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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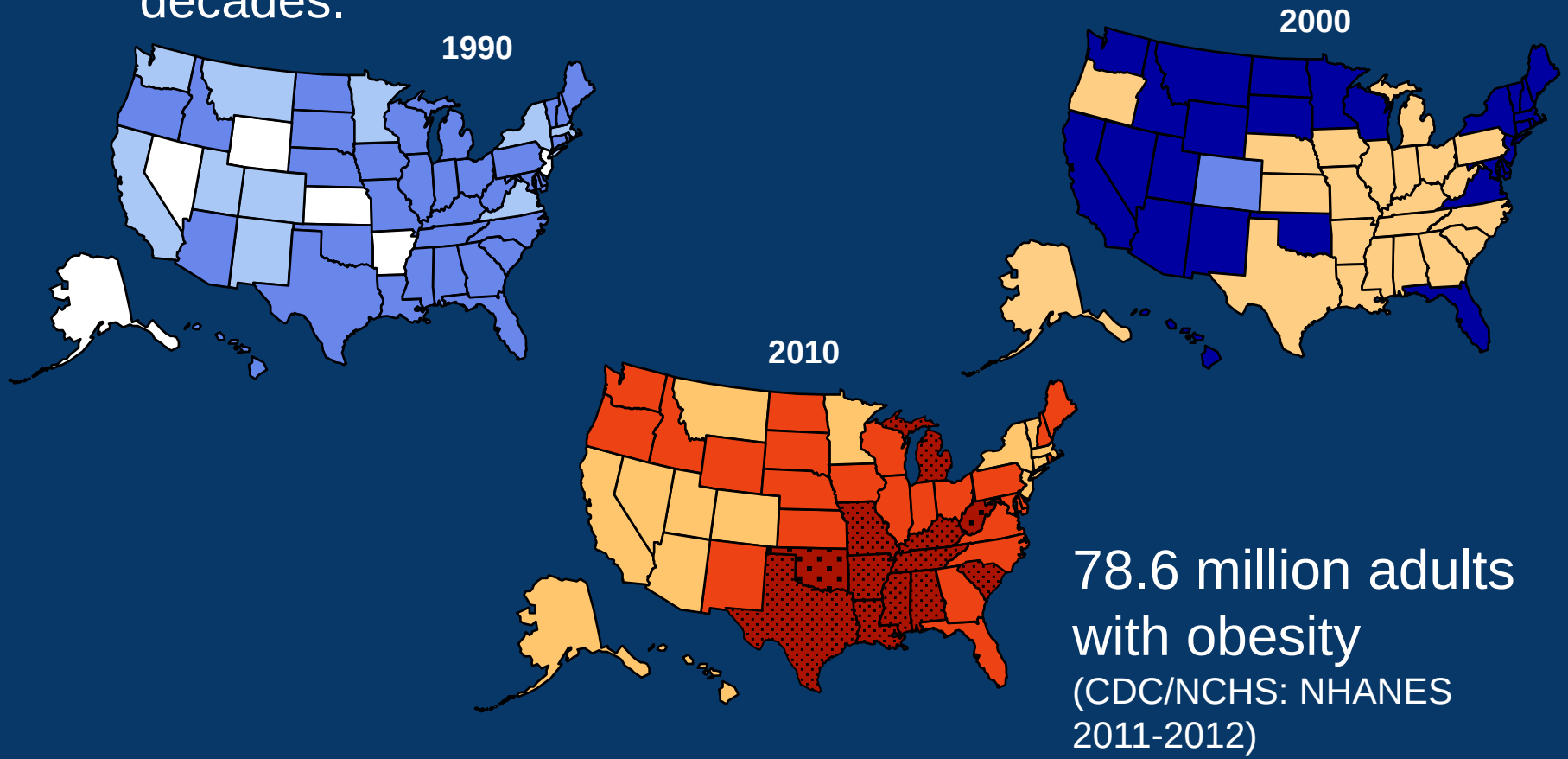
INTRODUCTION

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

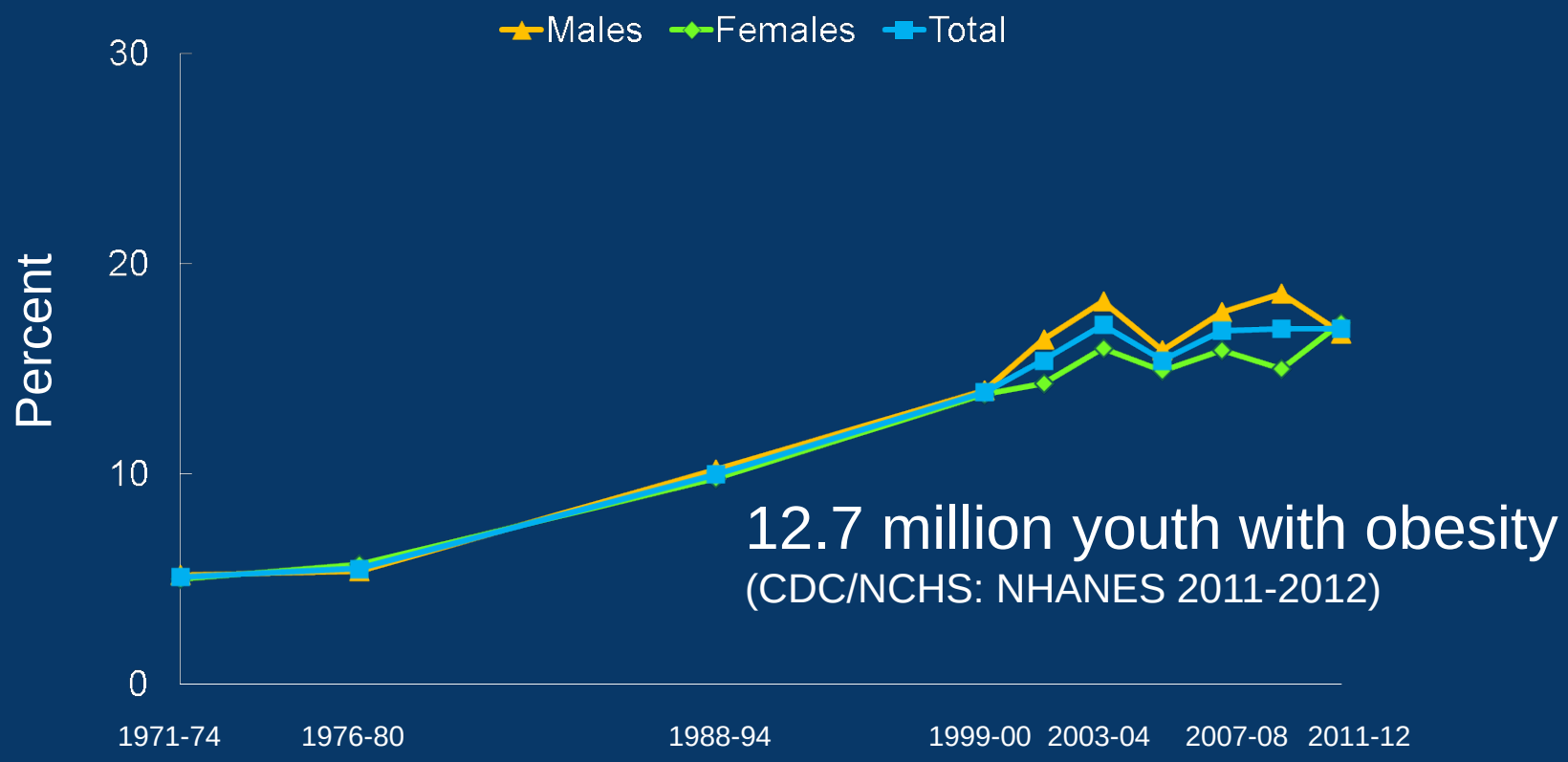


78.6 million adults with obesity
(CDC/NCHS: NHANES 2011-2012)

Source: CDC: Behavioral Risk Factor Surveillance System 1990, 2000 and 2010

INTRODUCTION

- **Trends in obesity among children and adolescents 2-19 years, by sex: US, 1971-74 through 2011-12**



Source: CDC/NCHS. National Health Examination Surveys II (ages 6-11), III (ages 12-17), and National Health and Nutrition Examination Surveys (NHANES) I-III, and NHANES 1999-2000, 2001-2002, 2003-2004, 2005-2006, 2007-2008, 2009-2010 and 2011-2012.

INTRODUCTION

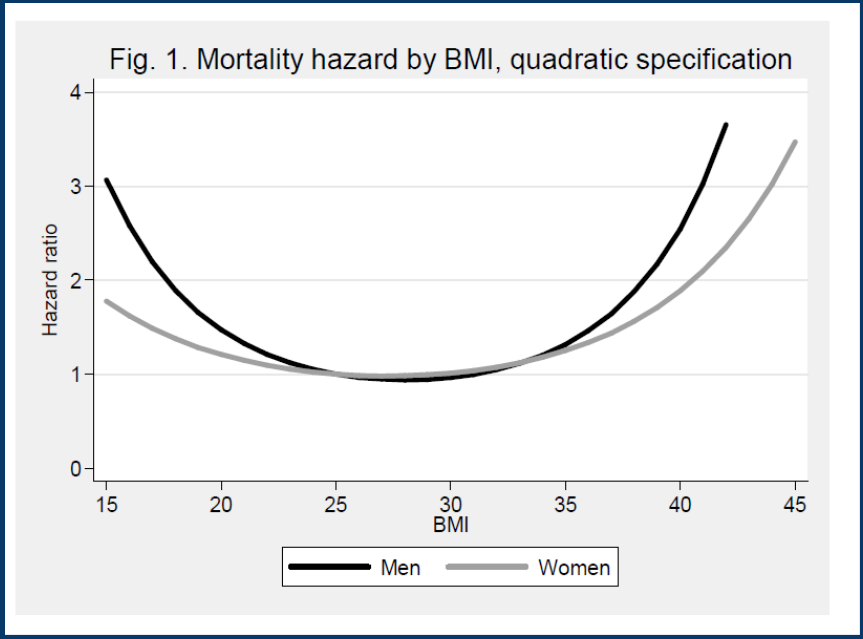
- Health Risks of Obesity Include:
  - » Coronary Heart Disease
  - » Type 2 Diabetes
  - » Stroke
  - » Certain Forms of Cancer
  - » Metabolic Syndrome
  - » Osteoarthritis
  - » Reproductive Issues
  - » Gallstones

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

INTRODUCTION

- Estimated relationship between with Body Mass Index and mortality

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



Source: Zajacova 2008.

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

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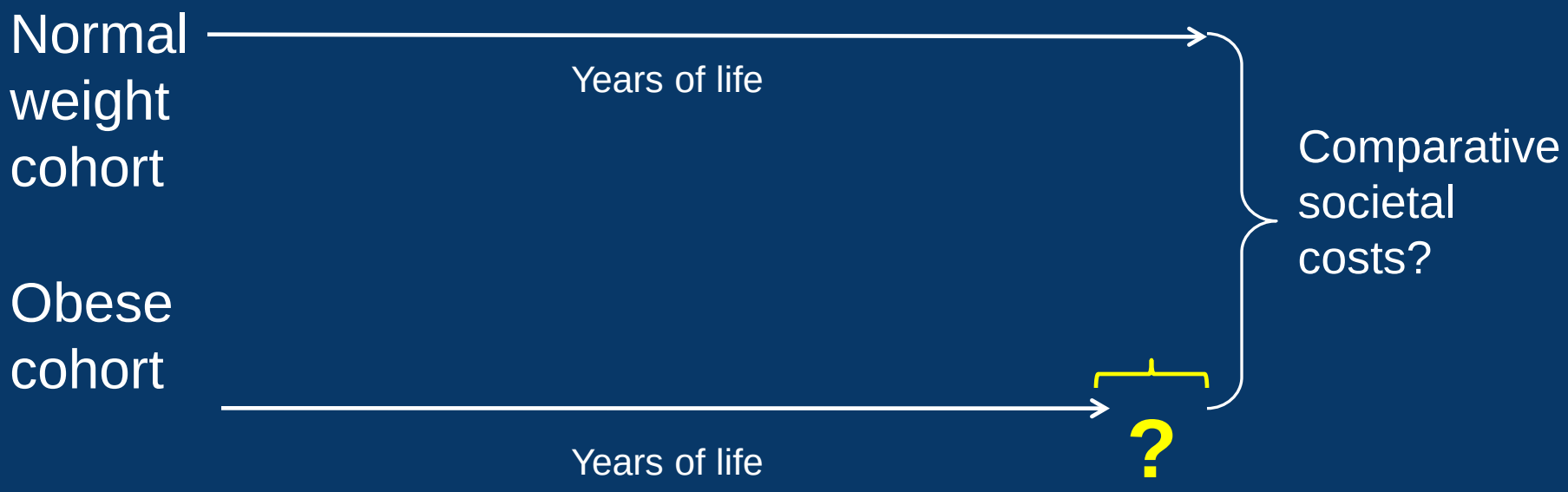
MODEL DEVELOPMENT

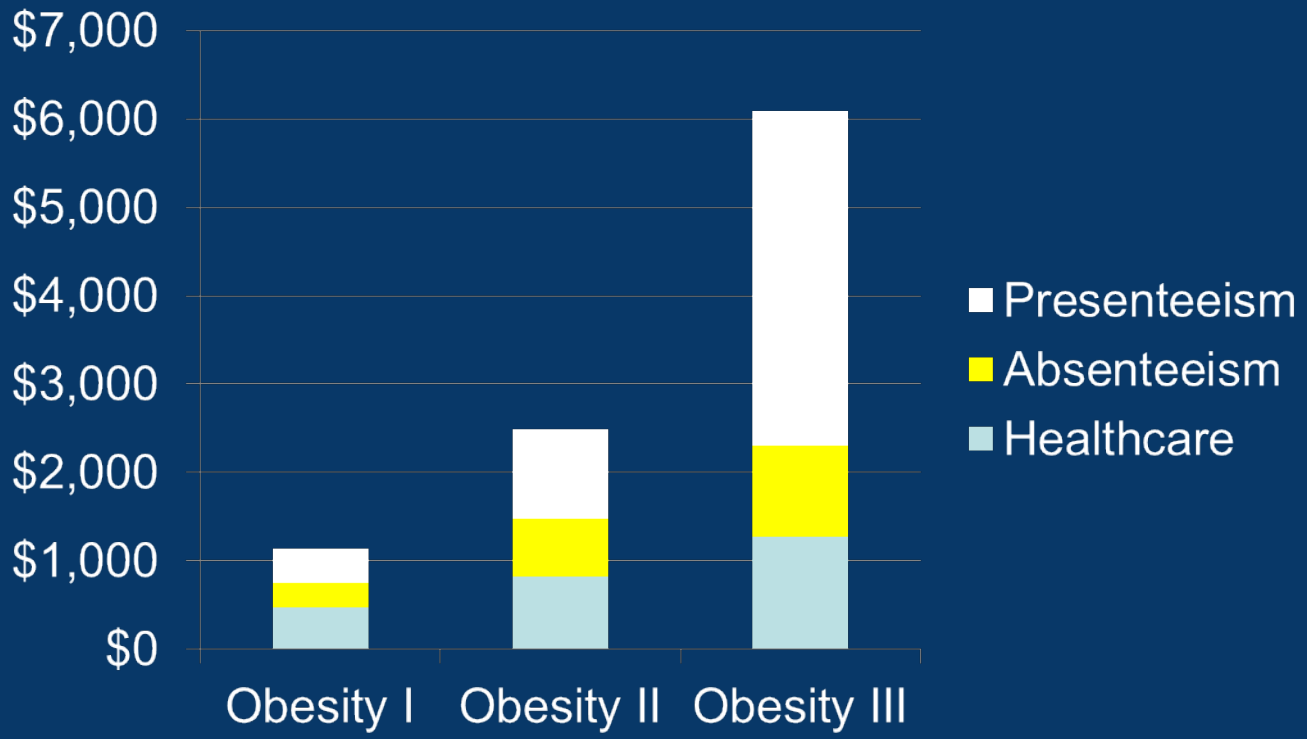
- Development of a Markov (state-transition) model)
  - » Compared net present value of lifetime costs of two hypothetical 1,000-person, demographically representative cohorts (one obese, one normal weight) from 25-85 years, or death



MODEL DEVELOPMENT

- 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



BMI; grade I obese, 30.0 –34.9 BMI; grade II obese, 35.0 –39.9 BMI; grade III obese, 40 BMI.

Source: Finkelstien et al., The Costs of Obesity in the Workplace, JOEM, 2010.

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:

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

Source: National Health and Nutrition Examination Survey data, 2013

- Normal cohort starting BMI: 20

MODEL DEVELOPMENT

- Probability Development

State Transition	Source
Mortality from any state	Fontaine et al. 2003
Transitioning from working to becoming SSDI Disabled	Bureau of Labor Statistics (BLS) data; Social Security Agency (SSA) data; Reynolds and Crimmins (2010)
From SSDI Disabled back to working	SSA Data

MODEL DEVELOPMENT

Cost Category	Definition
Direct medical costs	Costs of health care or medicine owing to obesity
Productivity cost: Absenteeism	Cost of time away from work owing to obesity
Productivity cost: Presenteeism	The impact of obesity on reduced productivity at work
SSDI (Social Security Disability Insurance)	Cost of SSDI claimed because of complications arising from obesity
Short-Term Disability	Cost of short-term disability incurred by private firms because of complications arising from obesity
Taxes Foregone	Taxes foregone due to lower wages resulting from obesity

MODEL DEVELOPMENT

Cost Category	Costing Source
Direct medical costs	Finkelstein et al., 2010 Andreyeva et al., 2004
Productivity cost: Absenteeism	Finkelstein et al., 2010
Productivity cost: Presenteeism	Finkelstein et al., 2010
SSDI (Social Security Disability Insurance)	Social Security Administration
Short-Term Disability	Van Nuys et al., 2014
Taxes Foregone	BLS; Han et al., 2009

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

Model Variation	Assumptions
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!