Is obesity becoming more disabling over time? Evidence from the NHANES 1988-2012

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EXTENDED ABSTRACT

Introduction
The decline in late-life disability at the close of the 20th century in the United States was a welcome development and served as a counterpoint to fears over the potential impact of increased longevity, and an elderly population that is expanding in both absolute and relative terms, on the nation's health care needs.1-3 However, it has also been argued that increases in the prevalence of obesity could reverse these trends, wiping out improvements to disability.3,4 Obesity is well known to be associated with a range disability, including limitations to mobility and difficulty with self-care needs.5,6

The ongoing relationship of obesity to population health and aging is currently the subject of spirited and provocative debate, and it is one of the most closely watched issues in public health. While obesity is clearly associated with increased risk for a variety of adverse health outcomes such as cardiovascular disease (CVD), diabetes, and cancer, there are signs that the obese population may have been growing healthier over the past few decades. The obese population has experienced major declines in CVD risk factors such as high cholesterol and hypertension since the 1960s, including a decline in the excess risk of high cholesterol relative to normal weight persons.7 There is also accumulating evidence that the excess risk of mortality associated with obesity has declined.8-10 These changes may be mediated, in part, by rapid advances in the prevention and treatment of CVD. While these trends are quite promising, they have also raised the question of whether obese persons are living longer with better-controlled risk factors but, paradoxically, experiencing more disability.

In a previous study,11 we found significant changes to the association between obesity and disability over time using cross-sectional data from National Health and Nutrition Examination Survey (NHANES) from 1988-2004 for adults aged 60 years and older. Comparing obese vs normal weight persons, the odds ratio for functional impairment increased from 1.78 to 2.75, and the odds ratio for impairment in activities of daily living (ADL) increased from 1.31 to 2.05.
In sum, the same weight status at the same age was associated with a higher risk of disability than it was in the past. In addition to decreasing mortality and, hence, increased longevity with obesity, the onset of obesity has occurred at younger ages over time.\textsuperscript{12,13} Both of these trends contribute to greater individual lifetime exposure to obesity and may explain the increase in risk of disability over time. Cumulative exposure to excess weight affects not only disease burden but conditions such as arthritis, which is closely linked to disability.\textsuperscript{14} Indeed, the obesity-associated risk of arthritis also increased over this time period.\textsuperscript{15}

Our findings called attention to disability as a potential cost of a longer life with obesity, and Gregg and Guralnik argued in an accompanying editorial that disability is “... perhaps one of obesity’s most important and persistent effects into the future” (p. 2066).\textsuperscript{16} They also note that increased longevity among disabled persons would increase the risk of becoming obese, further increasing the joint prevalence of obesity and disability.

In this study, we update our analyses to include more recent waves of the NHANES, extending the endpoint to 2012. The new time frame allows an examination of how the relationship of obesity and disability has changed over the last quarter century. Many of the underlying contributors have continued to evolve, and we raise the question of whether the excess risk of disability from obesity has continued to increase. If so, obesity may very well wipe out the broader trend of declines in late-life disability even if the prevalence of obesity itself is starting to level off.\textsuperscript{17,18} We present our preliminary findings in this extended abstract.

\textbf{Methods}

\textbf{Data}

We used data from the National Health and Nutrition Examination Surveys (NHANES), which are cross-sectional studies of the non-institutionalized US population including interviews and examinations, conducted by the National Center for Health Statistics (\url{http://www.cdc.gov/nchs/nhanes.htm}). Data are drawn from NHANES III (1988-1994), as well as the continuous series of NHANES from 1999-2012, to examine the association between disability and obesity over time. Our sample consists of 16,770 participants aged 60 and over who participated in both the interview and examination portions of the survey.

\textbf{Measures}

\textit{Disability:} NHANES collected information on functional limitations, which refer to restrictions in basic movements, and limitations in activities of daily living (ADLs), which represent more severe disability. For each question, participants were asked, “By yourself and without using any special equipment, how much difficulty do you have” with the particular task. Participants could report having no difficulty, some difficulty, much difficulty, or unable to do. Participants were considered to have a functional limitation if they reported much difficulty or unable to do any one of the following 6 tasks: walking one-fourth mile, walking up 10 steps without resting, stooping/crouching/kneeling, lifting or carrying 10 lb, walking between rooms on the same floor, and standing from an armless chair. Participants who required assistive devices to walk were also considered limited. For ADLs, participants were considered limited if they reported much difficulty or unable to do any of the 3 following tasks: getting in and out of bed, eating, and dressing. Because the prevalence of ADL limitation was low (<5%), we also ran models
where the respondents were considered to have an ADL limitation if they reported some difficulty, much difficulty, or unable to do. These two versions of ADL disability are labelled “severe” and “mild or severe” impairment.

**Body Mass Index**: BMI was calculated as weight in kilograms divided by height in meters squared from measured height and weight at the time of the examination. Weight categories were divided into: underweight (BMI <18.5), normal weight (BMI 18.5-24.9), overweight (BMI 25.0-29.9) and obese (BMI>=30.0). Additional covariates included self-reported age, sex, race/ethnicity (non-Hispanic black, Mexican American, non-Hispanic white, and other), education, income, the presence of chronic conditions, and smoking. Education was categorized into 3 categories (<12 years, 12 years, and > 12 years). Income was measured using the poverty income ratio (PIR) to account for household size and inflation over time.

**Time**: Period 1 corresponds to NHANES III (1988-1994), Period 2 covers 1999-2004, and Period 3 covers 2005-2012. Periods 1 and 2 are in keeping with the definitions used in our prior study. Period 3 represents the new, more recent waves of NHANES data.

**Analysis**
We used logistic regression to (separately) model the odds of having a functional limitation or an ADL limitation as a function of BMI category, time period, and BMI category interaction with time. Models were adjusted for age, sex, race/ethnicity, education, and income. All analyses were conducted using STATA 12.1 and accounted for the complex survey design of the NHANES.

**Preliminary Results**
**TABLE 1** provides the prevalence of different BMI categories as well as the prevalence of functional and ADL impairment within BMI categories across the three periods. Over the 3 periods, the prevalence of obesity rose from 23.5% of the population aged 60 and over in 1988-1994 to 36.0% of the population in 2005-2012.

**TABLE 2** provides odds ratios (ORs) based on the logistic regressions predicting the odds of functional or ADL impairment. The OR for the obese coefficient indicates the odds of impairment for an obese individual relative to one of normal weight in period 1. The OR for the obese-period interactions indicate the change in the association between obesity and disability for period 2 compared to period 1, and for period 3 compared to period 1, respectively. These models control for sociodemographic characteristics. In the text below, 95% CI are enclosed in brackets.

For functional impairment, the main effect of obesity shows that the odds of impairment for obese vs. normal weight persons in period 1 is strong and significant (OR=1.88 [1.55-2.28]). The main effects for time across the three periods are not significant, suggesting that the odds of functional impairment did not change for non-obese individuals. The interaction terms for obesity and time are positive and significant for both time periods, indicating that the relative odds of being functionally limited were significantly higher for periods 2 and 3 compared to period 1. The OR for obese increased to 2.84 (1.88 x 1.51 [2.48-3.26]) for period 2 and 2.65 (1.88 x 1.41 [2.32-3.26]) for period 3. There was no statistically significant difference in the association of obesity with functional impairment for period 2 compared to period 3 (p=.64).
This suggests that while the excess risk of functional limitation associated with obesity is still higher than it was in 1988-1994, it has not gotten worse in recent years.

The next model in TABLE 2 looks at the odds of ADL impairment defined as severe (much difficulty or unable to do). Here, the odds of ADL impairment for the non-obese showed significant declines in both period 2 (OR=0.66 [0.50-0.87]) and period 3 (OR=0.74 [0.58-0.95]) compared to period 1. For obese respondents, these declines were not seen: period 2 vs 1 OR=1.02 (0.66 X 1.55 [0.70-1.49]), period 3 vs 1 OR=1.15 (0.74 X 1.56 [0.79-1.69]). Since the non-obese experienced improvements but the obese did not, the OR for obesity went from 1.28 [0.91-1.80] in period 1, to 1.98 (1.28 x 1.56 [1.42-2.76]) in period 2, and 2.00 (1.28 x 1.56 [1.43-2.78]) in period 3. Again, the difference in the association of obesity and impairment for period 2 vs 3 was not significant (p=.67), suggesting that the increased risk in impairment between the obese and non-obese has not gotten worse over time.

For the final outcome measure of the odds of mild or severe ADLs, we found similar findings that the declines in impairment for the non-obese were not shared by the obese in period 2. For period 3 compared to period 1 however, the obesity*time interaction was not significant (OR=1.10 [0.84-1.44]), suggesting that the obese were now able to share in some of the declines in impairment seen by the non-obese in the previous period. FIGURE 1 shows the predicted probabilities obtained from Table 1 for ADL impairment (mild or severe).

**Preliminary conclusion and additional analyses planned**

The trend of a major increase in the risk of disability associated with obesity that was previously reported for 1988-2004 did not continue over the more recent period from 2005-2012. The excess risk associated with obesity appears to have leveled off. While obesity is still associated with an increased risk of both functional and ADL impairment, the concern that discrepancies would continue to worsen have not been borne out. Indeed, the most recent period (3) shows that obese population is now starting to reap the improvements in mild/severe ADL impairment that the normal weight population experienced earlier, in period 2, exhibiting a lagged effect.

Additional analysis will explore adjustments for more refined obesity categories as well as self-reported chronic conditions to examine whether these factors act as confounders or mediators in the obesity-disability association over time. We will also examine other parameterizations for time and stratification by age groups, sex, and race/ethnicity.

Our discussion will focus on how our findings could relate to broader trends in terms of demographic changes and the prevention and treatment of disease.
**TABLE 1: Prevalence of Disability by BMI Group: NHANES, 60+**

<table>
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<tr>
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<tbody>
<tr>
<td></td>
<td>NL</td>
<td>Ow</td>
<td>Ob</td>
</tr>
<tr>
<td>N</td>
<td>1865</td>
<td>2151</td>
<td>1262</td>
</tr>
<tr>
<td>Weighted (%)</td>
<td>35.4</td>
<td>38.7</td>
<td>23.5</td>
</tr>
<tr>
<td>Mean BMI</td>
<td>22.4</td>
<td>27.3</td>
<td>34.0</td>
</tr>
<tr>
<td>Functional</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>impairment %</td>
<td>26.7</td>
<td>27.4</td>
<td>36.8</td>
</tr>
<tr>
<td>(severe) %</td>
<td>5.0</td>
<td>4.3</td>
<td>6.0</td>
</tr>
<tr>
<td>ADL impairment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(mild or severe) %</td>
<td>17.7</td>
<td>15.3</td>
<td>22.2</td>
</tr>
</tbody>
</table>

NI=normal, Ow=overweight, Ob=obese
Estimates reflect NHANES survey weights

**TABLE 2: Relative Odds of Functional and ADL Impairment in NHANES 1988-2012, Ages 60+**

<table>
<thead>
<tr>
<th></th>
<th>Functional Impairment</th>
<th>ADL (severe)</th>
<th>ADL (mild or severe)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal weight</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Period 1 (1988-1994)</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Period 2 (1999-2004)</td>
<td>1.09 (0.95-1.25)</td>
<td>0.66 (0.50-0.87)</td>
<td>0.72 (0.61-0.84)</td>
</tr>
<tr>
<td>Period 3 (2005-2012)</td>
<td>1.12 (0.97-1.29)</td>
<td>0.74 (0.58-0.95)</td>
<td>0.77 (0.65-0.84)</td>
</tr>
<tr>
<td>Overweight</td>
<td>1.16 (1.03-1.30)</td>
<td>0.90 (0.69-1.18)</td>
<td>1.00 (0.88-1.15)</td>
</tr>
<tr>
<td>Obese</td>
<td>1.88 (1.55-2.28)</td>
<td>1.28 (0.91-1.80)</td>
<td>1.49 (1.21-1.83)</td>
</tr>
<tr>
<td>Obese X Period 2</td>
<td>1.51 (1.22-1.89)</td>
<td>1.55 (1.02-2.34)</td>
<td>1.53 (1.15-2.05)</td>
</tr>
<tr>
<td>Obese X Period 3</td>
<td>1.41 (1.14-1.75)</td>
<td>1.56 (1.03-2.36)</td>
<td>1.10 (0.84-1.44)</td>
</tr>
</tbody>
</table>

All models control for age, sex, race/ethnicity, education, and income.
95% Confidence intervals in parentheses
FIGURE 1: Predicted probability of ADL impairment (mild or severe) by BMI category and time


For normal weight: period 2 and 3 are sig different from period 1 (p=.005 and p=.007), period 2 not different from period 3 (p=.45). For obese: period 1 and 2 are not significantly different from one another (p=.46). Period 3 shows a significant decline from period 2 (p=.018).
References