

Health and Economic Benefits of Weight Loss among Obese U.S. Adults

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EXECUTIVE SUMMARY

The prevalence of obesity in the United States has reached 35 percent nationally and 40 percent among the elderly population—double what it was a generation ago. This compares to an obesity rate of 18.4 percent across all industrialized economies. High obesity rates and rising health care costs make obesity a costly disease. Health economists estimate that obesity is responsible for 27 percent of the increase in overall per-capita health care spending from 1987 to 2001.

Understanding the extent of the problem and the potential benefits of weight loss is key for U.S. policymakers pursuing solutions to the obesity epidemic. This paper quantifies the health and economic burdens that obesity creates and presents evidence of both the health benefits and savings opportunities that arise from weight loss among obese U.S. adults.

Obesity among all U.S. adults is estimated to generate \$147 billion in annual medical spending. By this measure, the cost of treating an obese person is \$1,429 greater than the cost of treating a person of normal weight. Another estimate puts obesity's annual direct cost at \$209.7 billion, or \$2,741 higher per capita.

Obesity drives health care spending primarily through the increased prevalence of costly comorbidities such as diabetes, cardiovascular disease (CVD), osteoarthritis, and certain cancers. The direct cost of these diseases is enormous and highly associated with obesity. For example, nearly half of all individuals with CVD are obese, and CVD costs nearly \$200 billion annually. Moreover, the risk of developing these comorbid diseases is significantly higher for the obese population. For example, the risk of developing type 2 diabetes is over 12 times greater for an obese woman compared to a nonobese woman.

Weight loss has been shown to improve health outcomes, which translates into cost savings. In addition, weight loss among obese individuals without a comorbid condition can dramatically reduce the risk of developing a comorbidity. This paper estimates the potential savings, nationally and for the Medicare population, from preventing the development of five comorbidities by reducing obesity rates by 10 percent. (See the following table for a summary of the savings estimates.)

Savings from Preventing Onset of Select Comorbidities through 10% Reduction in Obesity Rate		
Comorbidity	Total Savings	Medicare Savings
Type 2 Diabetes	\$852,285,656	\$281,539,748
Hypertension	\$282,826,916	\$138,857,879
Osteoarthritis	\$149,867,970	\$ 45,748,216
Colorectal Cancer	\$ 71,800,531	\$ 42,181,898
Breast Cancer	\$ 30,469,895	\$ 11,485,731

Note: Estimates reflect gross savings since they do not include the cost of interventions. Moreover, the results should not be added as there may be some overlap of risk factors for the various diseases.

INTRODUCTION

There is consensus among policymakers, health care professionals, health economists, health policy researchers, and other experts that obesity is a national problem. The United States has the highest obesity rate in the world, and we face up to \$209.7 billion per year in additional obesity-related health care costs. For the sake of both our nation's health and our economy, it is imperative that we lose weight.

Understanding the extent of the obesity epidemic and the potential benefits of weight loss is key for U.S. policymakers pursuing solutions to this problem. With this in mind, this two-part paper first quantifies the health and economic burdens that obesity creates and then presents evidence of both the health benefits and savings opportunities that arise from weight loss among obese U.S. adults.

I. HEALTH AND ECONOMIC BURDENS OF OBESITY

The standard metric for identifying obesity is body mass index (BMI), calculated as weight (in kilograms) divided by height (in meters) squared. An individual with a BMI of 30 or greater is considered obese (for example, an individual 5' 9" tall and 203 lbs.). While BMI does not measure a person's body fat percentage directly, it has been shown to be a useful, noninvasive, and cost-effective means for determining obesity rates. Some researchers have criticized the metric as too crude, but Frankenfield et al. (2001) find that, though it may underreport obesity relative to bioelectrical impedance (a technique for estimating body fat percentage), BMI is an effective predictor of body fat for those with a BMI greater than 30.

In this section, we look first at U.S. obesity rates and trends, situating the United States among

other countries' experience with obesity. We turn next to estimates of the various kinds of diseases and costs associated with obesity in the United States.

Obesity Prevalence

The United States leads the world in obesity, with particularly high rates among retirement-age Americans and minorities. While there is a wide disparity in obesity globally, obesity rates have been climbing in most developed nations. This section looks first at obesity prevalence in the United States and then globally.

U.S. Prevalence

Obesity prevalence—the share or proportion of a population that is obese—is 35 percent among all U.S. adults but varies significantly by subpopulation. For example, the obesity rate is more than 42 percent among Hispanics and nearly 48 percent among blacks (Ogden et al. 2014). Among low-income women and women without a high-school diploma, obesity prevalence is 42 percent (Ogden et al. 2010). More than 40 percent of U.S. adults age 65–74 are obese. Older women used to outpace older men in obesity prevalence, but in the last fifteen years, obesity has increased among older men while remaining steady among older women (Fakhouri et al. 2012).

No state has a rate below 20 percent, and thirteen states have rates above 30 percent: Alabama, Arkansas, Indiana, Iowa, Kentucky, Louisiana, Michigan, Mississippi, Ohio, Oklahoma, South Carolina, Tennessee, and West Virginia (CDC 2014a).

The obesity rate among U.S. adults doubled between 1980 and 2003 but has plateaued in the last decade (Trust for America's Health 2013 and Ogden et al. 2014). The rise in obesity was marked by stark differences across subpopulations. For example, the obesity rate increased more quickly between 1999 and 2011 for Americans with higher education than for those with less education (OECD 2014).

Global Prevalence

While the United States has outpaced other developed countries in the rate and rise in obesity, obesity rates have been climbing around the globe. The average obesity rate across all OECD economies is 18.4 percent, nearly half the rate in the United States, which has the highest rate of all 34 OECD countries (see Figure 1 on the following page). Obesity rates in China, Japan, Indonesia, and India are below 4 percent. Obesity rates in France and Germany are just below 15 percent, and in Canada just above 25 percent. Only two countries, Mexico and New Zealand, join the United States with rates above 30 percent (OECD 2014).

U.S. Obesity Spending

Medical spending on obesity and its associated diseases (or comorbidities) is known as the direct cost. The indirect cost refers to the

nonmedical burden of obesity (for example, reduced productivity from absenteeism and disability).

A spectrum of chronic diseases afflicts Americans and leads to significant health care expenditures and other economic costs. Obesity, a chronic disease itself, contributes to the incidence (the risk of acquiring a disease in a given time period) of numerous other chronic diseases, each with its own cost burden and impact on the U.S. economy. More than 75 percent of all U.S. health expenditures are the result of chronic diseases (CDC 2009).

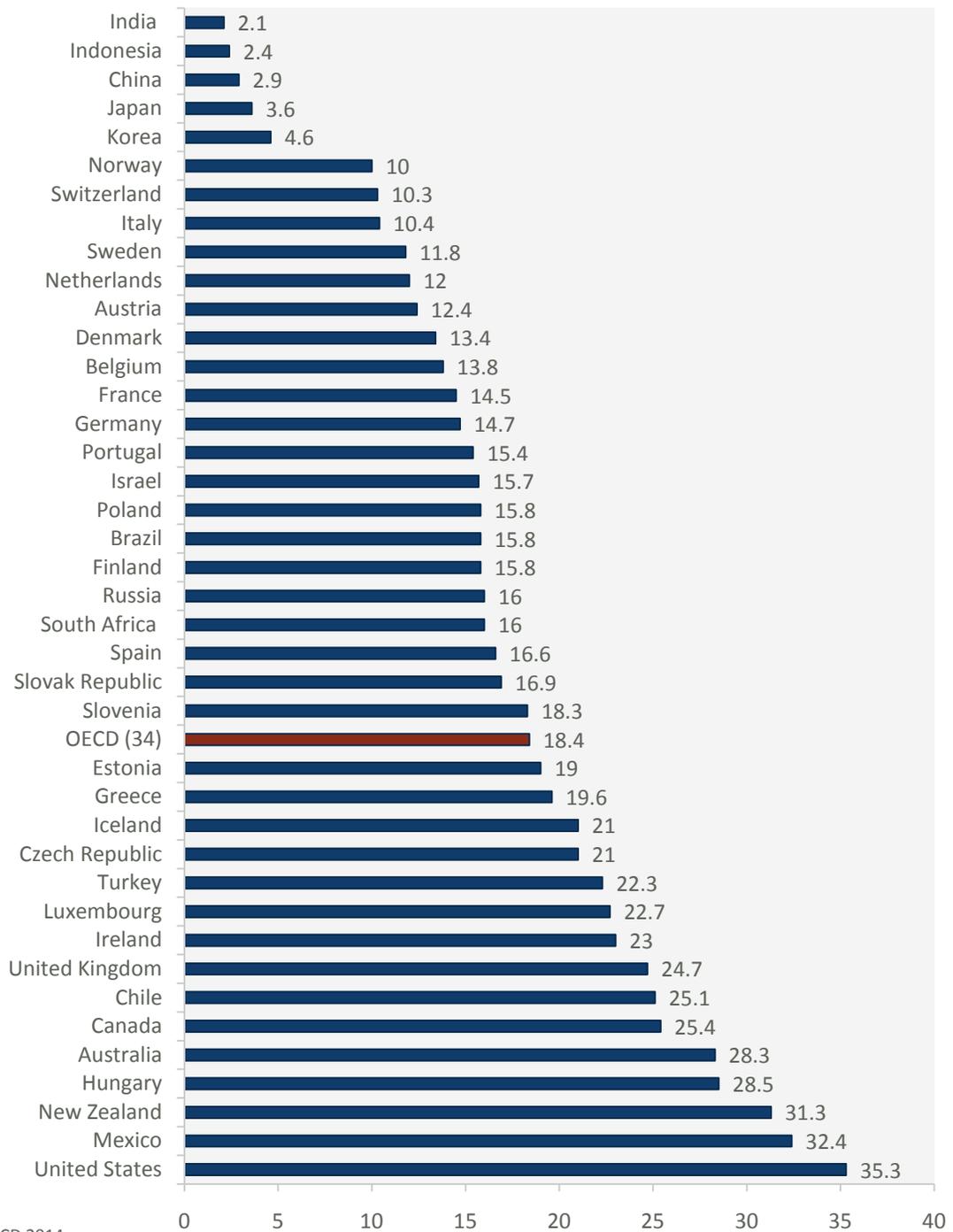
This section examines the aggregate direct cost of obesity before turning to the direct cost of select comorbidities, the Medicare costs associated with obesity and comorbidities, and the indirect cost of obesity.

People who are obese are much more likely to be hospitalized, a huge cost to the U.S. health care system. Almost one-third of U.S. health care spending goes toward inpatient hospital services.

Aggregate Direct Cost of Obesity

The direct cost of obesity comprises spending on doctors' visits, prescription drugs, emergency room visits, hospitalizations, surgeries, and other medical treatments. Obesity has been shown to substantially increase health spending. For example, people who are obese are much more likely to be

Figure 1. Global Obesity Rates
(% population age 15+)



Source: OECD 2014.

hospitalized, a huge cost to the U.S. health care system. The Agency for Healthcare Research and Quality reports that almost one-third of U.S. health care spending goes toward inpatient

hospital services (Weiss et al. 2014). Korda et al. (2013) find that, compared with people with normal BMI, severely obese people (defined as having a BMI of 35–50) age 45–64 face twice

the risk of hospitalization, while the risk of hospitalization for severely obese people age 65–79 is 50–60 percent greater than it is for those of normal weight in that age cohort.

Thorpe et al. (2004) examine the increase in medical spending due to obesity between 1987 and 2001 using 1987 data from the National Medical Expenditure Survey and 2001 data from the Medical Expenditure Panel Survey, Household Component. In 1987, health care spending for obese people was 15.2 percent higher than spending for those of normal weight. By 2001, this difference had grown to 37 percent. Thorpe and coauthors estimate that obesity is responsible for 27 percent of the increase in overall per-capita health care spending during this time. In dollar terms, medical spending on an obese person relative to someone of normal weight was \$321 greater in 1987 and \$1,609 greater in 2001.

In an oft-cited study of the total direct cost of obesity, Finkelstein et al. (2009) estimate the annual direct cost of obesity using data from the National Health Expenditure Accounts (NHEA) and the Medical Expenditure Panel Surveys (MEPS). Finkelstein and coauthors note that NHEA data include institutionalized patients, while MEPS data do not. This difference yields higher estimates from NHEA data. Based on MEPS data, obesity is estimated to generate \$86 billion in additional annual medical spending in the United States. On a per-capita basis, the annual cost of treating an obese person is \$1,429 greater than the cost of treating a person of normal weight. Using NHEA data causes the total estimate to rise to \$147 billion per year.

Cawley and Meyerhoefer (2012) find that these and other estimates of obesity's direct cost likely are too low. Cawley and Meyerhoefer analyze MEPS data, which Finkelstein et al. (2009) use for their lower estimate, but employ an instrumental variables approach, which allows them to correct for statistical issues (endogeneity and reporting error, specifically) that inhibit previous models. Using a family member's weight as an instrument, Cawley and Meyerhoefer estimate that obesity generates annual direct costs of \$209.7 billion. By this measure, annual spending on medical care is \$2,741 higher for an obese person than it is for someone of normal weight. This compares to \$1,300 per person in excess health spending attributable to smoking (Congressional Budget Office 2012).

Cawley and Meyerhoefer estimate that obesity generates annual direct costs of \$209.7 billion.

Direct Cost of Comorbidities

Because much of the direct cost of obesity is attributable to high-cost comorbidities, looking at these diseases individually offers a more granular perspective on the drivers of obesity's direct cost. Guh et al. (2009) identify twenty prominent comorbidities of obesity: asthma, cancer (breast, colorectal, endometrial, esophageal, kidney, ovarian, pancreatic, and prostate), chronic back pain, congestive heart failure, coronary heart disease, dyslipidemia,

gallbladder disease, hypertension, osteoarthritis, pulmonary embolism, stroke, sleep apnea, and type 2 diabetes. This list is by no means comprehensive. Here, we highlight eight comorbidities and their estimated annual direct costs, as well as the risk of obese people developing the diseases relative to those of normal weight. Relative risk estimates are drawn from Guh et al. (2009). It should be noted that, since there may be some overlap in the cost of these diseases, the cost estimates should not be summed to reach a total cost. See Table 1 at the end of this section for a summary of the direct costs and relative risks.

Cardiovascular Disease. Cardiovascular disease (CVD) comprises a number of different diseases of the heart. Among U.S. adults with CVD, 49 percent are obese (Go et al. 2014).

- Annual direct cost of CVD in the United States: \$193.4 billion (Ibid.). (This includes coronary heart disease and hypertension, which are presented individually below.)

Osteoarthritis. The most prevalent type of arthritis, osteoarthritis causes joint degeneration and often leads to disability in people who suffer from the disorder. Because obesity causes strain on weight-bearing joints, it is associated with the incidence of osteoarthritis.

- Annual direct cost of osteoarthritis in the United States: \$185.5 billion (Kotlarz et al. 2009).
- For obese men and women, the risk of developing osteoarthritis is 4.20 and 1.96 times greater, respectively, than the risk for men and women of normal weight.

Type 2 Diabetes. Diabetes is a disease characterized by high levels of blood glucose (i.e., blood sugar). Type 2 diabetes, which is prominently linked to obesity, causes the body to stop responding to the insulin that it produces naturally to absorb glucose. (Type 1 diabetes is far less common, is not associated with weight, and typically develops during childhood.) In the United States, 28.9 million people age 20 or older have diabetes. Of these, 90–95 percent (or approximately 26.0 million–27.5 million people) have type 2 diabetes (CDC 2014b). Nearly 55 percent of people with diabetes are obese (CDC 2004).

- Annual direct cost of type 2 diabetes in the United States: \$105.7 billion (Dall et al. 2009).
- For obese men and women, the risk of developing type 2 diabetes is 6.74 and 12.41 times greater, respectively, than the risk for men and women of normal weight.

Because much of the direct cost of obesity is attributable to high-cost comorbidities, looking at these diseases individually offers a more granular perspective on the drivers of obesity's direct cost.

Hypertension. Hypertension, or high blood pressure, is characterized by systolic blood pressure of 140 mm Hg or higher or diastolic blood pressure of 90 mm Hg or higher.

Compared to a nonobese individual, an obese person is twice as likely to have hypertension (Kotchen 2008).

- Annual direct cost of hypertension in the United States: \$69.9 billion (Heidenreich et al. 2011).
- For obese men and women, the risk of developing hypertension is 1.84 and 2.42 times greater, respectively, than the risk for men and women of normal weight.

Coronary Heart Disease. Coronary heart disease (CHD) is the most common heart disease and the leading cause of death for U.S. adults (NHLBI 2012). Also known as coronary artery disease, CHD causes plaque to build up in the arteries and increases the risk of heart attack. In 2010, CHD caused approximately one in six deaths (Go et al. 2014).

- Annual direct cost of CHD in the United States: \$35.7 billion (Heidenreich et al. 2011).
- For obese men and women, the risk of developing CHD is 1.72 and 3.10 times greater, respectively, than the risk for men and women of normal weight.

Breast Cancer. Obesity is linked to several types of cancer, the costliest of which is breast cancer (Mariotto et al. 2011). According to the National Cancer Institute, obesity is associated in particular with breast cancer among postmenopausal women, likely because of higher estrogen levels among obese women in this cohort (NCI 2012).

- Annual direct cost of breast cancer in the United States: \$16.5 billion (Mariotto et al. 2011).
- For obese women, the risk of developing breast cancer is 1.13 times greater than the risk for women of normal weight.

Obstructive Sleep Apnea. People who have obstructive sleep apnea (OSA) experience repeated interruptions in breathing as they sleep. Oxygen and sleep deprivation put people with OSA at higher risk for CVD and diabetes, among other diseases. OSA prevalence is low among normal-weight middle-aged individuals: 2–3 percent in men and 4–5 percent in women. But among the obese, OSA prevalence is over 30 percent (Pillar and Shehadeh 2008). Put another way, 70 percent of people with OSA are obese (Tuomilehto et al. 2013).

- Annual direct cost of OSA in the United States: \$16.0 billion (Kayyali et al. 2008).

Colorectal Cancer. The second costliest obesity-linked cancer is colorectal cancer (Mariotto et al. 2011). According to the National Cancer Institute, the link between obesity and colorectal cancer is stronger among men than women and is particularly associated with waist circumference (NCI 2012).

- Annual direct cost of colorectal cancer in the United States: \$14.1 billion (Mariotto et al. 2011).
- For obese men and women, the risk of developing colorectal cancer is 1.95 and 1.66 times greater, respectively, than the risk for men and women of normal weight.

Table 1. Direct Cost and Relative Risk of Comorbidities			
Comorbidity	Annual Direct Cost	Male RR*	Female RR*
Cardiovascular Disease	\$193.4 billion	NA**	NA**
Osteoarthritis	\$185.5 billion	4.20	1.96
Type 2 Diabetes	\$105.7 billion	6.74	12.41
Hypertension	\$ 69.9 billion	1.84	2.42
Coronary Heart Disease	\$ 35.7 billion	1.72	3.10
Breast Cancer	\$ 16.5 billion	NA**	1.13
Obstructive Sleep Apnea	\$ 16.0 billion	NA**	NA**
Colorectal Cancer	\$ 14.1 billion	1.95	1.66

* RR = relative risk (the probability of an obese individual developing a disease compared to a normal-weight individual)

** NA = not available

Obesity and Comorbidities in Medicare

The costs and risks associated with the comorbidities presented above relate to the overall U.S. population. In general, the prevalence and incidence of these diseases are even higher among the elderly. For example, 58 percent of Medicare beneficiaries have high blood pressure, 45 percent have high cholesterol, 31 percent have heart disease, and 29 percent have arthritis (CMS 2012). Along with a rise in the obesity rate among the elderly, there has been a related increase in chronic conditions (AHA 2012). This means that Medicare bears a disproportionate share of the direct cost associated with obesity and its comorbidities. For example, the annual per-person medical cost among U.S. adults with diabetes is \$6,414 but \$9,061 among diabetic adults age 65 and over (Dall et al. 2009). The prevalence of diabetes among all U.S. adults is 12.3 percent, while the prevalence among

those 65 and over is 25.9 percent (CDC 2014b). New cases of diabetes in 2012 totaled 7.8 for every thousand U.S. adults and 11.5 for every thousand adults age 65 and over (Ibid.).

Finkelstein et al. (2009) find that 23 percent of total obesity spending is borne by Medicare, which amounts to 8.5 percent of total annual Medicare spending. By this measure, \$50 billion of the \$585 billion in Medicare spending in 2013 is attributable to obesity.

23 percent of total obesity spending is borne by Medicare, which amounts to 8.5 percent of total annual Medicare spending.

More recently, Trogon et al. (2012) estimate the cost impact of obesity by state and find significant variation. For example, Medicare costs attributable to obesity are highest in California (\$3.4 billion annually), and lowest in Wyoming (\$35 million annually). The fraction of Medicare spending attributable to obesity also varies considerably, with a high of 10.2 percent in Ohio and a low of 5.2 percent in Hawaii.

Indirect Cost of Obesity

Obesity's indirect cost comprises nonmedical costs such as absenteeism, disability, and premature mortality induced by obesity and its comorbidities. The annual indirect cost of obesity is estimated to total \$66 billion per year (Hammond and Levine 2010). The indirect costs of comorbidities vary significantly. For example, CVD generates estimated annual indirect costs in the United States of \$122.0 billion (Go et al. 2014), while type 2 diabetes has indirect costs of \$53.8 billion per year (Dall et al. 2009).

II. HEALTH BENEFITS AND SAVINGS OPPORTUNITIES FROM WEIGHT LOSS

This section focuses on the promise that weight loss holds for both improving health outcomes for the obese and generating health care savings. We first present evidence of the positive impact of weight loss for those already afflicted with various comorbidities. We then present an analysis of the savings achievable from reducing the incidence of select diseases through weight loss.

Impact of Weight Loss on Comorbidities

Weight-loss interventions include pharmaceuticals, surgery, diet and exercise, and medical weight-loss programs. Some of these interventions are covered by insurance while others are not. Notably, prescription weight-loss medicines are excluded from Medicare Part D. While each type of treatment yields different successes and carries different risks, in all cases, successful weight loss is associated with improved health outcomes and reduced risks of comorbidities.

We present here longitudinal and cross-sectional evidence of the impact of weight loss on comorbidities. Both types of study show the benefits of weight loss among obese people, but longitudinal studies have the advantage of tracking the impact of weight loss for the same individuals over time.

The evidence presented here excludes improvements in comorbidities achieved through weight-loss surgery. According to Park and Torquati (2011), "Bariatric surgery results in significant improvements in diabetes (and other comorbid conditions of obesity) before any significant weight loss has taken place."

Weight loss among the obese can both reduce the severity of comorbidities in people who are already afflicted and prevent comorbidities before they develop. This section looks first at evidence of the former before presenting a savings analysis of the latter.

Evidence That Weight Loss Improves Comorbid Conditions

Here, we focus on the benefits of weight loss among those who already have comorbidities. We examine six comorbidities and the impact that weight loss has on obese individuals who suffer from these diseases.

Cardiovascular Disease. In a randomized clinical trial, Fayh et al. (2013) enrolled obese participants in either dietary counseling or dietary counseling and exercise. Weight loss of 5 percent of body weight resulted in significant reductions in cardiovascular risk factors. Specifically, the dietary counseling group saw an average decrease of 15.8 percent in total cholesterol; 33.8 percent in triglycerides; and 1.35 percent in high-sensitivity C-reactive protein (hs-CRP) levels, a measure of inflammation and a sign of risk for cardiovascular and other diseases.

Osteoarthritis. Messier et al. (2004) conducted an eighteen-month randomized, single-blind clinical trial on the effects of diet and exercise on knee osteoarthritis among overweight and obese adults. The primary outcome was self-reported physical function. Participants in the group focused on both diet and exercise lost 5.7 percent of their body weight, while participants in the diet-only group lost 4.9 percent of their body weight. At the conclusion of the study, the groups had self-reported improvements in physical function of 24 and 18 percent, respectively.

Type 2 Diabetes. A retrospective cohort study conducted by Kumar et al. (2012) analyzed the impact on medication dosage of weight loss among overweight and obese patients with

type 2 diabetes. The study sampled patients at the Johns Hopkins Weight Management Center in Baltimore, MD, and the George Washington Weight Management Program in Washington, DC, between March 2008 and August 2010. Kumar and coauthors found that 5 percent weight loss was associated with reductions in dosage of sulfonylureas, insulin, and anti-diabetic medications of 39 percent, 42 percent, and 49 percent, respectively.

In a meta-analysis published in 2014, Ribaric and coauthors identified sixteen articles comparing type 2 diabetes remission resulting from weight-loss surgery with remission resulting from “conventional” (i.e., nonsurgical) means. The articles, published between

Reduction in Prescription Drug Usage following Weight Loss

In addition to reducing hospital inpatient stays and emergency room visits, weight loss also leads to pharmaceutical savings. A new longitudinal study examining a medical weight-loss program found that, excluding the cost of intervention, participants saved on average over \$73 per month on medications for diabetes, hyperlipidemia, hypertension, and gastroesophageal reflux disease (Busko 2013 and Wiske and Pera 2013).

December 2004 and June 2013, examined randomized controlled trials and observational studies with a total of 3,005 participants in conventional weight-loss programs. The average excess weight loss for the conventional therapy participants was 11.3 percent, resulting in an average type 2 remission rate of 15.6 percent. (It should be noted that excess weight loss represents a larger number than the oft-reported weight loss as a percentage of original body weight.)

Hypertension. A study conducted at the University of Pittsburgh from 2007 to 2010 examined the impact of weight loss on cardiometabolic risk factors among the severely obese. Through a combination of diet and physical activity, participants lost on average 8–10 percent of their body weight, resulting in average decreases in systolic blood pressure of 11 percent and decreases in diastolic blood pressure of 7 percent (Goodpaster et al. 2010).

Coronary Heart Disease. Dattilo and Kris-Etherton (1992) conducted a meta-analysis of the impact of weight loss on CHD risk factors, particularly lipid and lipoprotein values. The meta-analysis comprised seventy studies on the topic from peer-reviewed journals. All of the studies achieved weight loss through dieting. Before weight loss, study participants had an average BMI of 34.8. Dattilo and Kris-Etherton found that for every one kilogram of weight loss, total cholesterol, low-density-lipoprotein cholesterol, and triglycerides decreased 0.05 millimoles per liter (mmol/L), 0.02 mmol/L, and 0.015 mmol/L, respectively.

Obstructive Sleep Apnea. Weight loss has been associated with improvements in OSA for decades (Tuomilehto et al. 2013). For example, a 1985 study conducted at Johns Hopkins Sleep Disorders Center analyzed the impact of weight loss on apnea episodes during non-rapid eye movement (non-REM) and rapid eye movement (REM) sleep. Researchers found that a 9 percent loss of body weight among mildly to moderately obese patients with OSA was associated with a 47 percent decrease in apnea episodes during non-REM sleep and a 34 percent decrease during REM sleep. Weight loss was also responsible for significant improvement in sleep patterns and oxygenation among study participants.

Medicare Savings from Weight Loss

A new analysis in *Health Economics Review* estimated that Medicare would achieve gross savings of \$7,446–\$10,126 per person over ten years from obese beneficiaries' losing 10 percent of their body weight (Thorpe et al. 2013).

A recent *Health Affairs* study examined the impact of 4.2 percent weight loss among overweight and obese adults age 60–64 who are at risk of cardiovascular disease or are prediabetic (Thorpe and Yang 2011). Depending on levels of participation in the weight-loss program under examination, gross savings of \$3.8 billion–\$4.7 billion would accrue to Medicare over ten years.

Preventing Disease Onset through Weight Loss: Savings Analysis

The medical savings achievable through weight loss has long been documented. A 1999 study in the *American Journal of Public Health* found that 10 percent weight loss among obese adults age 35–64 generated gross lifetime savings on medical care of \$2,200–\$5,300 per person (roughly \$3,100–\$7,400 in 2013 dollars) for five common obesity-related diseases (Oster et al.).

As demonstrated above, weight loss provides great benefit for obese people who have already developed comorbidities. But achieving weight loss before the onset of disease and preventing the development of comorbidities is clearly desirable—and possible. For example, weight loss is highly effective at preventing the onset of type 2 diabetes among the obese. A 2002 study by the Diabetes Prevention Program Research Group follows 3,234 non-diabetics at high risk of developing diabetes. The average BMI among participants is 34. The study finds that lifestyle intervention, which resulted in average weight loss of 6 percent of body weight, reduces the incidence of type 2 diabetes by 58 percent.

Disease prevention resulting from weight loss among the obese also offers sizeable savings. Here, we estimate potential savings—for the U.S. health care system as a whole and for Medicare specifically—from preventing the development of five comorbidities by reducing the U.S. obesity rate by 10 percent.

Data and Methodology

For each of the five comorbidities, we derive from the meta-analysis conducted by Guh et al. (2009) the risk of obese people developing the disease relative to people of normal weight. Using these estimates of relative risk, we construct five individual models to estimate how much a 10 percent reduction in the obesity rate would lower the annual incidence of comorbidities. To estimate the health care savings that lowering the incidence of comorbidities would yield, we incorporate in each model the direct cost of the comorbidity as presented in Part 1. We construct each model as follows. (See Table 2 for parameters and an example of our methodology.)

Using 2012 data from the U.S. Census Bureau, we analyze U.S. adults age 20 and over. Because we are looking only at adults at risk of developing comorbidities, we need first to remove from each model those who already have the respective disease. To derive our population estimates, we incorporate in the models estimates of disease prevalence in order to narrow our analysis of each comorbidity to adults without the disease. For example, there are more than 117 million U.S. women age 20 and over. The prevalence of type 2 diabetes among adult women is approximately 10 percent. Therefore, the number of women in our analysis is roughly 105 million, or 10 percent lower than the total number of U.S. women.

Table 2. Example of Comorbidity Model: Type 2 Diabetes

<i>Model Parameters</i>	
Obesity rate among U.S. women age 20+	36.1%
Obesity rate after 10% reduction	32.5%
Diabetes prevalence among U.S. women age 20+	10.1%
# of U.S. women age 20+ without diabetes	105,523,818
Direct cost per diabetes patient	\$6,414
Relative risk of obese women developing diabetes	12.41
Annual diabetes incidence among U.S. adults age 20+	7.8 out of 1,000
<i>Baseline for 1,000 Women</i>	
# of obese among 1,000 women	361
# of nonobese among 1,000 women	639
# of women who will develop diabetes	7.80
# of obese women	7.22
# of nonobese women	0.58
% of obese women who will develop diabetes	2.00%
% of nonobese women who will develop diabetes	0.09%
<i>Effect on Baseline of 10% Reduction in Obesity Rate</i>	
# of obese among 1,000 women	325
# of nonobese among 1,000 women	675
# of women who will develop diabetes	7.11
# of obese women	6.50
# of nonobese women	0.61
<i>Model Results</i>	
New annual diabetes incidence	7.11 out of 1,000
# of women who will not develop diabetes as a result of obesity rate reduction	72,703
Savings from preventing 72,703 women from developing diabetes	\$466,318,181

Next, we estimate the share of new cases that are attributable to obesity using estimates of the incidence of each comorbidity as well as relative risk estimates from Guh et al. (2009). For example, the incidence of diabetes is 7.8 among one thousand people (CDC 2014b). Guh and coauthors estimate that the risk of an obese woman developing type 2 diabetes is 12.41 times greater than the risk of a woman of

normal weight developing the disease. By this measure, of every 7.8 women in one thousand who develop type 2 diabetes, approximately 0.58 of them will be nonobese, while 7.22 of them will be obese. The obesity rate for U.S. adult women is 36.1 percent (Ogden et al. 2014), which means that 361 women out of one thousand are obese, while 639 are not obese. Therefore, 2 percent of obese women

(7.22/361) and 0.09 percent of nonobese women (0.58/639) will develop diabetes.

If the obesity rate among U.S. women dropped 10 percent—from 36.1 to 32.5 percent—325 women out of every thousand would be obese instead of 361. And instead of 7.22 obese women developing type 2 diabetes (2 percent of 361), only 6.5 would (2 percent of 325).

Because a reduction in the obesity rate would mean a rise in the number of nonobese, we would expect a slight increase in new cases of type 2 diabetes among the nonobese. In our example of a 10 percent reduction in the obesity rate among women, 0.61 nonobese women (0.09 percent of 675) would develop diabetes instead of 0.58 (0.09 percent of 639). This allows us to calculate a new incidence for type 2 diabetes among women. If 6.5 obese women and 0.61 nonobese women develop diabetes, the incidence is 7.11 instead of 7.8 among every thousand women.

After calculating the new incidence for each comorbidity in this fashion, we are able to estimate the number of people who will not develop the disease in question if the obesity rate drops 10 percent. Using the direct cost estimate for each disease to derive a per-person direct cost, we are then able to estimate the total savings associated with preventing the disease in this group of people. We present these estimates in the section that follows.

Results

The savings estimates below 1) exclude savings from reducing the severity or recurrence of diseases among people who already have them; 2) do not include the cost associated

with weight-loss interventions; and 3) should not be added together to derive total savings, as there may be some overlap of risk factors (Rowe et al. 2004).

As mentioned above, the incidence of comorbidities is generally higher among the elderly. Therefore, the savings opportunity from reducing obesity is even greater in the Medicare population. Yet, as noted earlier, prescription weight-loss drugs currently are not covered under Medicare Part D, excluding one potential method for achieving weight loss in this demographic. For each of the five comorbidities modeled here, Medicare savings represents approximately one-third or more of the total savings from preventing the onset of the respective disease. The Medicare estimates are based on U.S. adults age 65 and over and do not include Medicare beneficiaries under 65 (for example, patients under 65 with end-stage renal disease or certain disabled patients who are eligible for Medicare prior to turning 65).

The prevalence, annual incidence, and model results for each of the five comorbidities are presented below. (See Table 3 for a summary.)

Type 2 Diabetes. As reported above, the total annual direct cost of type 2 diabetes is \$105.7 billion. Type 2 diabetes prevalence is 11.1 percent among U.S. adults (CDC 2014b). A 10 percent reduction in the obesity rate would reduce the incidence of diabetes from 7.8 new cases for every thousand people (Ibid.) to 7.1 cases for every thousand women and 7.2 for men. This would yield estimated savings to the U.S. health care system of \$852.3 million. Of this, Medicare savings would be \$281.5 million, or 33 percent of total savings.

Hypertension. As reported above, the total annual direct cost of hypertension is \$69.9 billion. Prevalence of hypertension is approximately 30 percent among U.S. adults (CDC 2014c). A 10 percent reduction in the obesity rate would reduce the incidence of hypertension from 62.4 new cases for every thousand people age 45 and over (Carson et al. 2011) to 59 cases for every thousand women in this age group and 59.5 for men. This would yield estimated savings to the U.S. health care system of \$282.8 million. Of this, Medicare savings would be \$138.9 million, or 49 percent of total savings.

Osteoarthritis. As reported above, the total annual direct cost of OA is \$185.5 billion. Prevalence of OA is 12.1 percent among U.S. adults (Lawrence et al. 2008). A 10 percent reduction in the obesity rate would reduce the incidence of OA from 2.4 new cases for every thousand people (Oliveria et al. 1995) to 2.3 cases for every thousand women and 2.2 for men. This would yield estimated savings to the U.S. health care system of \$149.9 million. Of this, Medicare savings would be \$45.7 million, or 31 percent of total savings.

Colorectal Cancer. As reported above, the total annual direct cost of colorectal cancer is \$14.1 billion. Prevalence of colorectal cancer is approximately 0.5 percent among U.S. adults (SEER 2014b). A 10 percent reduction in the obesity rate would reduce the incidence of colorectal cancer from 0.54 new cases for every thousand women and 0.62 new cases for every thousand men (CDC 2013b) to 0.52 and 0.59 cases, respectively. This would yield estimated savings to the U.S. health care system of \$71.8 million. Of this, Medicare savings would be \$42.2 million, or 59 percent of total savings.

Breast Cancer. As reported above, the total annual direct cost of breast cancer is \$16.5 billion. Prevalence of breast cancer is approximately 2.5 percent among U.S. women (SEER 2014a). A 10 percent reduction in the obesity rate would reduce the incidence of breast cancer from 1.8 new cases for every thousand women (CDC 2013a) to 1.7 cases. This would yield estimated savings to the U.S. health care system of \$30.5 million. Of this, Medicare savings would be \$11.5 million, or 38 percent of total savings.

Table 3. Savings from Preventing Onset of Select Comorbidities through 10% Reduction in Obesity Rate

Comorbidity	Total Savings	Medicare Savings
Type 2 Diabetes	\$852,285,656	\$281,539,748
Hypertension	\$282,826,916	\$138,857,879
Osteoarthritis	\$149,867,970	\$ 45,748,216
Colorectal Cancer	\$ 71,800,531	\$ 42,181,898
Breast Cancer	\$ 30,469,895	\$ 11,485,731

Note: Estimates do not include cost of interventions and should not be added together.

CONCLUSION

Obesity, defined as having a BMI of 30 or greater, is an epidemic in the United States. The U.S. obesity rate, which doubled between 1980 and 2003, has reached 35 percent, the highest in the world. Health care costs for obese individuals are significantly greater than for nonobese: over \$2,700 more per capita, according to one recent estimate. As the obesity rate and the cost of delivering health care services have increased, the total annual economic burden of obesity—direct and indirect—has risen to over \$275 billion.

The direct health care cost imposed by obesity is primarily through the increased number of comorbidities associated with obesity. Examples of comorbidities include asthma, cancer (breast, colorectal, endometrial, esophageal, kidney, ovarian, pancreatic, and prostate), chronic back pain, congestive heart failure, coronary heart disease, dyslipidemia, gallbladder disease, hypertension, osteoarthritis, pulmonary embolism, stroke, sleep apnea, and type 2 diabetes. Many of these diseases are costly and closely linked to obesity. For example, among U.S. adults with CVD, 49 percent are obese, and the annual direct cost of CVD in the United States is \$193.4 billion. Nearly 55 percent of adult Americans with diabetes are obese, and the annual direct cost of type 2 diabetes in the United States is \$105.7 billion.

For obese individuals suffering from a comorbidity, there is clear clinical evidence that weight loss can result in improved health status. For example, even modest weight loss leads to significant improvement in clinical endpoints relevant for CVD (total cholesterol, triglycerides, and hs-CRP levels) as well as increased remission rates for type 2 diabetes. Clinical evidence shows positive outcomes (reduced risks) from weight loss for obese individuals suffering from osteoarthritis, CHD, and obstructive sleep apnea.

In addition, weight loss among obese individuals without a given comorbidity can significantly reduce their risk of developing that disease. The savings analysis presented here finds that a 10 percent reduction in the obesity rate (from 35 to 32.5 percent) could yield significant health care savings by preventing some obese individuals from developing costly comorbidities. For example, a 10 percent reduction in the obesity rate could reduce future health care spending by more than \$850 million for type 2 diabetes, \$283 million for hypertension, and \$150 million for osteoarthritis annually.

In the Medicare population, a 10 percent decline in the obesity rate (from 40 to 36 percent) would reduce future health care spending by \$282 million for type 2 diabetes, \$139 million

for hypertension, and \$46 million for osteoarthritis annually. It should be noted that these numbers should not be summed to determine a total savings estimate for two reasons. First, there are numerous other comorbidities that can be prevented by weight loss, and second, some comorbidities and their associated costs are interrelated.

Overall, the health benefits and savings from weight loss among the obese are significant for both preventing the development of costly comorbidities and improving health outcomes for those already diagnosed with comorbidities. Even a small drop in the obesity rate, whether for the entire population or the Medicare population, would result in significant benefits.

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