An In-Depth Look at the Lifetime Economic Cost of Obesity

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AGENDA

• Introduction and Research Question
• Methodology
• Model Development
• Results
• Conclusions
  » Limitations
  » Contributions
• Questions
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INTRODUCTION

- Adult obesity rates (percent of population with BMI ≥ 30) have increased substantially in the U.S. in the last several decades.


78.6 million adults with obesity (CDC/NCHS: NHANES 2011-2012)
INTRODUCTION


12.7 million youth with obesity
(CDC/NCHS: NHANES 2011-2012)
INTRODUCTION

• Health Risks of Obesity Include:
  » Coronary Heart Disease
  » Type 2 Diabetes
  » Stroke
  » Certain Forms of Cancer
  » Metabolic Syndrome
  » Osteoarthritis
  » Reproductive Issues
  » Gallstones

Source: National Heart, Lung and Blood Institute, National Institutes of Health
INTRODUCTION

- Estimated relationship between body mass index and mortality

  » Higher obesity categories (BMI > 30) associated with increasingly higher mortality risk

INTRODUCTION

• Along with the detrimental impacts on health and mortality risk, obesity has economic implications, some more easily quantifiable than others.

• Researchers have linked obesity with increases related to direct (e.g. healthcare) and indirect (e.g., productivity) costs.
RESEARCH QUESTIONS

• Obesity not only can cause individuals to bear additional private costs, but might result in non-trivial costs for society as a whole. Our research explores:

  » Are there economic costs of obesity borne by society? If so, what is the cost over the course of a lifetime?

  » What is the economic cost of obesity, taking into consideration mortality risk associated with obesity?
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METHODOLOGY

• I. Literature review
  » Informed model selection and design

• II. Development of a Markov (state-transition) model

• III. Model specification
  » Literature and data inform costing categories and probabilities
• Introduction and Research Question
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MODEL DEVELOPMENT

- Development of a Markov (state-transition) model
  - Compared net present value of lifetime costs of two hypothetical 1,000-person, demographically representative cohorts (one obese, one normal weight) from 25-85 years, or death

![Diagram showing comparison of normal weight cohort and obese cohort over years of life with question about comparative societal costs.](image)
Studies suggest that associated healthcare and productivity costs of obesity rise in a “J-shaped” fashion relative to obesity category.

Annual Medical Spending and Productivity Losses by BMI Strata: Men

- Obesity I: BMI 30.0 – 34.9
- Obesity II: BMI 35.0 – 39.9
- Obesity III: BMI 40

MODEL DEVELOPMENT

• Demographically representative of the current U.S. population between the ages of 20 and 24 (Source: U.S. Census data)

• Starting BMIs: range of obesity categories I, II and III (Sources: National Health and Nutrition Examination Survey data)
  » Informed costing categories and probabilities
    - Grade I obesity: BMI of 30-34.9
    - Grade II obesity: BMI of 35-34.9
    - Grade III obesity: BMI of 40 or above
MODEL DEVELOPMENT

- Obese cohort by race/ethnicity, sex, and BMI category:

<table>
<thead>
<tr>
<th>Race/Ethnicity</th>
<th>Sex</th>
<th>Obesity Class I (BMI 30)</th>
<th>Obesity Class II (BMI 35)</th>
<th>Obesity Class III (BMI 40)</th>
<th>Total Persons</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Hispanic White</td>
<td>Men</td>
<td>139</td>
<td>100</td>
<td>61</td>
<td>300</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>148</td>
<td>106</td>
<td>65</td>
<td>318</td>
</tr>
<tr>
<td>Non-Hispanic Black</td>
<td>Men</td>
<td>42</td>
<td>29</td>
<td>8</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>48</td>
<td>33</td>
<td>9</td>
<td>90</td>
</tr>
<tr>
<td>Hispanic</td>
<td>Men</td>
<td>95</td>
<td>25</td>
<td>0</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>74</td>
<td>19</td>
<td>0</td>
<td>93</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>545</td>
<td>312</td>
<td>143</td>
<td>1,000</td>
</tr>
</tbody>
</table>

Source: National Health and Nutrition Examination Survey data, 2013

- Normal cohort starting BMI: 20
## MODEL DEVELOPMENT

- **Probability Development**

<table>
<thead>
<tr>
<th>State Transition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mortality from any state</td>
<td>Fontaine et al. 2003</td>
</tr>
<tr>
<td>Transitioning from working to becoming SSDI Disabled</td>
<td>Bureau of Labor Statistics (BLS) data;</td>
</tr>
<tr>
<td></td>
<td>Social Security Agency (SSA) data;</td>
</tr>
<tr>
<td></td>
<td>Reynolds and Crimmins (2010)</td>
</tr>
<tr>
<td>From SSDI Disabled back to working</td>
<td>SSA Data</td>
</tr>
</tbody>
</table>
# MODEL DEVELOPMENT

<table>
<thead>
<tr>
<th>Cost Category</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct medical costs</td>
<td>Costs of health care or medicine owing to obesity</td>
</tr>
<tr>
<td>Productivity cost: Absenteeism</td>
<td>Cost of time away from work owing to obesity</td>
</tr>
<tr>
<td>Productivity cost: Presenteeism</td>
<td>The impact of obesity on reduced productivity at work</td>
</tr>
<tr>
<td>SSDI (Social Security Disability Insurance)</td>
<td>Cost of SSDI claimed because of complications arising from obesity</td>
</tr>
<tr>
<td>Short-Term Disability</td>
<td>Cost of short-term disability incurred by private firms because of complications arising from obesity</td>
</tr>
<tr>
<td>Taxes Foregone</td>
<td>Taxes foregone due to lower wages resulting from obesity</td>
</tr>
<tr>
<td>Cost Category</td>
<td>Costing Source</td>
</tr>
<tr>
<td>-------------------------------------</td>
<td>-----------------------------------------------------</td>
</tr>
<tr>
<td>Direct medical costs</td>
<td>Finkelstein et al., 2010</td>
</tr>
<tr>
<td></td>
<td>Andreyeva et al., 2004</td>
</tr>
<tr>
<td>Productivity cost: Absenteeism</td>
<td>Finkelstein et al., 2010</td>
</tr>
<tr>
<td>Productivity cost: Presenteeism</td>
<td>Finkelstein et al., 2010</td>
</tr>
<tr>
<td>SSDI (Social Security Disability Insurance)</td>
<td>Social Security Administration</td>
</tr>
<tr>
<td>Short-Term Disability</td>
<td>Van Nuys et al., 2014</td>
</tr>
<tr>
<td>Taxes Foregone</td>
<td>BLS; Han et al., 2009</td>
</tr>
</tbody>
</table>
MODEL DEVELOPMENT

- Cohort BMI fluctuates over time according to algorithm
  - Algorithm from Heo et al. 2003
  - Uses hierarchical linear models (HLM) to develop growth curves depicting natural changes in BMI over time:

\[
Y(t) = 0.266 + 0.0014\text{Age} - 0.036\text{Sex} + 0.985\text{BMI} \\
+ (0.759 - 0.0051\text{Age} - 0.026\text{Sex} - 0.016\text{BMI})t \\
+ (-0.0037 - 0.00011\text{Age} + 0.00033\text{Sex} + 0.00016\text{BMI})t^2
\]

- Simulation software: TreeAge Pro 2015
- Costs are adjusted for inflation and discounted over time at a rate of 3 percent
MODEL VARIATIONS

• There are a number of assumptions implicit in the model.

• We vary these assumptions to test the sensitivity of our results to different drivers of cost.
# MODEL VARIATIONS

<table>
<thead>
<tr>
<th>Model Variation</th>
<th>Assumptions</th>
</tr>
</thead>
</table>
| Main model               | Discount rate = 3 percent  
                          | White mortality tables are used for Hispanic subset of population  
                          | Obese cohort is 10 percent more likely than the normal-weight cohort to claim SSDI below age 50 and 66 percent more likely above age 50 |
| Discount rate variation  | Discount rate = 5 percent  
                          | White mortality tables are used for Hispanic subset of population  
                          | Obese cohort is 10 percent more likely than the normal-weight cohort to claim SSDI below age 50 and 66 percent more likely above age 50 |
| SSDI Entry variation     | Discount rate = 3 percent  
                          | White mortality tables are used for Hispanic subset of population  
                          | Obese cohort is 35 percent more likely than the normal-weight cohort to claim SSDI below age 50 and 80 percent more likely above age 50 |
| Life Table variation     | Discount rate = 3 percent  
                          | Black mortality tables are used for Hispanic subset of population  
                          | Obese cohort is 10 percent more likely than the normal-weight cohort to claim SSDI below age 50 and 66 percent more likely above age 50 |
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RESULTS

Using the assumptions of the model, on average, the per person, lifetime societal costs were found to be $92,235 greater for a person with obesity ($2013), at a 3 percent discount rate.

Using this estimate, if all 12.7 million U.S. youth with obesity became obese adults, the societal costs over their lifetime may exceed $1.1 Trillion.
RESULTS

• Sensitivity analysis suggests that our results are robust to changes in assumptions
  » Changing SSDI transition probabilities results in less than $3,000 lifetime cost difference
  » Changing to the mortality rates used for the Hispanic cohort population has little impact.

• Results are sensitive to the discount rate.
  » Changing the discount rate from 3 percent to 5 percent led to a reduction in lifetime cost estimates of almost $30,000.
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LIMITATIONS

» The model likely underestimates total costs, and only focuses on a single generation.

» Additionally, there is emerging research on other costs such as increased fuel consumption, military readiness, life insurance and workers’ compensation.

» Best available (but not perfect) data used as inputs
  – Lifetables for Hispanic segment of cohort
  – Inexact representation of life trajectories (working without interruption)
  – Same assumptions for both cohorts
CONTRIBUTIONS

• Estimate of societal, lifetime costs of obesity

• Demographically representative cohorts
  » By including the demographic breakdown of Americans currently between the ages of 20 and 24, the model captures the increasing diversity of the population

• BMI varies through “life” of the cohorts

• This research synthesizes studies which differ in methodology, scope and data sources to the extent possible.
CONCLUSIONS

- Obesity does not only impose costs on individuals.
- There are substantial societal costs of high obesity rates in the United States, including productivity costs in the workplace and disability claims costs.
- Even if lifetime costs of obesity, such as health care, can be contained, the increase in the number of Americans with obesity foreshadows substantial societal costs.
- Our model indicates that increased costs of obesity is NOT offset by the relationship of obesity with higher mortality.
- Focusing on obesity-related mortality may obscure issues related to increased morbidity.
QUESTIONS

Thank you!