WORKING PAPERS

Decomposing the American Obesity Epidemic

Thomas G. Koch
Nathan E. Wilson

WORKING PAPER NO. 318

May 2013

BUREAU OF ECONOMICS
FEDERAL TRADE COMMISSION
WASHINGTON, DC 20580

Decomposing the American Obesity Epidemic*

Thomas G. Koch Nathan E. Wilson†

May 14, 2013

Abstract

In recent decades, the prevalence of obesity in America has increased dramatically. Though it has attracted less attention, the demographic composition of the American population also changed during this period. We decompose the increase in the average body mass index of the American population over 30 years and show that demographic changes explain a statistically significant but economically marginal amount of the change. Instead, the rise in average obesity is best explained by increases in BMI within demographic groups. Furthermore, our results indicate that groups' experiences have been heterogeneous with younger women experiencing especially large gains in weight. We uncover some evidence consistent with the hypothesis that this can be at least partially attributed to increased labor force participation.

JEL Codes: I12, I18, H51
Keywords: obesity, BMI, demographic change

*Bureau of Economics, Federal Trade Commission. Contact: 600 Pennsylvania Avenue NW, M-8059, Washington DC, 20580. Phone: 512-809-8014 and 202-326-3485. E-mail: tkoch@ftc.gov and nwilson@ftc.gov. Fax: 202-326-2625. The views expressed in this article are those of the authors. They do not necessarily represent those of the Federal Trade Commission or any of its Commissioners. Many of the findings reported in this paper were originally discussed in a larger manuscript entitled "Decomposing the Origins and Implications of the American Obesity Epidemic." Details on changes are available upon request.

†Corresponding author.

1 Introduction

Observing the dramatic increase in the average American's weight over the last few decades (see, e.g., Cutler et al. (2003)), many commentators and public policy officials have reacted with alarm, labeling the phenomenon the "obesity epidemic." Scholarly research on obesity also has become widespread, but comparatively little has focused carefully on the question of how and why the average obesity rate has changed over the long term.[1] This is worrisome insofar as the increase in obesity has coincided with several demographic trends that might, at least partially, also explain it.[2] Alternatively, one might wonder whether the changes to the population average reflect disproportionately large changes for certain demographic groups, while other groups' body composition has remained unchanged.

To address these questions, we exploit 40 years of data that include information on demographics and body composition. These data, collected in the National Health Interview Survey (NHIS), provide such measures for a representative sample of the population from the 1970s through the current day. Like much of the clinical community, as well as many other researchers, our proxy for body composition is individuals' body mass index (BMI), which is defined as an individual's weight in kilograms divided by their height in meters squared. Individuals with BMI's less than 18.5 are considered unhealthily underweight, while those in excess of 25 are considered clinically overweight. Having a BMI greater than 30 is considered clinically obese.[3]

---

[1]The obesity literature has expanded rapidly. For recent surveys, see Rosin (2008) and Philipson and Posner (2008).

[2]See, e.g., a recent presentation by the Patient Centered Outcomes Research Institute on obesity (http://www.pcori.org/assets/PCORI-Obesity-Treatment-Options-Workgroup-Presentations-041613.pdf (accessed April 24, 2013). In particular, slide 30 indicates that obesity is higher for older Americans, African-Americans, and Mexican-Americans. All three of these groups grew in prominence during the same period that obesity is perceived to have increased.

[3]Despite its increasing commonality as a metric for evaluating weight issues, BMI scores do not map perfectly to what one might reasonably believe to be an unhealthy body composition. In particular, athletes and other extremely fit individuals often have BMI scores that qualify as "overweight" due to their high levels

Using the NHIS data, we uncover several salient facts: first, the change in average BMI since the late 1970s can be best explained by changes in BMI within demographic groups. Thus, the increase in obesity is not being driven by the aforementioned alterations to America's demographic structure. Indeed, our results show that the variation in the nation's demographic composition accounts for less than seven percent of the level change in America's average BMI. By contrast, within demographic group changes in average BMI account for 91 percent of the change.

Second, our results show that while average waistlines grew for almost all demographic groups, the magnitude of the increases varied both substantially and systematically. In particular, we found that working-age women have experienced disproportionately large gains in BMI. Indeed, between the late 1970s and more recent years, the BMIs of women between the age of 18 and 65 grew by 20-33% more than those of men of similar ages. Similarly pronounced differences are not observed along racial or ethnic lines.

Overall, our paper contributes to the growing literature on obesity. While the increase in average BMI over time has been well-documented, as has the existence of substantial variation in obesity across demographic groups, we believe that comparatively little has been done to link these two phenomena.[4] Finding that within demographic group changes dominate the impact of compositional variation should cause us to refocus efforts at understanding what behavioral or environmental factors may be involved.

In addition, our focus on identifying both within- and across-group changes can help clarify the likelihood of different explanations for the overall rise in obesity. As it stands, the literature has yet to settle on a primary cause, or quantitative division of causes, for

of muscle mass (Burkhauser and Cawley, 2008). Despite this problem, the preference for BMI stems from its comparative ease of construction from data often collected in surveys and its apparent broad correlation with other measures of obesity (Bhattacharya and Sood, 2011).

[4]Baum (2007) and Baum and Ruhm (2009) represent two noteworthy counter-examples. However, as we discuss further below, those papers data permit them to explore a subset of the issues considered here.

the growth in average BMI and obesity. Several leading explanations for the rise of obesity and BMI in the U.S. include: the relative price of food (Cutler et al., 2003, Lu and Goldman, 2010); proximity to restaurants (Currie et al., 2010, Anderson and Matsa, 2011); and the changing workplace environment (Lakdawalla and Philipson, 2009). Related work has considered the role of smoking (Gruber and Frakes, 2006, Courtemanche, 2009).[5]

The variation in BMI across demographic characteristics, such as gender and age, that our data show may shed light on the relative merits of these explanations. Given that we found that almost every group's BMI increased, our results suggest the relevance of factors affecting all groups, which is consistent with some past work (Chou et al., 2004). However, the disproportionate increases of women's BMIs suggests that other explanations are also at play. Specifically, since there seems little reason to think that women and men have systematically different exposure to "supply factors" like foods whose relative prices have changed, we *cautiously* interpret our results as consistent with the idea that "demand" factors like changing female labor force participation – which increased by 16% - 66% depending on how it's measured (OECD, 2013, Finkelstein et al., 2005) during our sample period – may also be at least a partial driver of the obesity epidemic.

2 Data

The NHIS has conducted annual surveys on the health of the U.S. population since the 1960s. These surveys involve fairly detailed questionnaires, which respondents complete themselves. We use the IHIS, a harmonized version of the NHIS data, generated by the University of Minnesota Population Center. Questions on height and weight, asked only of those age 18

[5]Lakdawalla and Philipson (2009) attempt to decompose the increase in weight attributable to technological change into supply factors (i.e., lower relative food prices) and demand factors (i.e., more sedentary work conditions). They find that 40 percent can be attributed to the former, while the latter account for 60 percent.

and older, have been converted into BMIs, which are consistently available since 1976. The IHIS also provides harmonized responses to standard demographic information: gender, age in years, race, and Hispanic ethnicity. As described in the IHIS documentation (2012), the NHIS has a complex survey design, with sampling weights, PSU and variance strata. All estimates reported below reflect this survey design.

Our approach to understanding what may underpin the changes in population-level descriptive statistics is to consider and contrast the incidence of obesity during two separate periods. Our early sample runs from 1976-9, while the late sample runs from 2007-10. Table 2 reports the sample means for the key demographic variables, and overweight/obesity incidence in the two periods.

Consistent with Cutler et al. (2003) and other scholars who have used different data, Table 2 shows that the average BMI grew substantially between the early and late periods. The overweight fraction of the U.S. population (i.e., those whose BMI is greater than or equal to 25) grew by almost 50 percent between the early and late periods. The fraction whose BMI qualifies them as clinically obese (i.e., those whose BMI is greater than or equal to 30) increased by more than 150 percent. However, the Table also indicates that America's population has changed dramatically during the last 40 years. Hispanic ethnicity more than doubled. Similarly, though less commented upon in the popular media, the black population also expanded by a substantial amount.[6] Simultaneously, the male share of the population grew modestly. Meanwhile, the age distribution shows evidence of major alterations: the youngest group (18-30) shrinks by six percentage points between periods, while the older groups, except for those in their early middle-age, grow in their proportion. This is consistent with the aging of the "baby boom" generation.

[6] The relative increase of respondents identifying as African-American can also be seen in Census data: http://www.infoplease.com/ipa/A0922246.html (accessed April 25, 2013).

Variable	Entire Sample	Early (1976-9)	Late (2007-10)
Demographic			
Male	0.48	0.46	0.49
Hispanic	0.11	0.05	0.13
White	0.84	0.88	0.82
Black	0.11	0.10	0.12
Age Group			
18-30	0.26	0.30	0.24
31-40	0.18	0.18	0.18
41-50	0.18	0.16	0.19
51-64	0.22	0.21	0.23
65+	0.16	0.16	0.17
Weight Metrics			
BMI	26.26	24.36	27.21
Overweight (BMI≥25)	0.55	0.39	0.63
Obese (BMI≥30)	0.21	0.10	0.26
True Obs	336252	246239	90013

Table 1: Sample Means for the NHIS, 1976-9 and 2007-2010, using sample weights. The final row indicates the actual number of surveyed individuals in each of the different periods (i.e., unweighted).

Taken together, one might suspect that the dramatic changes in population structure could explain a significant portion of the increase in obesity. This is because all of relatively more prominent groups are positively correlated with higher BMI levels (Chou et al., 2004). The empirical analysis below explicitly evaluates this possibility.

3 Understanding the Increase in Average Obesity

3.1 Within-Group or Across-Group Changes?

Cross-sectional analyses have demonstrated sizable cleavages in obesity and body-mass composition across demographic groups (Chou et al., 2004, Wang and Beydoun, 2007). In order to infer to what extent these cleavages matter in terms of explaining the change in the population average between time periods, we begin by constructing 100 demographic categories defined by the interaction of gender, Hispanic ethnicity, five race categories[7], and five age groups.[8]

Figure 1 plots the percentage changes in average BMI for each of the groups between the two time periods (1976 to 1979; and 2007 to 2010) sorted by magnitude.[9] It demonstrates that an increase in BMI was strikingly common across groups: 90 of the different groups experienced an increase in their average BMI. Due to these increases, we found that nearly all groups' average BMIs qualified as at least overweight in the later period. These results offer support to the hypothesis that the change in the overall incidence of unhealthy weight levels reflects changes in common behaviors rather than alteration in the demographic composition of the U.S. population.

Though the magnitude of many of the increases in BMI shown in Figure 1 are striking, it

[7] White, black, Aboriginal Indian (e.g., Cherokee or Inuit), Asian, and other.

[8] These age groups vary by age in years: 18 to 30, 31 to 40, 41 to 50, 51 to 64, and those 65 to 85.

[9] It was not possible to estimate changes for three groups due to the thinness of the sample.

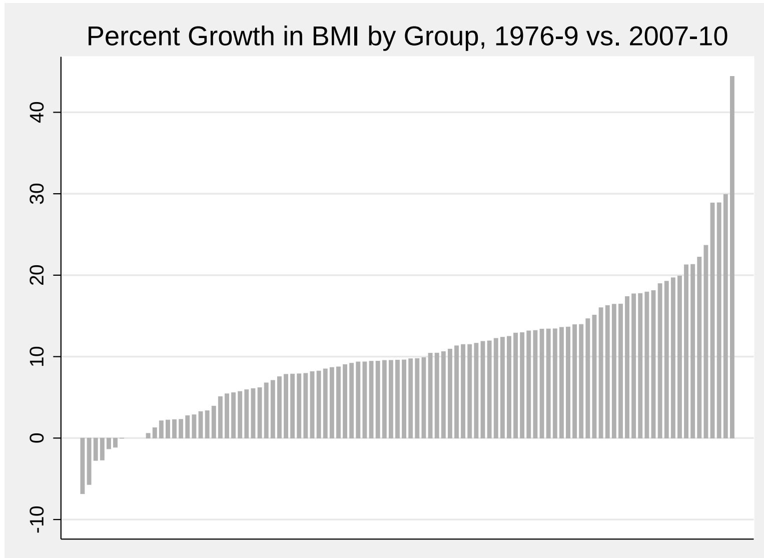


Figure 1: Percent change in average BMI, by gender-age-race-Hispanic ethnicity groups.

should be noted that the demographic groups are parsimoniously constructed and unevenly sized. For example, the demographic group experiencing the largest increase in average BMI, a clear outlier, is composed of late middle-aged women claiming both to be Native-American and have Hispanic ethnicity. Thus, its magnitude may, at least in part, reflect survey sampling issues. Therefore, to gain a fuller understanding of the documented within-group changes, the across-group changes (e.g., shifts in the demographic distribution), and how they respectively impact the average overall BMI for the U.S. population in the sample, we perform a Blinder-Oaxaca decomposition.

The Blinder-Oaxaca methodology allows researchers to decompose the magnitude of the difference in average population outcomes into portions relating to observable differences in the composition of the population and portions relating to genuinely different reactions. This decomposition can be understood by considering the following standard linear regression of individual i's BMI:

$$BMI_i = X_i\beta + \epsilon_i. \tag{1}$$

In this regression, X is a vector of the demographic group indicator variables. The parameters, β, reflect the average BMI within each group. When Equation (1) is estimated separately for each period t, $X_i\hat{\beta}$ equals the expected value of BMI in that period for individual i. Straightforwardly, this implies that the population average in a given period is just $E[BMI|period = t] = E[X_t]\beta_t$, or the expected population composition weighted by each group's innate BMI-level.

As documented above, there is a close to 3 point BMI point difference in average BMI levels (i.e., $E[BMI|early] - E[BMI|late] \approx -3$) across the early (1976-1979) and late (2007-10) time periods. In order to understand the explanation for this change, the Blinder-Oaxaca (BO) decomposition rewrites the difference between the average values of BMI in each period as:

$$\begin{aligned} E[BMI|early] - E[BMI|late] =& E[X_e]\beta_e - E[X_l]\beta_l \\ =& E[X_e - X_l]\beta_l + E[X_l](\beta_e - \beta_l) + [E[X_e] - E[X_l]](\beta_e - \beta_l), \end{aligned} \tag{2}$$

where the subscripts e and l indicate the early and late periods, respectively.

In order to better understand what exactly the BO provides, it is useful to explain each of the elements on the righthand side of Equation (2). The first term will capture the amount of the change in population averages due to changes in the relative sizes of groups. In other words, if a particular group with a high innate tendency towards obesity becomes more prevalent, then we can ascribe some increase in the average to the demographic changes. The second term reflects the amount of the change in population averages that is attributable to within demographic group changes in innate BMI levels. Thus, this element will provide insight into the possibility that very large changes for one group mask relative stasis for others. Finally, the third term corresponds to the interaction in changes in frequency of the group and the average BMI within that group.

Our estimation of Equation (2) show that while both compositional and within-group changes increased the population's average BMI between periods, the second term dominates. Indeed, we find that 91 percent of the almost three BMI point difference between the two periods can be tied to the changes in average BMI within groups. In contrast, less than seven percent corresponds to changes in the make-up of the population; one and a half percent is left for the interaction term. In other words, consistent with the impression given by Figure 1, we find that within-group changes in BMI levels dominate any impact of changes to the demographic composition of the U.S. population over time.[10]

It is worth spending a moment to contextualize these findings relative to previous work examining how the national obesity rate may have been influenced by changing demographic composition. In particular, Baum (2007) takes an approach that is not dissimilar in spirit to our analysis, looking at the demographic correlates of obesity in the National Health and Nutrition Examination Survey (NHANES) data, and seeing how those demographic factors vary between 1988-1994 and 1999-2002. However, unlike our analysis, that paper holds the relationship between demographics and obesity constant over time. This ignores the possibility of large within-group changes, which we show is key to understanding the overall growth in BMI over the long-run.[11] Alternatively, Baum and Ruhm (2009) use the National Longitudinal Survey of Youth (NLSY), following a cohort over time. Here, the restriction is the opposite: the relationship between obesity and demographics is allowed to vary over time, but only because the cohort is growing older. This, however, makes it impossible to compare old to young cohorts over time.

[10]Details on the results for individual groups are available upon request.

[11]Insofar as both of the Baum (2007) samples are drawn from a roughly similar era, the "structural" changes that occur within groups may be of sufficiently small magnitude as to be irrelevant.

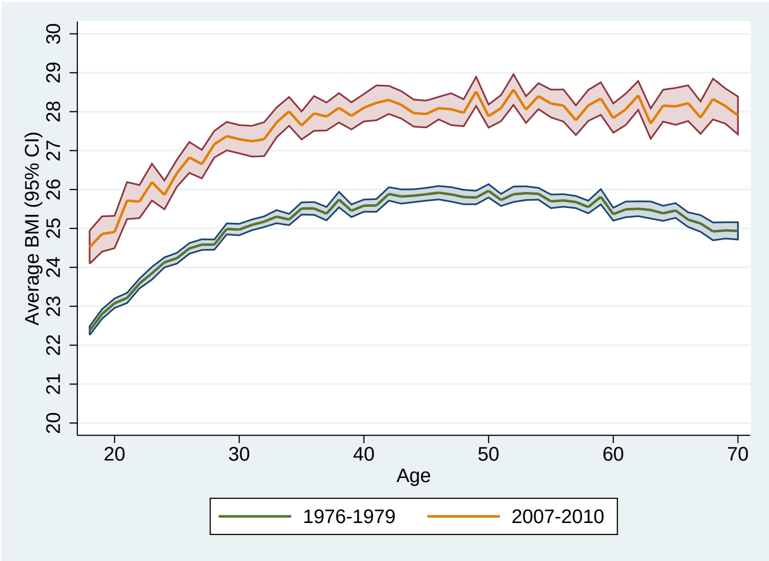
Moreover, while the prior work signally advanced our understanding of the role that demographics may play in magnifying the increase in average obesity, their research designs and data necessarily limit their ability to investigate different hypotheses about the long-run drivers of the obesity epidemic.[12] Our much longer sample and its comprehensive coverage of the popuation allow us to begin to address these questions. Therefore, we now build non-parametrically on our decomposition approach in order to determine whether different demographic segments consistently grew more obese than others, and if there are patterns in theses results that support some existing hypotheses more than others.

3.2 Has the Change in the Prevalence of Obesity Varied Across Groups?

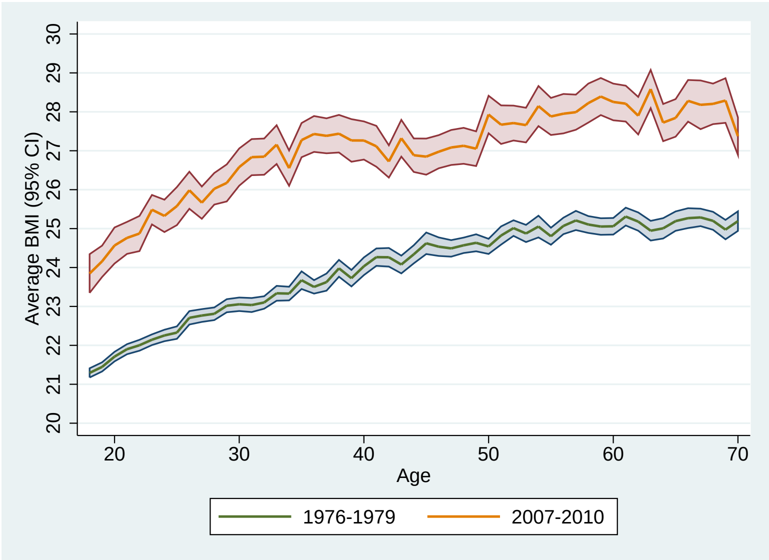
In addition to indicating that many groups' incidence of obesity increased, Figure 1 suggested that groups' experiences were quite heterogeneous. To understand the key dimensions of this variability, we examine the impacts on different collections of the demographic groups. Below, we focus on gender and age categories. In unreported analyses, we examined whether differences also existed across racial groups. Although some variation was observed, on the whole, the results were less striking than those for gender and age. Details are available upon request.

Figure 2 plots the average BMI (with 95% confidence intervals), by age, gender, and time. Unlike in our earlier analyses, we now exclude all individuals over 70 due to the small number of people in the sample over 70, which made it difficult to compellingly identify age-related trends for these individuals. Our results indicate that, on average, men and women of all age

[12]For example, the relatively short, and recent, time-frame of Baum (2007) make it difficult to identify what factors have changed. Similarly, the ability to construct a control or quasi-control group, with more limited exposure to the potential cause, is limited in Baum and Ruhm (2009) by the fact that it is a cohort study. Thus, any cause with national reach would affect each member of the cohort for equal time.

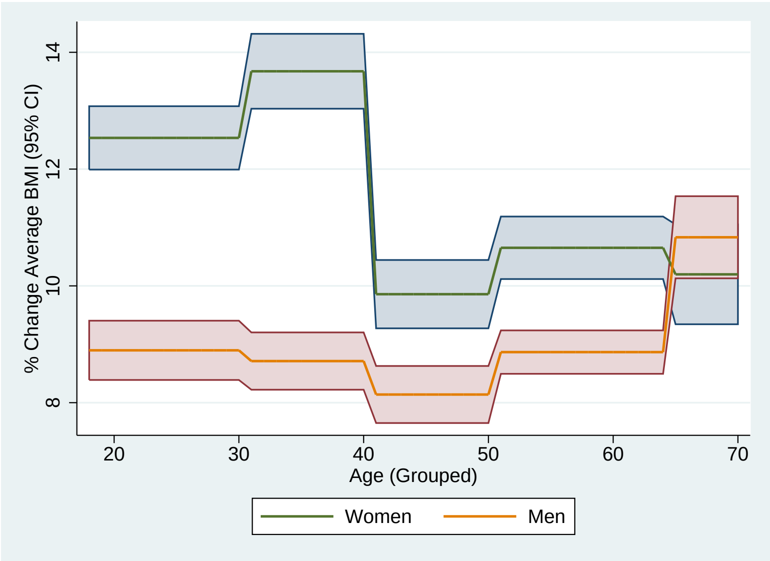


(a) Men

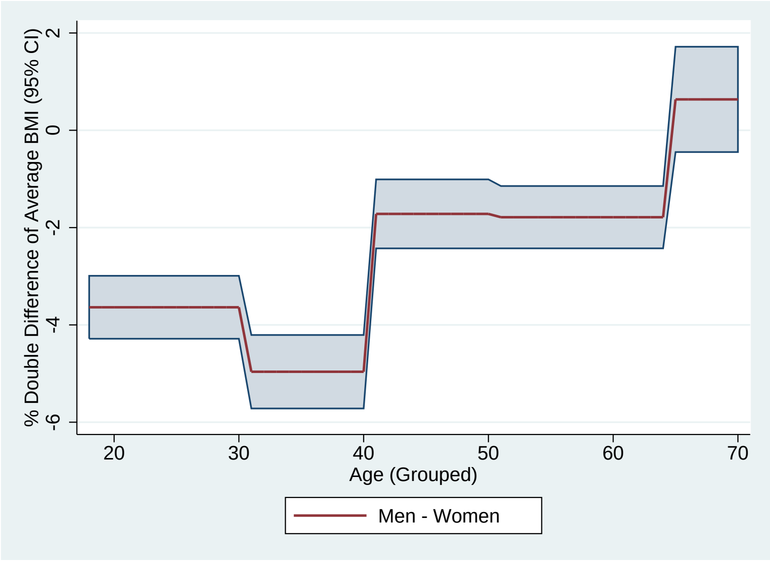


(b) Women

Figure 2: Average BMI, by age, gender, and time period.



(a) Both genders, differences between time periods



(b) Difference between genders

Figure 3: Percent changes in BMI by age and gender.

groups were significantly heavier in the latter period. However, the figures make it equally clear that not all groups' average BMIs grew at the same rate. In particular, it looks like the percentage increase may have been larger for women across many ages.

Unfortunately, the age-gender-time period cells are not large enough to reliably estimate whether such differences-in-differences are statistically significant. Therefore, we create aggregated groups using the same age categories described above; however, to ensure consistency with Figure 2, we continue to only use individuals aged 70 and younger. Figure 3(a) plots the percent change in average BMI across the two time periods, by gender across the different age groups. Figure 3(b) shows the plot of the difference between the two lines.[13]

The figures show that women of working age, i.e., those aged 18 to 65, saw their average BMI grow 2-5 percent points more than those of equal-aged men between the late 1970s and more recent years. Relative to the average change within age-gender groups, these differences are economically and statistically significant. Older men (i.e., those 65-70) experienced larger proportional gains on average than women in their peer group; however, the difference is not statistically significant.

We believe these estimates have significant value as a means of evaluating some of the various theories about the drivers of the American obesity epidemic. Since Figure 1 showed that most groups experienced significant increases, it suggests the appropriateness of looking for factors that will affect all population groups like falling relative costs of unhealthy food and increasingly sedentary work roles. Unfortunately, the data do not permit us to say which such mechanisms are most influential. However, our findings regarding the cleavage between men and women do suggest that theories that accomodate different effects across gender and age also are important, at least on the margin. In particular, we interpret our results – albeit

[13] In generating the results shown in Figures 3(a) and 3(b), we exploit the fact that the first difference of logged values closely approximates percentage changes.

extremely *cautiously* – as supporting the idea that weight gain may be related to changes in workplace environment, such as increased female labor force participation. After all, time series data suggest that women's role in the formal workplace increased dramatically during our period of study (OECD, 2013, Finkelstein et al., 2005).

Although Lakdawalla and Philipson (2009) do find a substantial role for demand factors (i.e., more sedentary work conditions), and Finkelstein et al. (2005) highlight the possible role of women's returning to the labor force, our conclusion is inconsistent with some of the prior literature. For example, Gomis-Porqueras et al. (2011) interpret mixed results of an identification scheme based on the earned income tax credit as inconsistent with female labor force participation's correlation with obesity. Somewhat similarly, cross-border analyses by Cutler et al. (2003) do not suggest a role for female labor force participation. However, these results rely on cross-sectional variation within only a small sample, and the difficulty of identifying effects in cross-country regression frameworks is well-known (Commander and Svejnar, 2011).

In order to shed new light on the possibility that women's increased participation in the labor force may partially explain the difference in weight gain across genders, we leverage the information on employment status that is present in the NHIS. To do this, we generate a binary variable that indicates whether or not a person is working.[14] We then examined whether or not the data indicate that employment status had differential effects on men and women of different ages' expected change in BMI.

Figures 4(a) and 4(b) show plots of the difference between the percent change in average BMI across the two time periods depending on whether an individual was employed or not,

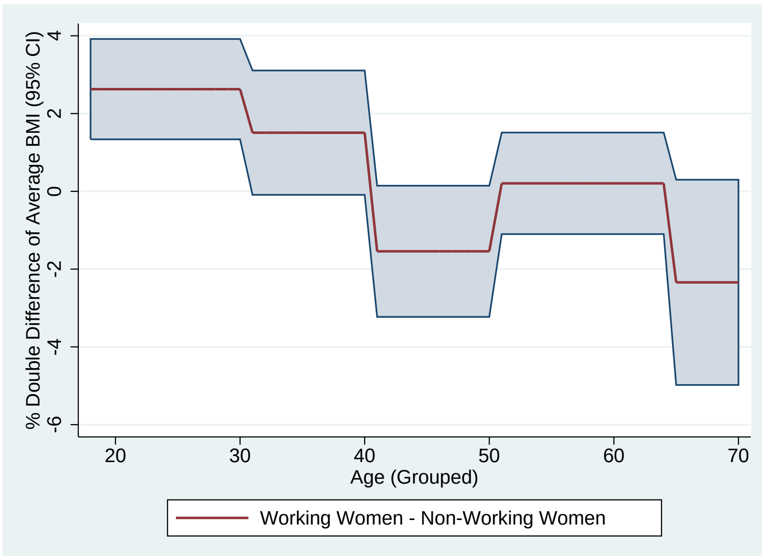
[14]The NHIS categorizes people into multiple bins. We reduce this dimensionality by setting our indicator equal to 1 if the respondent answers that they are working, even if not for pay. The variable is set to 0 if the respondent says that they are out of the labor force or unemployed (for any reason). The small number of observations involving responses outside of these categories are dropped.

by gender across the different age groups. Table 2 provides much the same information by estimating regressions of BMI and the log of BMI on interactions between the variables of interest after netting out the impact of gender-age-time effects. Both the regression results and the graphed results of our non-parametric analyses offer striking evidence in favor of the hypothesis that women's increased labor force participation at least partially explains the difference in growth rates between men and women.

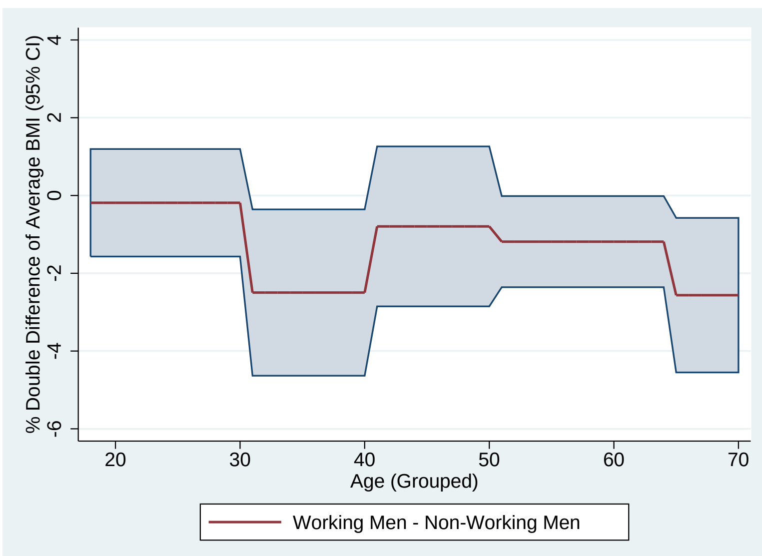
Table 2 shows that employment is associated with relatively higher BMIs in the later period, which is consistent with increasingly sedentary work roles. This already suggests one reason that women's BMIs may have risen relative to that of men, who were already well-represented in the workforce. Moreover, Figure 4(b) and Table 2 show that labor force participation actually is correlated with slower growth in men's BMI. In contrast, our data show that the opposite is true for women: employed individuals on average experienced approximately 2 percent large increases in BMI than those out of the labor force. Figure 4(b) shows that this is especially true for younger women.[15] Thus, women's increased participation in the labor force is especially correlated with gains in BMI.

Overall, we do not claim that our data constitute dispositive evidence as to the causal impact of employment on body composition. For example, the Figures cannot explain the fact that the overall data suggest that labor force participation rates changed approximately equally for women of many different age groups, while weight gain appears to have disproportionately affected the relatively young. This may suggest that the nature of work was more likely to change for younger women. Such caveats notwithstanding, we do interpret our findings as strong motivation for exploring in more controlled settings what role employment may have played. We look forward to subsequent research on this topic.

[15]Moreover, if employment is somewhat endogenous, as intuition and the prior literature (Cawley, 2004, Morris, 2007) suggest, then these simple averages will understate the true relationship between employment and obesity.



(a) Difference in women's change in BMI by employment status



(b) Difference in men's change in BMI by employment status

Figure 4: Changes in BMI by age, gender, and employment status.

Table 2: Relationship between age, gender, time, employment status and BMI.

	BMI b/se	ln(BMI) b/se
1(Male)	0.14	0.01**
	0.15	0.01
1(Employed)	-0.68***	-0.03***
	0.06	0
1(Late Period)	5.21***	0.20***
	0.14	0
1(Male & Employed)	1.02***	0.04***
	0.09	0
1(Employed & Late)	0.11	0.01*
	0.1	0
1(Employed & Late & Male)	-0.39***	-0.02***
	0.15	0.01
Age-Gender-Period FE	Yes	Yes
N	231768	231768

* $p<0.10$, ** $p<0.05$, *** $p<0.01$. Standard errors account for survey sampling.

4 Conclusion

Using rich data on Americans' health statuses over the past 30 years, we assess the relationship between population characteristics and body composition. Consistent with other research, we show that the distribution of BMI in America has shifted noticeably to the right, increasing the incidence of obesity. Decomposing this effect, we show that the change was not principally driven by alterations to the underlying demographic makeup of the American population occuring during this time. Instead, we find evidence that the overwhelming majority of demographic groups experienced gains in their average BMI. In addition, we find strong evidence that the gains were not equally distributed. In particular, there is evidence of particularly large gains in women's BMIs, and these gains appear associated with employment status. We believe these results help to clarify thinking about the different economic theories for the rise in obesity.

References

Anderson, Michael L. and David A. Matsa, "Are Restaurants Really Supersizing America?," *American Economic Journal: Applied Economics*, January 2011, *3* (1), 152–88.

Baum, Charles L., "The effects of race, ethnicity, and age on obesity," *Journal of Population Economics*, 2007, *20* (3), 687–705.

Baum, Charles L and Christopher J Ruhm, "Age, socioeconomic status and obesity growth," *Journal of Health Economics*, 2009, *28* (3), 635–648.

Bhattacharya, J. and N. Sood, "Who pays for obesity?," *Journal of Economic Perspectives*, 2011, *25* (1), 139–58.

Burkhauser, R.V. and J. Cawley, "Beyond BMI: The value of more accurate measures of fatness and obesity in social science research," *Journal of Health Economics*, 2008, *27* (2), 519–529.

Cawley, J., "The impact of obesity on wages," *Journal of Human Resources*, 2004, *39* (2), 451–474.

Chou, SY, M. Grossman, H. Saffer et al., "An economic analysis of adult obesity: results from the Behavioral Risk Factor Surveillance System.," *Journal of health economics*, 2004, *23* (3), 565.

Commander, S. and J. Svejnar, "Business environment, exports, ownership, and firm performance," *The Review of Economics and Statistics*, 2011, *93* (1), 309–337.

Courtemanche, Charles, "Rising cigarette prices and rising obesity: Coincidence or unintended consequence?," *Journal of Health Economics*, 2009, *28* (4), 781–798.

Currie, J., S. DellaVigna, E. Moretti, and V. Pathania, "The Effect of Fast Food Restaurants on Obesity and Weight Gain," *American Economic Journal: Economic Policy*, 2010, *2* (3), 32–63.

Cutler, D., J. Shapiro, and E. Glaeser, "Why Have Americans Become More Obese," *Journal of Economic Perspectives*, 2003, *17*, 93–118.

Finkelstein, Eric A, Christopher J Ruhm, and Katherine M Kosa, "Economic causes and consequences of obesity," *Annu. Rev. Public Health*, 2005, *26*, 239–257.

Gomis-Porqueras, P., O.A. Mitnik, A. Peralta-Alva, and M.D. Schmeiser, "The effects of female labor force participation on obesity," *Working Paper Series*, 2011.

Gruber, Jonathan and Michael Frakes, "Does falling smoking lead to rising obesity?," *Journal of Health Economics*, 2006, *25* (2), 183–197.

Lakdawalla, Darius and Tomas Philipson, "The Growth of Obesity and Technological Change: A Theoretical and Empirical Examination," *Economics and Human Biology*, 2009, *7* (3), 283–293.

Lu, Y. and D. Goldman, "The effects of relative food prices on obesityevidence from China: 1991-2006," Technical Report, National Bureau of Economic Research 2010.

Minnesota Population Center and State Health Access Data Assistance Center, *Integrated Health Interview Series: Version 5.0*, Minneapolis: University of Minnesota, 2012.

Morris, Stephen, "The impact of obesity on employment," *Labour Economics*, 2007, *14* (3), 413–433.

OECD, "Labour force statistics by sex and age: indicators," `http://stats.oecd.org/Index.aspx?DatasetCode=LFS_SEXAGE_I_R#,` 2013. Accessed May 6, 2013.

Philipson, T.J. and R.A. Posner, "Is the obesity epidemic a public health problem? A review of Zoltan J. Acs and Alan Lyles's obesity, business and public policy," *Journal of Economic Literature*, 2008, *46* (4), 974–982.

Rosin, O., "The economic causes of obesity: a survey," *Journal of Economic Surveys*, 2008, *22* (4), 617–647.

Wang, Youfa and May A Beydoun, "The obesity epidemic in the United Statesgender, age, socioeconomic, racial/ethnic, and geographic characteristics: a systematic review and meta-regression analysis," *Epidemiologic reviews*, 2007, *29* (1), 6–28.