ESTIMATING HEALTHCARE COST ASSOCIATED WITH PREVALENCE OF OBESITY IN THE US

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ABSTRACT

Rates of overweight and obesity have increased dramatically around the world. The obesity epidemic increases the risk for several of the leading causes of preventable death such as type 2 diabetes, heart disease, stroke, and certain types of cancer, leads to loss of quality of life, and significant cost. In this paper, a computational simulation model is developed to model the progression of weight of individuals across four BMI categories over their lifetime and consequently forecast the total lifetime healthcare costs of obesity and overweight individuals. The results of our model can not only help guide physicians, third-party payers and patients to make inferences about future healthcare costs linked to obesity, but also provide data for decision making amongst policymakers.

INTRODUCTION

Obesity is a growing global problem. In the past four decades, the percentage of Americans who are obese has doubled to near 35%, and close to two third of the population is overweight [1]. The obesity epidemic increases the risk for other health problems such as type 2 diabetes, heart disease, stroke, and certain types of cancer, some of the leading causes of preventable death. Finkelstein et. al reported that obese patients incur 46% more inpatient costs, 27% more physician visits and outpatient costs, and 80% increased spending on prescription drugs in comparison with normal-weight individuals [2]. These costs are further saddled by productivity losses associated with obesity which was estimated to be around $174 billion in 2007 [3]. National health-care costs attributable to obesity/overweight alone have been estimated to rise to 860.7–956.9 billion US dollars by 2030, accounting for 16–18% of total US health-care costs [4].

Obesity imposes a serious challenge to patients and their families, clinicians/practitioners, as well as health policy makers who are required to allocate limited set of resources to obesity treatments and interventions. Policymakers are interested in developing and pursuing policies that can prevent the expected rise in the cost of obesity. Because of the high morbidity, mortality, and cost from obesity and associated illness, policymakers and the public have been interested in understanding how these costs will change over time and how new policies may alter these trends in costs. There are little long-term data and analysis that can potentially guide these types of decisions by looking at accumulated impact (in term of the healthcare cost) of obesity as well as obesity interventions. There are various studies that have attempted to capture obesity-associated costs [5], but they do not discuss possible strategies for the prevention and treatment of obesity.

To address such shortcomings, in this paper, a computational simulation model is developed to model the progression of weight status of individuals across four body mass index (BMI) categories over the lifetime of individuals to forecast the total lifetime healthcare costs associated with obesity and overweight. The results of our model can not only help guide physicians, third-party payers and patients to make inferences about future economic outcomes linked to obesity, but also provide data for decision making amongst policymakers.

METHODOLOGY

We developed a Markov model using TreeAge Pro 2016 (TreeAge Software Inc., Williamstown, Massachusetts, USA) with a one year cycle length to capture progression of individuals across 5 mutually exclusive discrete health states representing the individual's BMI (normal weight (18·5 ≤ BMI < 25), overweight (25 ≤ BMI < 30), obese (30≤BMI < 35), and severely obese (BMI≥35)) and death (absorptive state). With passing of each one year time step, everyone will have probabilities of staying in the same BMI state or transitioning to another BMI state or death. Death is an absorptive state which means once individuals move into this state they leave the model.

An adult can enter the model at any age 20 years or older with his/her initial BMI status. Each cycle (i.e., year), individuals accrue associated healthcare costs based on their BMI state. The healthcare cost that is captured in this study represents the direct medical costs (e.g., outpatient, hospitalization, emergency room visits, and medications). The healthcare costs that an individual accrues in each cycle of his/her lifetime are totaled when individual transitions to death state.

In terms of data inputs and sources, state transition probabilities came from the Coronary Artery Disease Risk Development in Young Adults (CARDIA) [6], a study examining the development and determinants of clinical and subclinical cardiovascular disease and its risk factors. We used Medicare claims data linked to the Surveillance, Epidemiology, and End Results (SEER) program [7] and the Medical Expenditure Panel Survey (MEPS) [8] to determine the direct medical costs for various BMI states. A 3% annual discount rate converted all past and future costs to 2017 $US.

We executed two different types of simulation runs. In the first set of simulation runs, we sent 1,000 individuals with a given starting age (varying from 20 to 60) and BMI status (normal weight, overweight, obese, and severely obese) through the model 1,000 times for a total of 1,000,000 trials. Then we reported the average and standard deviation of the total (lifetime) healthcare costs associated with prevalence of obesity. In the second set of simulation runs, we distributed 1000 individuals among our 4 BMI states at the start of the simulation according to the current (initial) distribution of the US population among these 4 BMI states. We also defined the initial age distribution of the individuals according to the current age distribution of the US adult population. The simulation run was repeated1000 times. Finally, we performed stochastic sensitivity analyses to explore the effects of varying the transition probabilities on obtained results.

RESULTS AND DISCUSSION

Our preliminary results showed that the lifetime direct health care costs of obese patients are on average 50% more than that of normal weight individuals. Moreover, as age of individuals increases, obese patients incur more lifetime healthcare costs in comparison with their normal weight counterparts. Comparing the lifetime healthcare costs of obese versus overweight individuals, we observed that obese patients, on average, incur about 25% more in healthcare costs than overweight patients. We also observe that as patients age, obese patients incur more healthcare costs than their overweight counter parts. Comparing overweight versus normal weight patients we observe that, on average, overweight patients incur about 19% more healthcare cost than normal weight individuals. Our results show that for obese patients to reduce their healthcare costs, it is not enough that they reduce their weight to overweight status. Instead, they must reduce their weight to normal state to observe a significant reduction in their healthcare costs.

Our results also showed that the lifetime healthcare costs of obese and overweight individuals increased as they aged with a peak around age 50. This may be attributed to the fact that chance of developing health complications associated with obesity and overweight increases around and after age 50.

Our sensitivity analysis showed that our results are more sensitive to varying the transition probabilities that are associated with progression of obesity as opposed to those that are related to reduction of weight status or BMI of individuals. These findings imply that if we can slow down the progression of obesity through preventive interventions and programs, then we will have a more significant effect on reduction of healthcare costs associated with obesity as opposed to focusing on interventions that are related to weight loss once the patients have gained weight.

Overall, our model estimated the lifetime healthcare costs associated with obese, overweight, and normal weight individuals throughout their lifetime. Various stakeholders can benefit from our results. For example, patients and physicians can use these numbers to better decide on the weight management programs and the economic effects those programs may have. Moreover, policy makers can use the obtained results to design more effective and targeted obesity interventions.

Our study like other modeling and simulation studies has its own limitations. First, we do not explicitly consider the short terms and long terms health complications associated with obesity prevalence. The short-term health complications can be pre-hypertension, hypertension, pre-hyperlipidemia, hyperlipidemia, pre-diabetes, and diabetes. Long terms health complications are various types of cancer, cardiovascular disease, stroke, and diabetes complications. Considering these health complications in the model and capturing their associated costs will lead to more realistic estimates of the healthcare cost. Finally, we do not account for productivity losses due to patients not being productive or being out of work due to obesity health complications. As employers realize the effects of obesity on the productivity of their employees and consequently their profits, they may consider sponsoring healthy lifestyle programs with weight-loss initiatives.

Future extensions of our study can incorporate the short term and long terms health complications associated with prevalence of obesity into the model. They can also capture the utilities associated with health complications and as a result, not only calculated the quality adjusted life years associated with obesity and overweight, but also the productivity losses associated with weight gain. Finally, by taking into account both healthcare costs and productivity losses, the total societal costs of obesity can be calculated.

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