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## Changes in the Association Between Body Mass Index and Medicare Costs, 1997–2006

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The rising prevalence of overweight and obesity at older ages is projected to result in escalating Medicare spending.<sup>1,2</sup> Although prior research on excess Medicare costs associated with overweight and obesity has assumed that these costs are similar over time, the health effects of excess weight may be changing, with significant implications for health care costs. For example, mortality associated with obesity has declined,<sup>3</sup> while the association between obesity and disability has increased.<sup>4</sup> It is unclear how changes in the health of the obese population have affected obesity-associated health care costs. Available evidence is conflicting<sup>5,6</sup> and is based on estimated expenditures from the Medical Expenditure Panel Surveys (MEPS), which substantially underestimates spending.<sup>7</sup> Using Medicare claims data, we examined whether trends in Medicare Part A and B spending differed by body mass index (BMI) over time (1997–2006).

### Methods

The Medicare Current Beneficiary Survey (MCBS) is an institutional review board–approved, ongoing, nationally representative survey of Medicare beneficiaries that links up to 3 years of survey data to Medicare Part A and B claims. Community-dwelling MCBS respondents between 1997 and 2006 were included if they were 65 years and older and were covered by both Part A and B. Underweight participants and participants with missing data were excluded, yielding an analytic sample comprising 29 413 individuals, contributing 66 176 person-years of observations. All analyses were weighted to provide estimates that are nationally representative of beneficiaries meeting inclusion criteria.

Medicare expenditures were calculated as total Medicare payments for services covered by Part A and B and converted to 2006 dollars. Body mass index (calculated as weight in kilograms divided by height in meters squared) was corrected for self-report following methods described by Cawley and Burkhuuser<sup>8</sup> and was categorized as normal weight (18.5–24.9), overweight (25.0–29.9), or obese ( $\geq 30.0$ ).

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**Author Contributions:** Mr Shaffer had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. *Study concept and design:* Alley and Stuart. *Acquisition of data:* Shaffer and Stuart. *Analysis and interpretation of data:* Alley, Lloyd, Shaffer, and Stuart. *Drafting of the manuscript:* Alley, Lloyd, and Stuart. *Critical revision of the manuscript for important intellectual content:* Shaffer and Stuart. *Statistical analysis:* Shaffer. *Obtained funding:* Stuart. *Administrative, technical, and material support:* Lloyd. *Study supervision:* Alley.

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Demographic and socioeconomic covariates included age, sex, self-reported race/ethnicity, marital status, education, income in relation to the Federal poverty line, prior Social Security Disability Insurance status, census region, metropolitan status, and a mortality variable indicating whether participants died over the follow-up period. We predicted spending for each person-year using a generalized linear model with a gamma distribution and log link and used robust variance estimators to correct standard errors for repeated observations within individuals. Regression models predicted spending based on BMI categories, a continuous time term, and their interaction, controlling for demographic and economic covariates. Additional models controlled for 10 chronic conditions commonly linked to obesity (diabetes, hypertension, ischemic heart disease, hyperlipidemia, heart failure, chronic lung disease, osteoarthritis, hypothyroidism, gastroesophageal reflux disease, and sleep apnea) to explore whether changes in spending were accounted for by changes in comorbidity over time. All analyses were conducted using Stata statistical software (version 10; StataCorp).

## Results

The prevalence of obesity increased from 21% in 1997 to 29% in 2006. Obese participants in the later period were more likely to be male, were less likely to be widowed, and had higher education and income levels than those in the earlier period. They were also more likely to have chronic conditions such as diabetes and hypertension relative to obese participants in 1997.

The Figure shows average Medicare spending by BMI status and time in constant 2006 dollars. In 1997, the mean expenditure for Part A and B services for normal-weight beneficiaries was \$6832, but expenditures were significantly less for overweight and obese beneficiaries (\$5473 [ $P<.001$ ] and \$5790 [ $P=.02$ ], respectively). Expenditures increased over time for all groups but appeared to increase more quickly in obese beneficiaries.

In regression analysis adjusting for demographic and economic covariates, expenditures increased by a mean of \$122 per year ( $P<.001$ ) for normal-weight beneficiaries, and increased significantly faster for overweight (excess increase of \$108 per year [ $P=.01$ ]) and obese beneficiaries (excess increase of \$149 per year [ $P=.001$ ]). Adjusting for chronic conditions accounted for differences in the trend across BMI groups. After adjusting for chronic conditions, interactions between overweight and time ( $P=.71$ ) and obesity and time ( $P=.98$ ) were no longer significant.

## Comment

Although Medicare expenditures increased in all BMI groups over this period, expenditures increased significantly faster for overweight and obese Medicare beneficiaries. Increasing rates of weight-related chronic conditions over time appeared to account for this trend.

We found smaller obesity-related differences in expenditures than reported in previous research.<sup>1,5,6</sup> This may be due to differences in expenditure data (claims vs estimated expenditures), costs included (Medicare only vs total costs), or participant age range.

Our results suggest that projections related to the future costs of obesity should take into account changes in chronic health conditions among the obese older population as drivers of increased expenditures. If the parallel trends of increasing obesity and increasing numbers of chronic conditions continue, obesity-related Medicare spending may rise faster than projected based on prevalence of obesity alone.

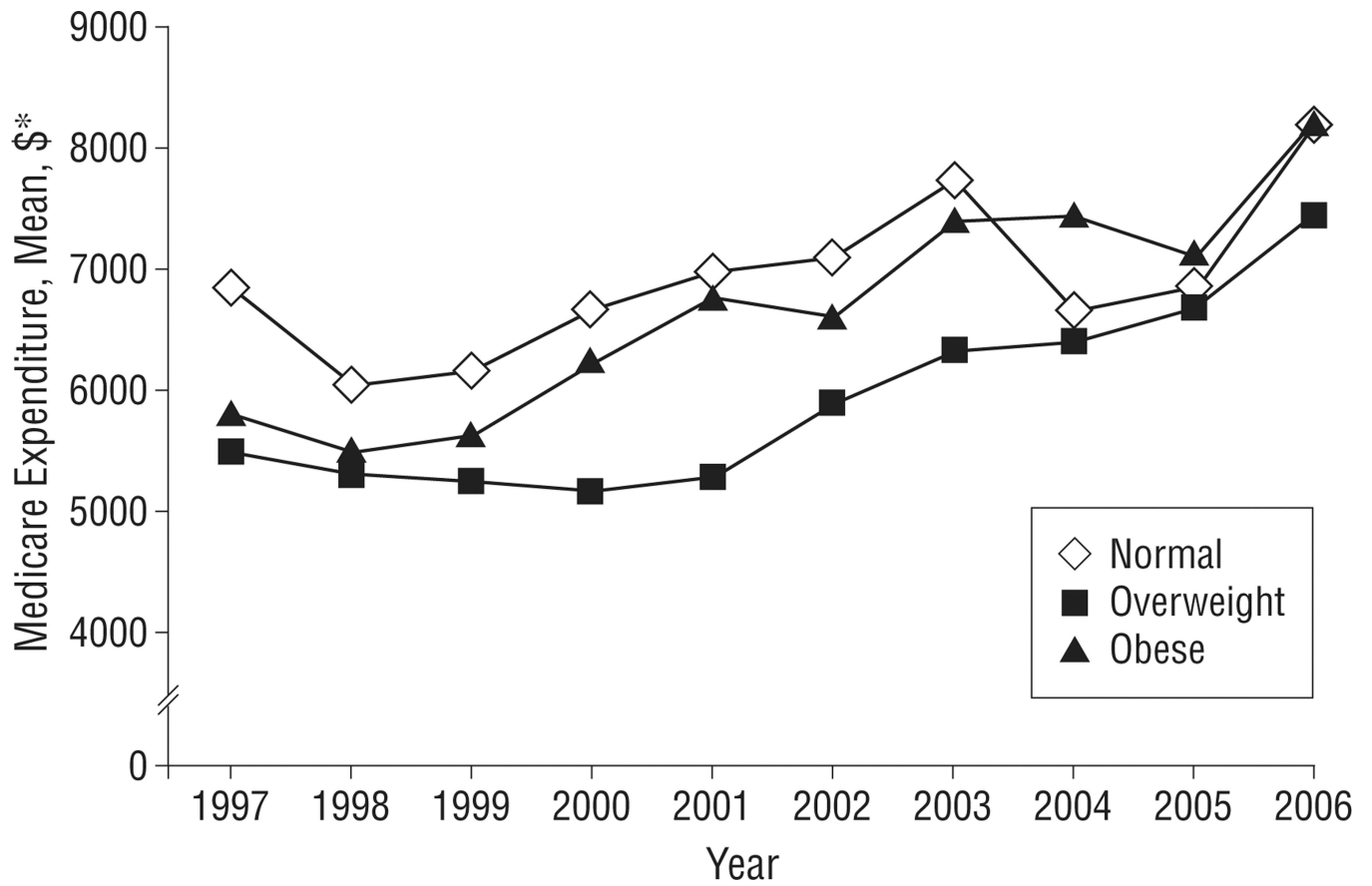
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**Figure.** Mean Medicare expenditures by body mass index category and time: Medicare Beneficiaries, 1997–2006. \*In 2006 constant dollars.