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Decomposing the American Obesity Epidemic

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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 o cials 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 re ect 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

Using the NHIS data, we uncover several salient facts: rst, 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 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 a ecting 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. Speci cally, since there seems little reason to think that women and men have systematically di erent 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.

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 $\geq$ 25)	0.55	0.39	0.63
Obese (BMI $\geq$ 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.

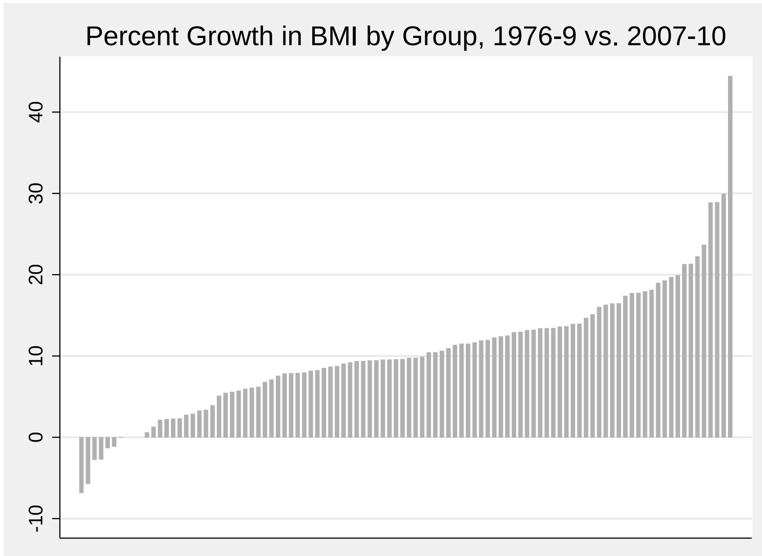


Figure 1: Percent change in average BMI, by gender-age-race-Hispanic ethnicity groups.

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:

$$BMI_i = X_i \beta + \epsilon_i. \qquad (1)$$

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:

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

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.

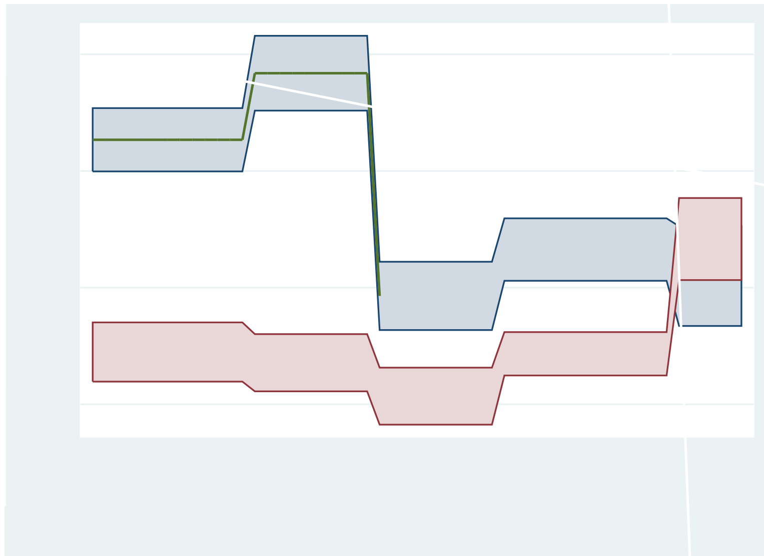
[10] Details on the results for individual groups are available upon request.

[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.

(a) Men

(b) Women

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



(a) Both genders, di erences between time periods

(b) Di erence between genders

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

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 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

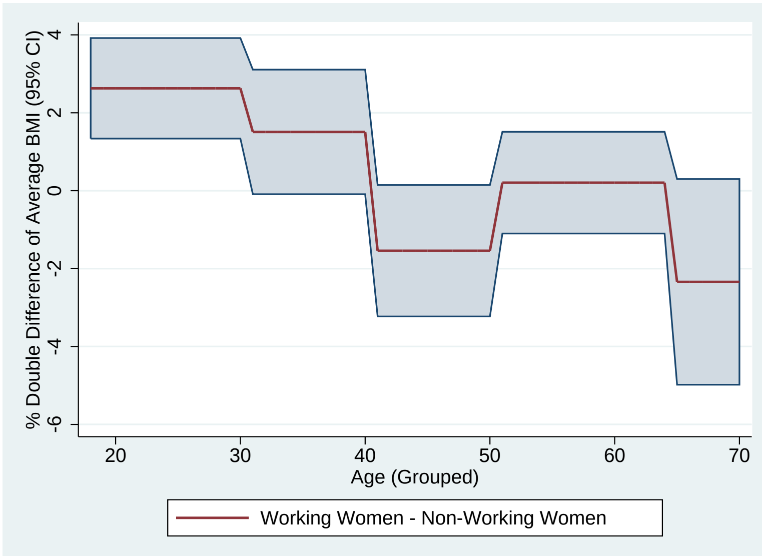

% Double Difference of Average BMI (95% CI)
4
2
0
-2
-4
-6
20
30
40
50
60
70
Age (Grouped)
Working Women - Non-Working Women

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 e ect, 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 nd evidence that the overwhelming majority of demographic groups experienced gains in their average BMI. In addition, we nd 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 di erent economic theories for the rise in obesity.

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