, Ford et al. 2001, Jia and Lubetkin 2005, Manderbacka, Lundberg and Martikainen 1999, Okosun et al. 2001). Overall, the conflicting trends in obesity and self-rated health, particularly by period and cohort suggest that the association between obesity and self-rated health may not work in the same way for all periods and cohorts.

One reason for the divergence might be due to the fact that self-rated health is a subjective measure with multiple components. Despite the association with a myriad of health conditions and behaviors, self-rated health is only a measure of one's perceived health. In particular, when reporting their own health, different groups or cohorts of people at different points in period time may emphasize or consider different aspects of health depending on which

health-related factors matter the most to them. For example, older people are more likely to think about health problems and functional limitations, while younger adults are more likely to emphasize health behaviors (Krause and Jay 1994). This is also the case across periods as differing health conditions take precedence over others. Over the course of a decade, adults are now more likely rate obesity as a major health concern for society, surpassing smoking (Mendes 2012).

Given the multi-dimensionality of health, messages and evolving treatments for specific health risks, diseases, or conditions may also play a role in helping individuals to determine which health-related factors are important. For instance, whether or not individuals include obesity in their health ratings might be attributable to changing health messages as well as the intensity of the messages. Individuals in particular periods or birth cohorts may be particularly resistant to (or accepting of) changing their beliefs about obesity as was the case for the anti-smoking campaigns (Link and Phelan 2009). Similarly, health messages targeting obesity have varied dramatically and changed over time, especially as mainstream and scientific interest in the topic has grown. Additionally, health messages about obesity are necessarily complex because they cannot advise people to simply stop eating. While some messages focus on healthy food choices, others focus on increasing physical activity, and the messages about which diet to follow (i.e. choosemyplate.gov; dashdiet.org; etc.) seem to change every few years. Secondly, the medical responses to obesity and its comorbidities have shifted though the introduction of pharmaceuticals to treat hypertension, diabetes, and high cholesterol, etc. For example, early pharmaceutical treatments for high cholesterol were not effective or well tolerated by patients. Statins, introduced in the 1980s, offered the first effective drug treatment for high cholesterol

with limited side effects (Chang and Lauderdale 2009). Older adults are often the primary target for statin use.

As the messages and treatment options regarding obesity have changed, many scholars argue that obesity has become increasingly medicalized (Chang and Christakis 2002, Conrad 1992). Medicalization refers to the process by which "human problems or experiences become defined as medical problems, usually in terms of illnesses, diseases, or syndromes" (Conrad and Barker 2010)(S74). Following this trend, the American Medical Association changed their policy in mid-2013 to recognize obesity as a disease, rather than just a health problem. As a result, individuals in particular time periods or birth cohorts may be more likely (or less likely) to emphasize obesity when rating their health compared to individuals in other periods or cohorts. This may result in a stronger (or weaker) association between obesity and self-rated health in both more recent periods and birth cohorts. Furthermore, the association may not be uniform across both periods and cohorts due to the subjective nature of self-rated health, changing health messages and treatments related to obesity, and the conflicting trends in self-rated health across periods and cohorts. We contribute to the literature on the multi-dimensionality of health by assessing the relationship between obesity and self-rated health across historical time and birth cohorts.

Research Expectations

Given the recent increase in the prevalence of obesity, it is possible that the association between body weight and self-rated health has changed over periods and cohorts. However, the ambiguous and complex nature of obesity may make it difficult for individuals to associate obesity with their health. We may therefore see very little evidence of change in the extent to which people associate obesity with poor health in periods or cohorts. We test these alternative

ideas. To do so, we assess historical changes in two domains. First, we assess the volume of scientific and mainstream publications on the topic of obesity in order to empirically gauge the historical changes in the volume of messages about the health risks of obesity to the general public. We do so using systematic literature reviews of PubMed and *The New York Times*. The extent to which obesity is studied by the medical and public health communities and mainstream press will provide insight into the extent that information about obesity has shifted from the periphery to the center. Not surprisingly, we expect that both scientific and mainstream publications on obesity have increased over the last four decades.

Second, we examine how obesity, cohort, and period are associated with SRH, net of other health conditions. Generally, we expect that obese adults are more likely to report poor or fair health compared to normal weight adults. Given the limited prior research on self-rated health, we expect that adults will be less likely to report fair or poor health in the most recent survey periods. In contrast, we anticipate that adults in more recent birth cohorts will be more likely to report fair or poor health.

Finally, we expect that the association between self-rated health and obesity will vary across periods and cohorts. If people believe that being obese worsens health, then this is likely to be reflected in a lower health rating among obese and morbidly obese adults. This insight enables us to assess differences in obesity-related health beliefs over several decades and by birth cohort because the key measures necessary for the analysis—self-rated health, height and weight, and health conditions—have been measured in a consistent manner in the NHANES surveys since the early 1970s. Furthermore, the association between obesity and self-rated health may vary due to period or cohort change. This will be assessed in logistic regression models using interaction terms between weight status and periods and weight status and cohorts.

Building on prior research, we expect that the association between obesity and self-rated health will weaken across time periods such that adults of any age in more recent periods will be less likely to associate obesity with poor or fair health. As the prevalence of obesity has risen in more recent time periods and become normative, adults may not associate their weight with their health status. Additionally, as more effective and advanced treatments have become widely available, the comorbidities associated with obesity are able to be better managed. Therefore, weight status has less influence on one's health rating. On the other hand, we expect that adults in more recent birth cohorts will be more likely to associate obesity with fair or poor health. Changes in health messages may differentially influence birth cohorts. It is possible that more recent cohorts' exposure to media messages as children/young adults changed their beliefs and/or behaviors about health or how they associate obesity with their health ratings. By assessing these two types of interactions, we may see opposing period and cohort effects overlooked in previous analyses.

Data

Systematic Literature Enumeration

As the prevalence of obesity has increased across periods and cohorts, the volume of messages about the negative health consequences of the obesity epidemic also grew substantially. Scientific and public awareness of obesity as a health risk of epidemic proportions began to emerge in the mid-1990s to early 2000s (Brownell 2005, Mendes 2012, Oliver 2006). While we recognize that the generalized negative health effects of obesity have been written about for hundreds of years, we focus on the recent classification of obesity as a modern epidemic. To demonstrate this trend, we conducted two systematic literature enumerations. First, to appraise the growth in professional interest in obesity research from 1970 to 2008, we

searched the English language, peer-reviewed literature using PubMed (National Library of Medicine, Bethesda, Maryland). PubMed is one of the largest databases of biomedical research housing over 22 million citations (U.S. National Library of Medicine 2012). The search was limited to human subject clinical trials, meta-analysis, practice guidelines, randomized control trials, and reviews. We used the MeSH headings "United States," "obesity" or "overweight" or "body mass index" or "BMI" and additionally used other qualifiers such as "obesity, abdominal" or "obesity, morbid". Prior research on U.S. trends in obesity has followed a similar method (Wang and Beydoun 2007). From the time period of interest, which overlaps with the collection of the National Health and Nutrition Examination Survey (NHANES), we located 1,607 articles. We exported the citations using a reference management program and classified the articles by publication date.

Second, to measure general audience exposure to obesity-related messages, we reviewed newspaper articles published by *The New York Times* from 1970 to 2007 using ProQuest. We restrict our systematic review of the popular media to *The New York Times* as its archives are fully digitized through 2007. The search was limited to English language articles excluding advertisements, classified advertisements, stock reports, table of contents, obituaries, marriage announcements, images, credits, reviews, and legal notices. We used the search terms "United States," "obesity" or "overweight" or "body mass index" or "BMI." We exported the citations using a reference management program and classified the articles by publication date. While only analyzing one newspaper, it is important to consider the wide reach of *The New York Times*. It ranks third in circulation among U.S. newspapers (Audit Bureau of Circulation 2012), its news service delivers over 200 articles daily to more than two dozen other papers, and its syndicate service provides articles to thousands worldwide (The New York Times Syndicate 2012).

Data. To evaluate the statistical relationship between obesity and self-rated health, we pooled data from the National Health and Nutrition Examination Survey (NHANES): NHANES I (1971-1975), NHANES II (1976-1980), NHANES III (1990-1994), and the continuous NHANES (1999/2000; 2001/02; 2003/04; 2005/06; and 2007/08). Having a sample that spans four decades permits us to estimate both period and cohort effects together in the same model. The NHANES is a nationally representative study of health and nutrition of children and adults aged 1 to 74 years old in the United States. The study has been conducted by the National Center for Health Statistics (NCHS) as a part of the Centers for Disease Control and Prevention since the early 1970s. Previous National Health Examination Surveys were conducted in the 1960s, but do not contain information on self-rated health or were conducted on specific samples of children and adolescents. The NHANES has a complex, multistage probability sample design, and collects demographic, socioeconomic, health and anthropometric data though interviews and examinations. While the target population is the civilian, non-institutionalized U.S. population, oversampling procedures are used for particular sub-populations (i.e. Hispanics, Blacks, low income persons, etc.). All of the models were weighted using adjusted survey weights to produce nationally representative results. We created adjusted survey weights within each survey by first dividing the summation of the provided survey weight by the sample size. Next we divided the survey weight by the previously calculated quotient.

Sample. We restricted the analysis to adults aged 25-64 who completed both the questionnaire and examination portions of the survey. Pregnant women were dropped (n=893) from the sample due to the confounding between BMI and pregnancy. Underweight adults with a BMI less than 15 and severely overweight adults with a BMI greater than 50 were also dropped from the sample. Additionally, the foreign born were excluded from the sample because

information about obesity and its relationship to health may be quite different outside the United States, particularly in poorer countries where obesity is much less common, and food insecurity and under-nutrition pose significant health risks during childhood (Popkin & Doak 1998). People in these contexts may have been less exposed to health messages about obesity, and may be less likely to think about overweight as a health problem (Kuyper, Smith, & Kaiser, 2009). Indeed, in most poor countries, the prevalence of overweight and obesity increases with education (Monteiro, Conde, Lu, & Popkin, 2004; Sobal and Stunkard 1989), suggesting that overweight may be discounted as a major health risk. Therefore, in this paper we focus on U.S.-born adults.

The final data set included 30,454 adults across the four panels of data.

Self-rated Health. The dependent variable was a response to a single item that asked the respondent to rate their general health (1= Poor, 2=Fair, 3=Good, 4= Very Good, and 5=Excellent) (mean 3.6). We constructed a dichotomous indicator of fair/poor health (=1) versus the remaining categories (=0). Approximately fourteen percent of the sample reported fair or poor health.

Body Mass Index. The key independent variable was weight status. During the NHANES examination, technicians measured each respondent's height and weight using standardized equipment and procedures. These measures were used to calculate each respondent's Body Mass Index (BMI= weight in kg/ (height in meters) ^{2}). In the analysis, BMI is categorized into three groups: normal weight (BMI ≥ 25), overweight (BMI ≥ 25 & ≤ 29.9), and obese (BMI ≥ 30)^2. Supplemental analyses using alternative coding strategies for BMI produced nearly identical results as those based on the categorical indicators.

To control for the changing prevalence of obesity and for increases in weight among obese people across the time periods, we standardized the distribution of BMI in the population.

Specifically, we constructed a "BMI-standardized" weight such that, when applied, the BMI distribution matched the distribution observed in NHANES III, and was identical across all survey years[3]. Figure 1 presents the unstandardized and standardized BMI distributions. In the unstandardized BMI distribution, there is clear evidence of the shift towards heavier BMI across time periods. The standardized BMI distribution illustrates that the standardization process adjusts for changes in the distribution over time. By using the BMI-standardized weight, we ensure that results showing changes in the relationship between obesity and self-rated health are not driven by increases in BMI among obese individuals.

"Figure 1 about Here"

Birth Cohort. To assess changes in obesity-related health beliefs by cohort, we constructed four birth cohorts based on the respondent's year of birth. The birth cohorts include the G.I. generation (1907-1919; n=3,072; 10% of the sample), Silent Generation (1920-1939; n=7,702; 25%), Baby Boomers (1940-1959; 12,898; 42%), and Generation X (1960-1982; 6,782; 22%).

Survey Period. To assess secular or period changes in obesity that affected all adults similarly, we included controls for the period in which the survey was conducted. NHANES I 1971-1975 is considered Survey 1 (16% of the sample); NHANES II 1976-1980: Survey 2 (23%); NHANES III 1990-1994: Survey 3 (26%); the continuous NHANES 1999-2008: divided into Survey 4a (12%) and Survey 4b (22%)[4].

Controls. We controlled for important socio-demographic characteristics common across the four waves of NHANES, which were harmonized and coded consistently with respect to units or response categories across survey waves. The controls included race/ethnicity (Hispanic 4%, non-Hispanic white (reference category; 82%), non-Hispanic black 12%, and non-Hispanic other

2%), gender (male; 49%), age (coded continuously; mean 43), age-squared to detect non-linearity (mean 1996) and marital status, categorized as married (reference category; 66%), formerly married (widowed, separated or divorced; 16%), and single or cohabiting (18%).

Educational attainment is used as the indicator of socioeconomic status following the standard used in other recent work on time trends in obesity (Zhang and Wang 2004). Education is categorized into the three categories: less than high school graduate (18%), high school graduate (reference category; 30%), attended some college and college graduate or above (52%). We tested different classifications of education using up to five categories, but found substantively similar results.

We also controlled for smoking behavior: smoked at least 100 cigarettes in lifetime and currently smoke ("current smoker"; 31 %), smoked at least 100 cigarettes but no longer smoke ("former smoker"; 24%), and never smoked 100 cigarettes ("non-smoker" as the reference category; 45%). Finally, we controlled for the number of chronic health conditions reported by the respondent prior to the health examination section of the NHANES: asthma, anemia, congestive heart failure, heart attack, stroke, bronchitis, emphysema, cancer hypertension, and diabetes. A scale was constructed by summing the number of reported chronic conditions (mean 0.65).

Results

The Volume of Obesity in the Media

As shown in Figure 2, there was a dramatic increase in PubMed and *The New York Times* articles related to obesity and overweight in the last 40 years as a portion of all articles published. Between 1970 and 2008, PubMed published 1,606 obesity-related articles. From 1970 to 1974, the average annual number of publications was 2.8, twenty years later this grew to 17, and by

2005 the average was over 167. In other terms, in the early 1970s only 0.2 PubMed articles per 10,000 annually were related to obesity, but in the late 2000s this had risen to 2.7 per 10,000. Similarly, 509 articles were published in *The New York Times* from 1970 to 2007. The average annual number of obesity-related publications was 4.6 from 1970-1974 or 0.4 articles per 10,000, doubled by 1990, and reached 39 articles annually by 2005, representing almost 8.5 articles per 10,000 annually. Overall, both the popular media and academic articles have increasingly focused their attention on obesity, particularly in the last two decades.

"Figure 2 about Here"

NHANES Results

We begin the analysis of the NHANES data by exploring the prevalence of BMI, normal weight, overweight, and obesity by periods and cohorts. The results are presented in Table 1. The results are presented using the normalized survey weight (not the BMI standardized weight). The average BMI increased across cohorts from 26 in the G.I. Generation to 28 in Generation X and in periods from 25.7 in Survey 1 to almost 29 in the second half of Survey 4. Also, BMI increased over time within the Silent Generation, Baby Boomers, and Generation X from around 25 to around 30. While the prevalence of overweight remained relatively stable across periods and cohorts, the prevalence of obesity increased over time and, most notably, within cohorts. For example, within the Baby Boom cohort, the prevalence of obesity more than tripled from 12 percent in the first survey to 39 percent in the most recent survey. A similar pattern is found among the Silent Generation and Generation X.

"Table 1 about Here"

We now turn to multivariate analysis to evaluate whether the association between obesity and SRH has been increasing over periods and cohorts by estimating logistic regression models

predicting fair or poor health as a function of weight status, cohort and/or period effects, and controls. The results are presented in Table 2. Model 1 includes the cohort effects, Model 2, the period effects, and Model 3 includes both. All three models indicate that adults who are obese are significantly more likely to report fair or poor health compared to normal weight adults, by more than 50 percent (exp(0.46)). Additionally, adults in all of the birth cohorts are significantly less likely to report fair or poor health compared to the earliest birth cohort, the G.I. Generation (Model 1). When cohort is not included in the model, the period effects bounce around, with those in the third survey (early 1990s) being the least likely to report fair/poor health (Model 2). Finally, when both period and cohort effects are included in the model (Model 3), it becomes clearer how the cohort and period effects work in opposite directions. All cohorts are significantly less likely to report fair or poor health compared to the G.I. Generation; in contrast, adults in the most recent survey period (mid-to-late 2000s) are more likely to report fair or poor health compared to adults in the early 1970s (marginally significant at the .10 level).

The control variables work in the expected directions. For instance, adults with a high school degree or less are more likely to report fair or poor health compared to their more educated counterparts. Hispanics and blacks, adults who are single and formerly married, current and former smokers, and those with a greater number of health conditions have increased odds of reporting fair or poor health.

"Table 2 about Here"

Next, we assess whether the association between weight status and fair/poor health varies across periods and cohorts by testing two-way interactions between weight status, and period and cohort. The results are presented in Table 3. Model 1 includes cohort interactions with weight status, Model 2 includes the period-weight status interactions, and Model 3 includes both types

of interactions. Overall, the results reflect the opposing cohort and period effects found in Table 2.

In the model including the cohort interactions (Model 1), there is a significant interaction effect indicating that the relationship between obesity and fair/poor health is significantly greater (more positive) for the youngest birth cohort, Generation X, than the G.I. Generation. In Model 2, the period interactions suggest that the relationship between overweight and fair/poor health is weaker (more negative) in the last two periods (2000s) than in the first period (early 1970s). These opposing effects grow stronger when both cohort and period interactions are included together in Model 3. The relationship between overweight and fair/poor health is significantly weaker (more negative) in more recent time periods, but stronger for more recent birth cohorts. A similar pattern is found for obese adults. Compared with their normal weight peers, more recent cohorts of obese adults are more likely to report ill health, while obese adults in more recent time periods are less likely to assess their health as fair or poor, net of the controls.

"Table 3 about Here"

To help illustrate the opposing effects, Figure 3 plots the log-odds of being obese on reporting fair or poor health by period and cohort. The figure illustrates two important points. First, the association between being obese and SRH has declined over time. In other words, in earlier survey periods, obese adults had greater log-odds of reporting fair or poor health than they do in recent periods. Second, the association between obesity and SRH has strengthened over cohorts. Obese adults in Generation X have the highest log-odds of reporting fair or poor health by the end of Survey 4.

"Figure 3 about Here"

Discussion

In this study, we examined the association between overweight/obesity and self-rated health, and assessed how it varied across periods and cohorts. Our results point to several important findings. First, consistent with prior research, obesity is significantly associated with fair/poor self-rated health. However, this association changed in opposing directions across periods and cohorts. The odds of an obese person reporting fair/poor health compared to a normal weight peer declined over time, but increased across birth cohorts. These interactions are consistent with prior work that showed both improving SRH trends in period and worsening health in more recent birth cohorts independent of one another (Liu and Hummer 2008, Martin et al. 2007, Zack et al. 2004).

What accounts for the opposing period and cohort results? We hypothesize that several forces might be operating simultaneously. Among adults in recent periods, SRH may be less sensitive to obesity because of the ambiguous nature of obesity as a health risk. First, the comorbidities are diffuse and variable, making it difficult to pinpoint excess weight as the source of ill health. Related, the scientific consensus about the health risks of obesity is more obscure than some other health behaviors or conditions, such as smoking. Although the more serious condition of obesity and severe obesity (BMI >35) is associated with a range of other chronic comorbidities and diseases, merely being overweight (i.e., BMI 25 to 29.9) is not consistently associated with health risks (Campos et al. 2006, Oliver 2006). This ambiguity may reduce the clarity of health messages about obesity, leading to a flattening relationship between obesity and SRH recently. At the same time, medical advances have helped to better manage weight-related conditions such as high cholesterol. For instance, as of 2002, nearly one-fifth of American adults were taking statins which have contributed to the substantial decline of high cholesterol (Carroll

et al. 2005). Recent advances that allow for control over health conditions related to obesity may play a role in the flattening of its relationship with SRH over time.

On the other hand, overweight or obese individuals in cohorts like the Baby Boom or Generation X have likely modified their assessments of health downward in response to their weight. This may be attributable to the increasing mainstream and scientific attention paid to obesity as a health issue during their early-to-mid adult years (for evidence see Figure 2) and the recent medicalization of obesity and its comorbidities. Additionally, more recent cohorts have experienced an earlier onset of obesity than previous cohorts. For example, using NLSY data, researchers found that women born in the most recent cohort became obese 28 percent more rapidly than women born in the earliest cohort (McTigue, Garrett and Popkin 2002). This early and rapid onset of obesity among may serve to increase awareness of the health problems associated with obesity among younger cohorts. Finally, prior research also suggests that the declining self-assessments of health among middle-aged adults (Zack et al. 2004) are attributable to broad social and demographic transformations in family structure, marital patterns, and lifestyles that have increased their psychological distress (Yang and Lee 2009). Although not tested here, obesity may be one of the lifestyle factors younger cohorts include in their assessments of SRH.

Coming back to the question posed at the beginning of this paper, what do the findings suggest about why the prevalence of obesity increased contemporaneously with improved ratings of health? One reason obesity and SRH can both increase is because the association between obesity and SRH declined over time. The association has also increased across cohorts, but these increases are likely offset by the period declines. For example, a weakening obesity-SRH relationship among earlier cohorts will likely dominate the overall pattern because they have

worse health, and because these cohorts, especially the baby boomers, tend to be larger than later cohorts. Conversely, the dynamics occurring for Generation X are unlikely to have a large influence of the obesity-SRH relationship since they are still young and relatively healthy (even if they have higher BMIs for their age).

The contribution of this study should be considered within its limitations. While we contribute to the literature on self-rated health and obesity by pooling four decades of cross-sectional NHANES data, it would be ideal to follow adults over time to assess how increasing obesity contributes to individuals' self-assessment of their health. Longitudinal data would also allow us to assess how SRH assessments change over time and across cohorts as the prevalence of obesity increases. Second, ideally respondents would be asked directly if their weight status affected their health, but historical data with this information are unavailable. Instead, we can only assess the association between obesity and SRH net of other health conditions and behaviors. Third, our assessment of obesity uses measured height and weight to calculate BMI, which is relatively reliable and correlated with other body fatness assessments (e.g., dual energy x-ray absorptiometry) (Centers for Disease Control and Prevention 2011), but has limitations compared with more precise assessments. While other measures such as waist to hip ratios may have stronger associations with objective health, respondents generally know their body weight, so BMI category may be more often factored into their self-assessments of health. Despite the limitations, our findings on the obesity-SRH association are noteworthy. They suggest that there has been an important shift in U.S. adults' conceptualizations of health over the past four decades. Future research should examine the mechanisms behind the period and cohort effects and tailor weight interventions appropriately.

Notes

1. The overall trend of reductions in fair/poor health ratings have been found using multiple data sources (NHIS and CPS, and NHANES). Yet, increases in the percentages of fair/poor health have been found in the BRFSS.
2. We recognize that the prevalence of morbid obesity has increased in recent periods; however, we do not have a sufficient sample of morbidly obese adults in the earliest periods.
3. The adjusted weight was constructed by (1) creating a categorical variable for BMI with a category for each 1-point interval, and (2) multiplying each person's sample weight by the ratio of the percentage of persons in their BMI category in the NHANES III and the percentage of persons in their BMI category in their survey year.
4. Alternate indicators for period and cohorts were tested; however, given the non-linear effects we chose the categorical coding of both effects.

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Table 1. Weighted Prevalence of Obesity and Mean BMI by Cohort and Period

	G.I. Generation	Silent Generation	Baby Boomers	Generation X	Period Average
Mean BMI					
Survey 1	26.4	25.9	24.9		25.7
Survey 2	26.3	26.3	25.0		25.8
Survey 3		28.2	27.1	25.7	27.0
Survey 4a		29.3	28.9	28.0	28.5
Survey 4b		30.1	29.4	28.5	28.9
Cohort Average	26.3	26.9	28.2	28.1	
Prevalence of Normal Weight (BMI<25)					
Survey 1	0.44	0.47	0.60		0.50
Survey 2	0.43	0.45	0.58		0.50
Survey 3		0.31	0.41	0.56	0.42
Survey 4a		0.23	0.29	0.38	0.32
Survey 4b		0.17	0.25	0.34	0.30
Cohort Average	0.44	0.40	0.34	0.37	
Prevalence of Overweight (BMI>=25 & <30)					
Survey 1	0.35	0.39	0.28		0.35
Survey 2	0.38	0.37	0.28		0.34
Survey 3		0.38	0.35	0.27	0.33
Survey 4a		0.35	0.35	0.33	0.34
Survey 4b		0.33	0.35	0.32	0.34
Cohort Average	0.36	0.37	0.34	0.32	
Prevalence of Obesity (BMI>=30)					
Survey 1	0.21	0.15	0.12		0.15
Survey 2	0.18	0.18	0.13		0.16
Survey 3		0.31	0.24	0.18	0.24
Survey 4a		0.42	0.36	0.29	0.34
Survey 4b		0.50	0.39	0.34	0.37
Cohort Average	0.20	0.22	0.32	0.32	

Source: NHANES I, NHANES II, NHANES III, and continuous NHANES (1999-2007)

Sample: 30,454 adults ages 25-64, excluding pregnant women, immigrants, and BMI <15 & >50

Weighted using the normalized survey weight

Table 2. Weighted Logistic Regressions Predicting Poor/Fair Health

	Model 1: Cohorts		Model 2: Periods		Model 3: Cohorts and Periods	
	B	SE(B)	B	SE(B)	B	SE(B)
Weight Status (REF=Normal)						
Overweight	0.00	0.07	-0.01	0.07	0.00	0.07
Obese	0.46 ***	0.07	0.45 ***	0.07	0.45 ***	0.07
Cohorts (REF=G.I. Generation)						
Silent Generation	-0.34 ***	0.09			-0.42 ***	0.11
Baby Boomers	-0.40 ***	0.11			-0.63 **	0.18
Generation X	-0.27 +	0.15			-0.63 *	0.27
Periods (REF=Survey 1)						
Survey 2			-0.03	0.09	0.05	0.09
Survey 3			-0.22 *	0.09	0.02	0.12
Survey 4a			-0.10	0.09	0.19	0.14
Survey 4b			-0.04	0.10	0.27 +	0.16
Educational Attainment (REF=Some College/College+)						
Less than High School	1.44 ***	0.09	1.48 ***	0.09	1.46 ***	0.09
High School	0.77 ***	0.07	0.78 ***	0.07	0.78 ***	0.07
Race/Ethnicity (REF=NH-White)						
Hispanic	0.62 ***	0.11	0.62 ***	0.10	0.62 ***	0.11
NH-Black	0.49 ***	0.06	0.48 ***	0.06	0.49 ***	0.06
NH-Other	0.29	0.28	0.28	0.28	0.28	0.28
Male	0.01	0.06	0.01	0.06	0.01	0.06
Age (years)	0.09 ***	0.02	0.07 ***	0.02	0.08 ***	0.02
Age-squared	0.00 **	0.00	0.00 *	0.00	0.00 **	0.00
Marital Status (REF=Married)						
Single	0.32 ***	0.09	0.33 ***	0.08	0.30 ***	0.09
Formerly Married	0.32 ***	0.06	0.32 ***	0.06	0.31 ***	0.06
Health Conditions	0.68 ***	0.03	0.68 ***	0.03	0.68 ***	0.03
Smoking Status (REF=Never Smoker)						
Current Smoker	0.54 ***	0.06	0.54 ***	0.06	0.55 ***	0.06
Former Smoker	0.23 **	0.08	0.23 **	0.08	0.24 **	0.08
Intercept	-5.77 ***	0.44	-5.57 ***	0.43	-5.39 ***	0.51

Source: NHANES I, NHANES II, NHANES III, and continuous NHANES (1999-2007)

Sample: 30,454 adults ages 25-64, excluding pregnant women, immigrants, and BMI <15 & >50

Weighted using the BMI-adjusted survey weight

*** p<.001 ** p<.01 *p<.05 +p<.10

Table 3. Weighted Logistic Regressions Predicting Poor/Fair Health with Period and Cohort Interactions

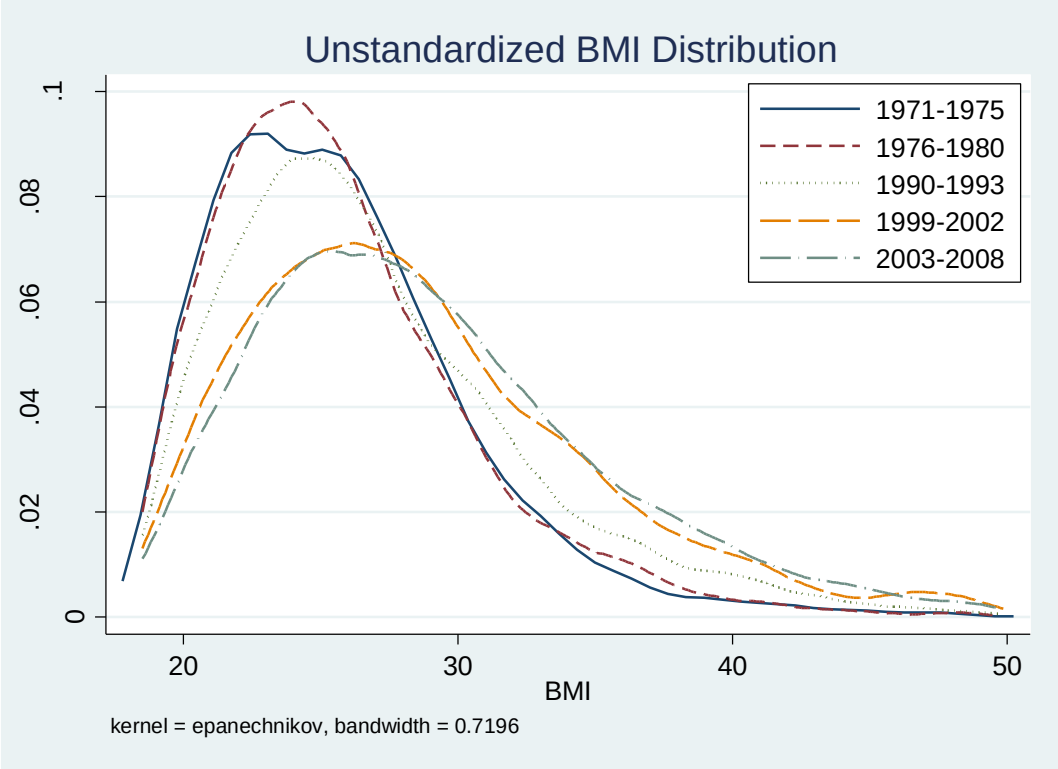
	Model 1: Cohorts		Model 2: Periods		Model 3: Cohorts and Periods	
	B	SE(B)	B	SE(B)	B	SE(B)
Weight Status (REF=Normal)						
Overweight	0.02	0.12	0.33 **	0.11	0.11	0.13
Obese	0.33 *	0.14	0.62 ***	0.13	0.37 *	0.16
Cohorts (REF=G.I. Generation)						
Silent Generation	-0.39 ***	0.11			-0.59 ***	0.13
Baby Boomers	-0.37 *	0.15			-0.98 ***	0.21
Generation X	-0.38 +	0.20			-1.19 ***	0.30
Periods (REF=Survey 1)						
Survey 2			0.04	0.12	0.16	0.13
Survey 3			-0.08	0.13	0.36 *	0.17
Survey 4a			0.05	0.14	0.61 **	0.20
Survey 4b			0.21	0.14	0.82 ***	0.20
Interactions						
Overweight						
x Silent Generation	0.06	0.13			0.26 *	0.13
x Baby Boomers	-0.10	0.16			0.57 **	0.17
x Generation X	0.02	0.19			0.83 **	0.25
x Survey 2			-0.15	0.13	-0.23 +	0.14
x Survey 3			-0.19	0.16	-0.50 *	0.20
x Survey 4a			-0.41 *	0.20	-0.83 **	0.25
x Survey 4b			-0.49 **	0.17	-0.96 ***	0.22
Obese						
x Silent Generation	0.12	0.16			0.29 +	0.16
x Baby Boomers	0.02	0.17			0.53 *	0.21
x Generation X	0.33 +	0.20			0.94 **	0.28
x Survey 2			-0.06	0.16	-0.13	0.17
x Survey 3			-0.24	0.17	-0.53 *	0.22
x Survey 4a			-0.07	0.20	-0.49 +	0.26
x Survey 4b			-0.26	0.17	-0.74 **	0.23

Table 3. Continued

	Model 1: Cohorts		Model 2: Periods		Model 3: Cohorts and Periods	
	B	SE(B)	B	SE(B)	B	SE(B)
Educational Attainment (REF=Some College/College+)						
Less than High School	1.45 ***	0.09	1.47 ***	0.09	1.46 ***	0.09
High School	0.76 ***	0.07	0.78 ***	0.07	0.77 ***	0.07
Race/Ethnicity (REF=NH-White)						
Hispanic	0.61 ***	0.11	0.63 ***	0.10	0.61 ***	0.11
NH-Black	0.49 ***	0.06	0.48 ***	0.06	0.49 ***	0.06
NH-Other	0.29	0.28	0.28	0.28	0.27	0.28
Male	0.01	0.06	0.01	0.06	0.01	0.06
Age (years)	0.09 ***	0.02	0.07 ***	0.02	0.08 ***	0.02
Age-squared	0.00 **	0.00	0.00 *	0.00	0.00 **	0.00
Marital Status (REF=Married)						
Single	0.32 ***	0.09	0.33 ***	0.08	0.31 ***	0.09
Formerly Married	0.32 ***	0.06	0.32 ***	0.06	0.32 ***	0.06
Health Conditions	0.68 ***	0.03	0.68 ***	0.03	0.69 ***	0.03
Smoking Status (REF=Never Smoker)						
Current Smoker	0.54 ***	0.06	0.54 ***	0.06	0.54 ***	0.06
Former Smoker	0.23 **	0.08	0.23 **	0.08	0.24 **	0.08
Intercept	-5.73 ***	0.45	-5.73 ***	0.44	-5.32 ***	0.52

Source: NHANES I, NHANES II, NHANES III, and continuous NHANES (1999-2007)
Sample: 30,454 adults ages 25-64, excluding pregnant women, immigrants, and BMI <15 & >50
Weighted using the BMI-adjusted survey weight
*** p<.001 ** p<.01 *p<.05 +p<.10

Figure 1. Unstandardized and Standardized BMI Distributions



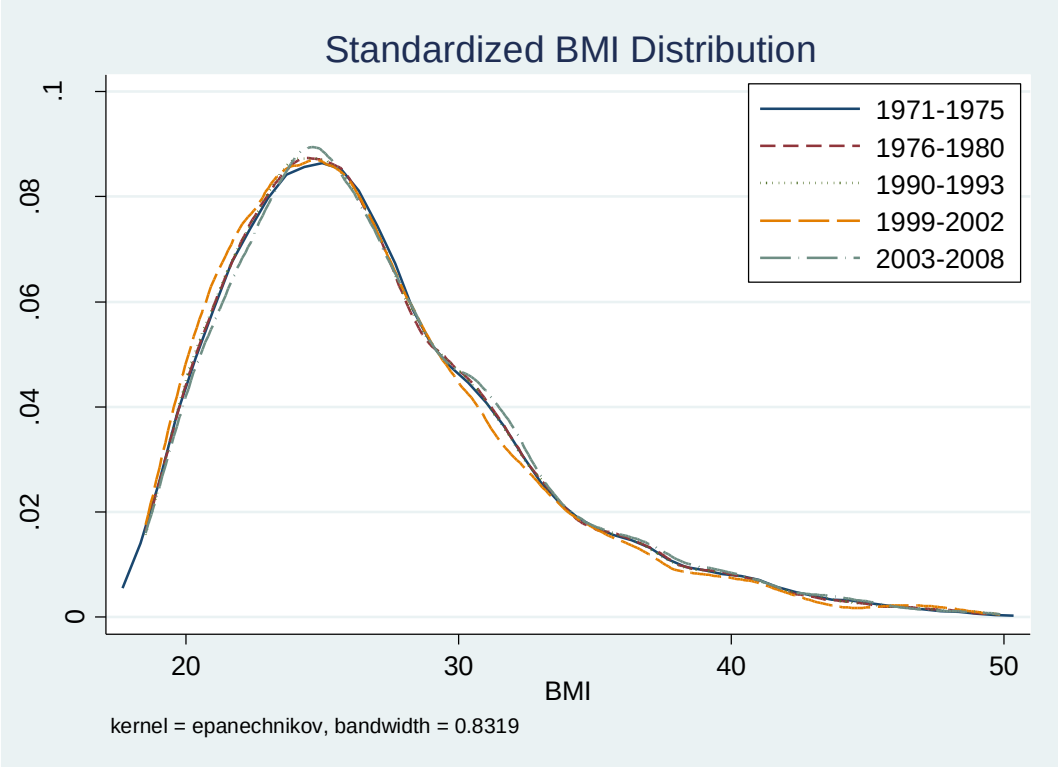


Figure 2. Systematic Literature Enumeration

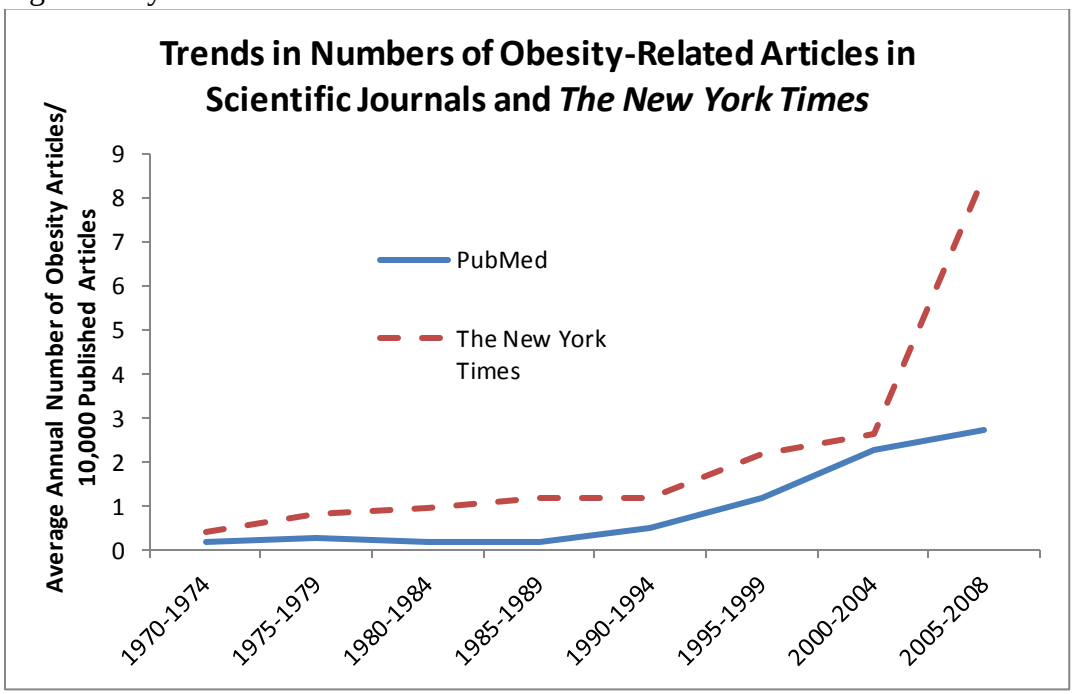


Figure 3. Log-odds of Obesity (relative to normal weight) on reporting fair/poor health