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# Weight Loss-Associated Decreases in Medical Care Expenditures for Commercially Insured Patients With Chronic Conditions

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**Objective:** Savings associated with weight loss for populations with chronic conditions are poorly understood. The purpose of this study was to estimate medical expenditure savings associated with weight loss among commercially insured adults with chronic medical conditions. **Methods:** **The:** 2001–2015 Medical Expenditure Panel Survey data were used to estimate the effect of changes in body mass index (BMI) on health expenditures from instrumental variable regression models. **Results:** Decreases in annual medical expenditures associated with a reduction in BMI of 1 kg/m<sup>2</sup> varied by condition (eg, \$289 for back pain and \$752 for diabetes). The greater the weight loss, the greater the savings. The higher the baseline BMI, the greater the savings for similar levels of weight loss. **Conclusions:** The detailed estimates of savings for populations with chronic conditions can be used by employers to evaluate the cost-effectiveness of weight management interventions.

**Keywords:** chronic conditions, health economics, medical expenditure savings, weight management

In 2018, the age-adjusted prevalence of obesity in US adults was 42.4%.<sup>1</sup> Obesity is a significant risk factor for several common and costly chronic medical conditions including diabetes, cardiovascular disease, and depression.<sup>2</sup> The estimated annual medical cost of obesity in the United States was \$147 billion (in 2008 \$US).<sup>3</sup> Employers bear a large share of the excess costs attributed to obesity given that normal-weight employees cost on average \$3830 per year in a covered medical, sick day, short-term disability, and workers' compensation claims whereas morbidly obese employees cost more than twice that amount, or \$8067 (in 2011 \$US).<sup>4</sup> While more than half of all large employers offer nutrition and weight management programs as part of their benefits packages, the cost-savings associated with these programs has not been well documented.<sup>5</sup> Without an estimate of the savings

associated with weight loss for employee populations, it is challenging for employers and policymakers to assess the economic impact of investments in weight management programs.

Estimates of the savings associated with preventing weight gain among hypertensive Medicare patients with pre-diabetes enrolled in the Diabetes Prevention Program show weighted average savings per member \$1112 annually.<sup>6</sup> While prevention studies are instructive, they do not provide insights into how effective weight loss interventions affect healthcare spending. In 2015, Cawley et al published an estimation of medical savings associated with weight loss for people with and without diabetes with all types of insurance.<sup>7</sup> However, their analysis has not been replicated for commercially insured populations or for populations with obesity-associated chronic conditions other than diabetes. This information is required for comprehensive cost-effectiveness analyses of obesity treatments and prevention programs. Additionally, understanding the relationship between baseline body mass index (BMI), weight loss, and medical savings can also serve as the basis for targeting interventions to those with the greatest potential savings.

Thus, we performed an analysis to estimate the medical care cost savings associated with weight loss among commercially insured adults with one of seven chronic medical conditions: diabetes, hyperlipidemia, hypertension, mental health disorders, pulmonary disorders, arthritis, and back pain. Specifically, we estimated the cost savings associated with various levels of weight loss (from 5% to 20% BMI reduction) among adults with one or more of these chronic conditions over a 2-year period.

## METHODS

### Population Data

Data from the 2001–2015 Medical Expenditure Panel Survey (MEPS) longitudinal, event, and medical conditions data files were used for this analysis.<sup>8</sup> MEPS, a nationally representative survey of the civilian noninstitutionalized population, collects self-reported medical condition information, insurance coverage, patient demographics, health services utilization, and healthcare spending data over 2 calendar years.

MEPS longitudinal data files were used to examine the impact of the change in BMI from obese (BMI  $\geq$  30) year 1 (baseline) to overweight (BMI 25.9–30) in year 2 on health expenditures. Patient characteristics and comorbidities used in this analysis were taken from year 1. Total health expenditures and condition-specific expenditures were taken from annual totals for each calendar year.

### Inclusion Criteria

Medical conditions in the MEPS files are coded using the *International Classification of Diseases*, Ninth Revision (ICD-9). The ICD-9 codes were collapsed to three-digit codes and subsequently coded into 259 clinically relevant medical conditions using the AHRQ Clinical Classification System (CCS).<sup>9</sup> We selected respondents with the following clinical conditions based on CCS codes: diabetes (CCS 49, 50), hyperlipidemia (CCS 53), hypertension (CCS 98, 99), mental health disorders (CCS 65–75 for years 2001–2003, 650–663 for years 2004–2015), pulmonary disorders

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Medical expenditure savings associated with weight loss vary by chronic conditions but are highest for people with diabetes and arthritis and those with the greatest weight loss. The detailed estimates of savings for populations with chronic conditions can be used by employers to evaluate the cost-effectiveness of weight management interventions.

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(CCS 127, 129–134), arthritis (CCS 201–2014), and back pain (CCS 205). We included respondents who had received care for one of these conditions as determined by at least one office-based visit, emergency room visit, prescription drug use, home health service, or inpatient care.

Our analyses were limited to adults (aged 24–64 years) with 12 months of employer-sponsored insurance and at least one child between the ages of 11 and 20 years (the latter was necessary for the development of the instrumental variables). We excluded pregnant women, underweight adults ( $\text{BMI} < 18.5 \text{ kg/m}^2$ ), those with extreme BMI values ( $\geq 80 \text{ kg/m}^2$ ), and those with total annual health expenditures above \$506,000 (which represented the 95th percentile of total costs). We also excluded any respondent missing weight data or any of the other covariates in the regression models.

### Statistical Analysis

We examined the impact of the reduction in baseline BMI in year 1 on year 2 total health expenditures and condition-specific health expenditures for respondents with each condition. We used a two-stage residual inclusion instrumental variable (IV) modeling approach. For an effective IV regression model, it is imperative that the instrument is strongly correlated with the predictor of interest (ie, baseline BMI). In their estimation of savings associated with weight loss for people with diabetes, Cawley et al used the respondent's biological child's BMI as the instrument (noting that parents tend to report their child's weight more accurately than their own).<sup>7</sup> Because the MEPS data do not provide information on biological relationships, we used the BMI of the oldest child between the ages of 11 and 20 years as the instrument for the respondent's BMI. We calculated the *F*-statistic for the first stage of the IV regressions for each of the conditions to evaluate the power of our instrument. Since they indicated significant power (eg, *F*-statistic of 37 for respondents with diabetes; *F*-statistic of 211 for respondents with hypertension—all of which exceeded the minimum standard for instrument power of *F*-statistic greater than 10), we proceeded with this instrument for our analysis.<sup>10</sup>

In the first stage of the analysis, we ran an ordinary least squares model with the endogenous variable of BMI regressed on the instrumental variable of the oldest child's BMI and covariates. In the second stage, we used a generalized linear model with gamma distribution and log link function to model the impact of BMI on total health expenditures. The residual term of the first stage, as well as respondent's BMI and other covariates, were included in the second stage. For each of our models, we controlled for patient characteristics including age, gender, race/ethnicity, education, marital status, region, and income level. Additionally, we controlled for household composition, self-reported (vs proxy) survey information, sex of child whose BMI was used as the instrument, age in months of the child whose BMI was used as an instrument, and year.

For each of the seven chronic conditions, we calculated health expenditure savings at four levels of reduction in BMI: 5%, 10%, 15%, or 20%. First, we used our two-stage residual inclusion IV model to calculate predicted total health expenditures for each individual using actual BMI. If an encounter had multiple chronic conditions associated with it, the expenditures for that event encounter were split evenly across the conditions to avoid overcounting. We then reduced BMI by 5%, 10%, 15%, and 20% to obtain four predicted total health expenditures for each of the respective reduction levels. The predicted change in health expenditures for an individual equals the difference in the prediction using reduced BMI and the starting prediction using actual BMI. We then averaged these changes in health expenditures across all individuals with that health condition. To avoid double-counting expenditures, we distributed total encounter spending equally across all conditions associated with each health encounter. We also examined an approach of weighting the condition spending by the average

**TABLE 1.** Baseline Population Characteristics of Respondents Who Lost Sufficient Weight to Move from Obese to Overweight

Characteristics	Percent
Age	
18–34	12.3%
35–44	11.7%
45–54	18.3%
55–64	29.3%
65–74	18.8%
75+	9.6%
Region	
Northeast	16.1%
Midwest	20.7%
South	39.1%
West	24.0%
Number of Chronic Conditions	
1	21.4%
2	16.9%
3	16.3%
4	13.2%
5+	32.2%
Average BMI Year 1	31.8
Average BMI Year 2	28.5

BMI, body mass index.

spending of the condition relative to the overall average across all conditions. These results were similar, so we distributed spending equally across all conditions in the encounter in the final model. To determine annual condition-specific spending, all health expenditures from events with condition-specific clinical classification codes were summed for each calendar year.

Analyses were performed using STATA version 15.0. Survey estimation commands were used to adjust for the complex survey design of MEPS. All spending amounts are presented in terms of 2019 dollars using the Personal Health Care Expenditures.<sup>11</sup>

### RESULTS

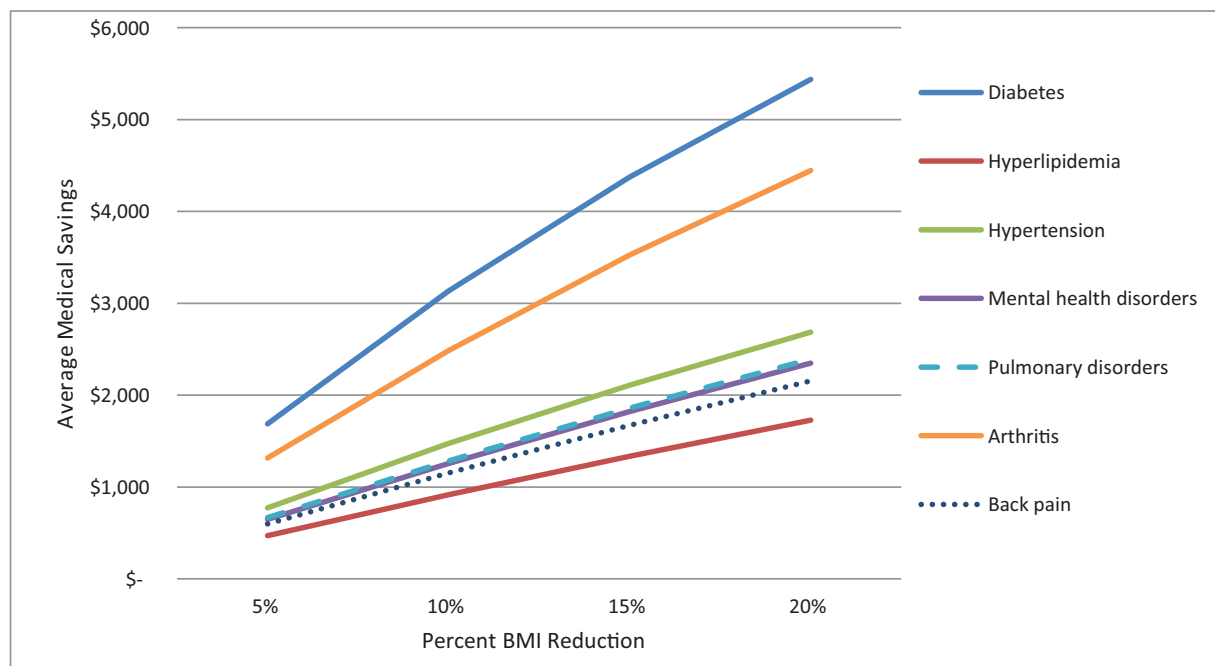
The baseline characteristics of the 20,971 commercially insured respondents with at least one chronic condition who lost sufficient weight to move from being obese to overweight are shown in Table 1. Nearly half of the population was between the ages of 45 and 65 years old and 39% lived in the southern United States. They had a large number of comorbid conditions: 32% had five or more chronic conditions and nearly 30% had three or four chronic conditions. Overall, their unadjusted annual healthcare expenditures fell from \$2574 per year compared to \$2068, a 20% reduction in spending.

Table 2 presents the overall results from the regression analysis. We found statistically significant savings associated with weight loss for people with diabetes, hypertension, mental health disorders, arthritis, and back pain but not for people with hyperlipidemia or pulmonary disease. Expected savings associated with weight loss varied by condition with the greatest savings for diabetes and hypertension (eg, for each decrease in 1 BMI unit ( $\text{kg/m}^2$ ), people with diabetes saved an estimated \$752 and people with hypertension saved \$367). The greatest percent savings associated with weight loss were for people with diabetes (−34%) and arthritis (−41%). Across multiple conditions, women had greater expected savings than men for each decrease in 1 BMI unit, as did married people compared to unmarried people. Notably, people of the Non-Hispanic White race had statistically significantly higher expected savings than people of other races for similar levels of weight loss for four of the chronic conditions.

**TABLE 2. Reduction in Healthcare Expenditures Associated with Weight Loss**

Condition	N	Total Medical Expenditures (Baseline) Mean, SD	Condition-Specific Medical Expenditures (Baseline) Mean, SD	Decrease in Total Healthcare Expenditures for Each Decrease in 1 BMI unit (kg/m <sup>2</sup> )		Direction of Statistically Significant Covariate Effect				
				\$	P value	Female Gender (relative to males)	Race (Relative to Non-Hispanic White)	Age (Relative to 24–34 yr olds)	Education (Relative to High School Grads)	Marital Status (Relative to Unmarried)
Diabetes	1967	\$9127 (\$22,005)	\$2303 (\$4607)	-\$752	0.05	+0.04	–Black and Hispanic 0.03	ns	ns	+0.045
Hyperlipidemia	3584	\$7054 (\$17,576)	\$777 (\$1137)	-\$238	0.1	+<0.001	–Non-Hispanic Other and Hispanic 0.004	ns	ns	ns
Hypertension	5335	\$6736 (\$16,143)	\$650 (\$1638)	-\$367	0.004	+0.01	–Black and Hispanic 0.001	ns	ns	+0.005
Mental health disorders	3660	\$7943 (\$17,420)	\$1216 (\$3022)	-\$306	0.02	ns	ns	ns	ns	+<0.001
Pulmonary disease	1101	\$7331 (\$12,431)	\$1132 (\$1808)	-\$306	0.07	ns	ns	+45–64 yr <0.001	ns	ns
Arthritis	2742	\$8681 (\$14,595)	\$1874 (\$6609)	-\$209	<0.001	+<0.001	–Black and Hispanic 0.02	+45–64 yr 0.008	ns	+0.04
Back pain	2582	\$7,81 (\$15,502)	\$1663 (\$5225)	-\$289	0.04	+0.009	ns	ns	ns	+0.007

BMI, body mass index.



**FIGURE 1.** Predicted reductions in average annual healthcare expenditures per person associated with 5% to 20% reduction in BMI by chronic condition. BMI, body mass index.

Figure 1 presents the reduction in spending associated with 5%, 10%, 15%, and 20% BMI reduction by condition. The expected savings for each condition over a range of baseline BMIs from 30 to 45 kg/m<sup>2</sup> are presented in the Appendix Tables, <http://links.lww.com/JOM/A944>, <http://links.lww.com/JOM/A945>, <http://links.lww.com/JOM/A946>, <http://links.lww.com/JOM/A947>, <http://links.lww.com/JOM/A948>, <http://links.lww.com/JOM/A949>, <http://links.lww.com/JOM/A950>. For all conditions, the greater the weight loss, the greater the reduction in expected total healthcare expenditures (eg, for people with diabetes and a baseline BMI of 40, a 5% BMI reduction resulted in \$2665 savings in total medical expenditures but a 20% reduction in BMI resulted in \$8443 savings). Additionally, the higher the baseline BMI, the greater the savings for similar percent reductions in BMI (eg, for people with diabetes who had a 10% reduction in BMI and a baseline BMI of 30, their savings was \$1714 compared with \$4920 for those with a baseline BMI of 40).

## DISCUSSION

This analysis, the first to provide detailed estimates of savings associated with weight loss among commercially insured obese populations with chronic medical conditions, has three key findings. First, weight loss is associated with statistically significant savings for obese people with diabetes, hypertension, mental health disorders, arthritis, and back pain. The key drivers of the savings associated with weight loss are due to reduced medication costs as a result of controlling HbA1C, blood pressure, and cholesterol and preventing the transition from pre-diabetes to diabetes.<sup>6,7</sup> Although weight loss was associated with a trend toward savings for people with hyperlipidemia and pulmonary disease, this finding was not statistically significant. This finding warrants further exploration. This analysis suggests that impact analyses of employer-sponsored weight management programs should include total medical expenditures and condition-specific outcomes and expenditures to validate the estimates provided in this analysis.

Second, for all populations with chronic conditions, the greatest savings associated with weight loss were found among

the most populations with the highest baseline BMI. The magnitude of the expected savings among morbidly obese patients exceeds \$2000 in year 2 for diabetes and arthritis (eg, \$2665 savings for people with diabetes and a baseline BMI of 40 who lost 5%). This suggests that investments in weight management programs that produce even relatively small amounts of weight loss, when directed at the most obese populations, could provide meaningful savings for employers.

Finally, it is notable that people of the Non-Hispanic White race had statistically significantly higher expected savings than people of other races for similar levels of weight loss for four of the chronic conditions. Given the abundance of clinical research demonstrating the health benefits of even modest (ie, 5%–10%) weight loss among obese patients with chronic conditions,<sup>12</sup> we recommend that employer-sponsored weight management programs recruit populations of all racial/ethnic groups. Evaluations of such programs should evaluate the economic impacts of weight loss across racial/ethnic groups to provide empiric evidence regarding actual changes in total medical expenditures.

When comparing the results of this analysis with those for diabetes patients provided by Cawley et al,<sup>7</sup> we have similar results but note that the medical expenditures associated with this condition have continued to rise in the 5 years since its publication (despite accounting for the difference in their study reporting \$2015 vs \$2019 for this work). This may be due to increases in the costs associated with the treatment of obesity and its comorbidities or a reflection of increasing costs of healthcare generally.

Our study has three key limitations. First, although the MEPS data are a robust source of health expenditures in the United States, it contains only self-reports or proxy reports, not actual measurements of weight and height. This is problematic because people tend to under-report their weight, with heavier individuals under-reporting more.<sup>7</sup> The use of an instrumental variable approach was specifically selected to try to address and mitigate such bias. Second, the sample sizes for some of the analyses (especially for populations with BMIs over 40) were small; thus, the standard

deviations around the savings estimates are quite large. We chose not to stratify populations into cohorts on the basis of their baseline BMI (eg, BMI of 40–45) to increase the power of this analysis because we wanted to provide estimates for every unit of BMI for other researchers to use in their cost-effectiveness analyses. Finally, given the dramatic changes in health services utilization resulting from deferred care due to the COVID-19 pandemic, it is not clear whether the estimates provided are likely to match empiric evidence in 2020 or 2021.

Our study is the first to provide detailed estimates of decreases in expected health expenditures for commercially insured obese populations with chronic medical conditions. These results can be used to identify key target populations for employer-sponsored weight management programs and can inform the cost-effectiveness analysis of such programs.

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### REFERENCES

- Hales CM, Carroll MD, Fryar CD, Ogden CL. Prevalence of Obesity and Severe Obesity Among Adults: United States, 2017–2018. 2020. Available at: <https://www.cdc.gov/nchs/products/databriefs/db360.htm>.
- Pi-Sunyer X. The medical risks of obesity. *Postgrad Med*. 2009;121:21–33.
- Finkelstein EA, Trogdon JG, Cohen JW, Dietz W. Annual medical spending attributable to obesity: payer- and service-specific estimates. *Health Aff (Millwood)*. 2009;28:w822–w831.
- Van Nuys K, Globe D, Ng-Mak D, Cheung H, Sullivan J, Goldman D. The association between employee obesity and employer costs: evidence from a panel of U.S. employers. *Am J Health Promot*. 2014;28:277–285.
- Mattke S, Liu H, Caloyeras JP, et al. *Workplace Wellness Programs Study: Final Report*. RAND Corporation; 2013.
- Alva ML, Hoerger TJ, Jeyaraman R, Amico P, Rojas-Smith L. Impact of the YMCA of the USA Diabetes Prevention Program on Medicare spending and utilization. *Health Aff (Millwood)*. 2017;36:417–424.
- Cawley J, Meyerhoefer C, Biener A, Hammer M, Wintfeld N. Savings in medical expenditures associated with reductions in body mass index among US adults with obesity, by diabetes status. *Pharmacoeconomics*. 2015;33:707–722.
- The Medical Expenditure Panel Survey. Available at: <https://www.meps-ahrq.gov/mepsweb/>. Accessed June 30, 2019.
- Healthcare Cost and Utilization Project (H-CUP), 2015; Available at: <https://www.hcup-us.ahrq.gov/overview.jsp>. Accessed June 1, 2019.
- Stock J, Wright J, Yogo M. A survey of weak instruments and weak identification in generalized method of moments. *J Bus Econ Stat*. 2002;20:518–529.
- Using appropriate price indices for analysis of health care expenditures or income across multiple years, 2018. Available at: [https://meps.ahrq.gov/about\\_meps/Price\\_Index.shtml-t1a3](https://meps.ahrq.gov/about_meps/Price_Index.shtml-t1a3). Accessed June 1, 2019.
- Knowler WC, Barrett-Connor E, Fowler SE, et al. Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med*. 2002;346:393–403.