State-Level Estimates of Annual Medical Expenditures Attributable to Obesity*

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Abstract

FINKELSTEIN, ERIC A., IAN C. FIEBELKORN, AND GUIJING WANG. State-level estimates of annual medical expenditures attributable to obesity. *Obes Res.* 2004;12:18–24.

Objective: To provide state-level estimates of total, Medicare, and Medicaid obesity-attributable medical expenditures.

Research Methods and Procedures: We developed an econometric model that predicts medical expenditures. We used this model and state-representative data to quantify obesity-attributable medical expenditures.

Results: Annual U.S. obesity-attributable medical expenditures are estimated at $75 billion in 2003 dollars, and approximately one-half of these expenditures are financed by Medicare and Medicaid. State-level estimates range from $87 million (Wyoming) to $7.7 billion (California). Obesity-attributable Medicare estimates range from $15 million (Wyoming) to $1.7 billion (California), and Medicaid estimates range from $23 million (Wyoming) to $3.5 billion (New York).

Discussion: These estimates of obesity-attributable medical expenditures present the best available information concerning the economic impact of obesity at the state level. Policy makers should consider these estimates, along with other factors, in determining how best to allocate scarce public health resources. However, because they are associated with large SE, these estimates should not be used to make comparisons across states or among payers within states.

Key words: cost, Medicaid, Medicare, state, BMI

Received for review May 13, 2003.
Accepted in final form November 12, 2003.
*The online version of this article (available at http://www.obesityresearch.org) contains supplemental tables.
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Introduction

Results from the 1999 to 2000 National Health and Nutrition Examination Survey indicate that an estimated 64% of U.S. adults are either overweight or obese (1).[1] This is alarming, given that obesity has been shown to promote many chronic diseases, including type 2 diabetes, cardiovascular disease (2,3), several types of cancer (endometrial, postmenopausal breast, kidney, and colon cancer) (4), musculoskeletal disorders, sleep apnea, and gallbladder disease (2,3).

Recent studies have documented the impact that obesity has on annual medical expenditures among adults. Sturm (5) found that obese adults (18 to 65 years of age) have 36% higher average annual medical expenditures compared with those of normal weight. Finkelstein et al. (6) found that aggregate obesity-attributable medical expenditures account for 5.3% of adult medical expenditures in the United States and that roughly 50% of these expenditures are financed by Medicare and Medicaid. To date, however, no estimates are available that document obesity-attributable medical expenditures at the state level, including the amount of state Medicare and Medicaid expenditures attributable to obesity. This analysis fills that gap. These estimates will assist state policy makers in determining how best to allocate scarce public health resources and provide information concerning the economic impact of obesity on states.

Because no single data set exists that allows for directly quantifying state-level expenditures attributable to obesity (BMI $\geq$ 30 kg/m^2), we first used nationally representative data to develop a model that predicts obesity-attributable medical expenditures. We then used this model and state-representative data to quantify total obesity-attributable medical expenditures for each state and Medicare and Medicaid obesity-attributable expenditures within each state. This approach has been successfully applied to estimate state-level expenditures for smokers (7–9).

[1] The National Institutes of Health weight classification system relies on BMI (BMI = weight in kilograms divided by height in squared meters) and uses the following cut-off points: underweight, BMI $<$ 18.5 kg/m^2; normal, BMI = 18.5 to 24.9 kg/m^2; overweight, BMI = 25.0 to 29.9 kg/m^2; obese, BMI $>$ 30.0 kg/m^2.

Research Methods and Procedures

Data

We used the 1998 Medical Expenditure Panel Survey (MEPS)[2] linked to the 1996 and 1997 National Health Interview Surveys (NHISs) to develop a national model for predicting obesity-attributable medical expenditures. MEPS is a nationally representative survey of the civilian non-institutionalized population that quantifies total annual medical expenditures for each individual and the percentage of expenditures financed by third-party payers. The data also include information about each individual's health insurance status and sociodemographic characteristics (e.g., race/ethnicity, gender, education).

The MEPS sampling frame was drawn from the 1996 and 1997 NHISs. Although MEPS does not capture height and weight (the determinants of BMI), these self-reported variables are available for a subset of adult NHIS participants and can be merged with MEPS data. We excluded from the MEPS/NHIS population those with missing height and weight data (which included all individuals less than age 18 at the time of the NHIS interview) and pregnant women. Our final population included 10,128 adults, with weighting variables that allowed for generating nationally representative estimates of the adult civilian non-institutionalized population.

The Behavioral Risk Factor Surveillance System (BRFSS) is a state representative telephone survey of the adult non-institutionalized population that tracks health risks in the United States. To increase the precision of our predictions, we pooled 3 years of BRFSS data (1998 to 2000). Although BRFSS does not directly capture annual expenditures, it includes information about each individual's height and weight, health insurance status, and sociodemographic characteristics (e.g., race/ethnicity, gender, education). This information was input into our national model to compute expenditures at the state level.

Analogous to our MEPS restrictions, we excluded from the BRFSS population those with missing height and weight data (n = 12,195) and pregnant women (n = 5032). We also excluded those with missing sociodemographic variables (n = 68,931) necessary to predict annual expenditures based on the MEPS model. Our final BRFSS population included 398,446 adults, with weighting variables that allowed for generating state-representative estimates. Appendix Table A1 (available at *Obesity Research Online*: http://www.obesityresearch.org) presents descriptive statistics for the MEPS/NHIS and BRFSS populations.

[2] Nonstandard abbreviations: MEPS, Medical Expenditure Panel Survey; NHIS, National Health Interview Survey; BRFSS, Behavioral Risk Factor Surveillance System.

Methods

Estimating state-specific obesity-attributable medical expenditures involved three steps. First, we used the MEPS/NHIS data, which included information on obesity and expenditures, to create a model that predicts annual expenditures as a function of obesity status, insurance status, and sociodemographic characteristics. Second, we used BRFSS and results from the MEPS/NHIS analysis to estimate the fraction of each state's expenditures attributable to obesity and the fraction of each state's Medicare and Medicaid expenditures attributable to obesity. Third, we multiplied these fractions by state-specific medical expenditure estimates to compute obesity-attributable medical expenditures for each state (and for Medicare and Medicaid within each state).

MEPS/NHIS National Model

We used two independent four-part regression models to predict 1) total annual obesity-attributable medical expenditures among adults (i.e., medical expenditures for adults with BMI $\geq$ 30 kg/m^2) and 2) annual obesity-attributable medical expenditures financed by Medicare and Medicaid. The four-part regression approach was pioneered by authors of the RAND Health Insurance Experiment to assess the impact of cost sharing on annual medical expenditures and is now commonly applied to medical expenditure data (10,11). The inclusion of dummy variables indicating each individual's BMI category (underweight, overweight, and obese, with normal weight as the omitted reference category) allowed us to predict the impact that obesity had on annual medical expenditures. A detailed Methods appendix is available from the authors on request.

The primary difference between specifications 1 (total expenditures) and 2 (insurance expenditures) is that the dependent variable in specification 2 is limited to expenditures paid by an insurer (Medicare, Medicaid, other public, private)[3]; therefore, these regressions do not include the uninsured. In actuality, some of the expenditures for Medicare recipients are financed by supplemental insurers. However, this will not bias our estimates for Medicare unless the fraction of expenditures among Medicare recipients that are attributable to obesity varies between Medicare-funded services and services funded by other insurers.

All regressions included the same set of independent variables and were limited to variables contained in both the MEPS/NHIS and BRFSS data. Besides BMI category variables, these included dummy variables for insurance cate-

[3] Individuals and their corresponding insurance payments were assigned to insurance categories based on the following algorithm: those with any evidence of Medicare during the year were classified as "Medicare," those with any evidence of Medicaid and no evidence of Medicare were classified as "Medicaid," those with evidence of another source of public insurance (e.g., VA, CHAMPUS, Indian Health Service) and no evidence of either Medicare or Medicaid were classified as "Other Public," and those with any evidence of private insurance and no evidence of public insurance were classified as "Private Insurance." The remainder were classified as "Uninsured."

gory (Medicaid, Medicare, and other public insurance, with private insurance as the omitted reference category). Specification 2 also included BMI category × insurance category interaction terms, which allowed us to compute separate estimates of obesity-attributable medical expenditures for Medicaid and Medicare. Other independent variables included gender (male, female), race/ethnicity (white, black, Hispanic, Asian, other), age, region (Northeast, Midwest, South, West), household income (<100%, 100% to 199%, 200% to 399%, ≥400%, of poverty level), education (less than college graduate, college graduate, masters or doctoral, other degree), and marital status (married, widowed, divorced/separated, single). Regressions were estimated using SUDAAN (12) to control for the complex survey design used in MEPS. Appendix Table A2, a and b (available at *Obesity Research Online*: http://www.obesityresearch.org), presents regression results for both specifications.

BRFSS State-Level Estimates

Using the regression output from specification 1, we predicted total annual medical expenditures for each individual contained in BRFSS. This was accomplished by multiplying each individual's characteristics (the independent variables) by their respective coefficients generated from the four regressions and combining the results as described in Manning et al. (11). Using the BRFSS weighting variables and each individual's predicted medical expenditures, we computed total predicted medical expenditures for each state. We then limited the sample to each state's obese population to predict total obesity-attributable medical expenditures within each state. These were calculated as the difference between predicted expenditures for the obese population with the obesity dummy variable set to 1 and predicted expenditures for the obese population with the obesity dummy variable set to 0, leaving all other variables unchanged. Because normal weight was the reference category, the second term predicted total expenditures for the obese population had they been of normal weight. This allowed us to isolate the effect of obesity while maintaining any other inherent characteristics that may contribute to higher annual medical expenditures.

Within each state, the percentage of aggregate medical expenditures attributable to obesity was calculated by dividing aggregate predicted expenditures attributable to obesity by total predicted expenditures for the entire state. An analogous approach used specification 2 to determine the fraction of state-specific medical expenditures attributable to obesity for Medicare and Medicaid recipients. Because BRFSS is limited to adults, the results should be interpreted as the fraction of adult medical expenditures that are attributable to obesity among adults in each state (and for Medicare and Medicaid within each state).

Estimating Total and Public Sector Expenditures

To quantify annual adult obesity-attributable medical expenditures for each state (and Medicare and Medicaid expenditures within each state), we multiplied the corresponding fractions by published estimates of 1998 state-specific expenditures (13). We used 1998 because it is the most recent year for which annual state-level medical expenditures are available for the total, Medicare, and Medicaid populations. We then inflated these estimates to 2003 using national adjustment factors for total, Medicare, and Medicaid expenditures (1.41, 1.24, and 1.61, respectively). Adjustment factors were calculated as the ratio of 2003 projected annual medical expenditures to 1998 annual medical expenditures, both reported by the Centers for Medicare and Medicaid Services Office of the Actuary.

The 1998 state-specific expenditure estimates included medical expenditures for adults and children, and because of data limitations, our fractions are for adults only. Therefore, before applying these fractions, it was necessary to reduce the expenditure estimates by the percentage of expenditures dedicated to youth (those less than age 18). For total state medical expenditures, these fractions were generated from MEPS. However, because MEPS allows only for regional stratification, we applied census region-specific fractions rather than state-specific fractions. These fractions are detailed in Appendix Table A3 (available at *Obesity Research Online*: http://www.obesityresearch.org).

The fraction of each state's Medicaid expenditures attributable to adults was calculated based on age-specific expenditure data available from the 1999 Medicaid Statistical Information System (14), which was the first year this information was available for all states. We assumed that the fractions did not change between 1998 and 1999. All Medicare expenditures were assumed to be for adults. Appendix Table A4 (available at *Obesity Research Online*: http://www.obesityresearch.org) presents estimates of total, Medicare, and Medicaid expenditures for adults in 2003.

Results

Based on 1998 to 2000 BRFSS self-reported data, obesity prevalence is estimated at 20% for the total U.S. adult population, 21% for Medicare recipients, and 30% for Medicaid recipients. Overall, obesity prevalence varies considerably by state, ranging from 15% in Colorado to 25% in West Virginia. Obesity prevalence ranges from 12% (Hawaii) to 30% (Washington DC) for Medicare recipients and from 21% (Rhode Island) to 44% (Indiana) for Medicaid recipients. Appendix Table A5 (available at *Obesity Research Online*: http://www.obesityresearch.org) shows state-specific obesity prevalence for the total, Medicare, and Medicaid populations.

Table 1 shows the estimated percentage of total, Medicare, and Medicaid adult medical expenses that are attributable to obesity. For the United States as a whole, ~6% of

total adult expenditures, 7% of Medicare expenditures, and 11% of adult Medicaid expenditures are attributable to obesity. At the state level, percentages range from 4% (Connecticut) to 7% (Alaska; Washington DC). Medicare percentages range from 4% (Arizona) to 10% (Delaware), and Medicaid expenditures range from 8% (Rhode Island) to 16% (Indiana). The higher percentages for Medicaid are driven largely by the higher prevalence of obesity among Medicaid recipients.

Figure 1 and Table 1 combine the percentages reported above with estimates of adult medical expenditures to produce state-specific (and Medicare and Medicaid within state-specific) estimates of obesity-attributable medical expenditures among adults in 2003. For the United States as a whole, obesity-attributable medical expenditures are estimated at $75 billion, with $17 billion financed by Medicare and $21 billion financed by Medicaid. State-level estimates range from $87 million (Wyoming) to $7.7 billion (California). Obesity-attributable Medicare estimates range from $15 million (Wyoming) to $1.7 billion (California), and obesity-attributable Medicaid expenditures range from $23 million (Wyoming) to $3.5 billion (New York).

Discussion

Our results show that obesity imposes a substantial drain on health care resources across states, averaging ~6% of adult medical expenditures, and that roughly one-half of these expenditures are financed by Medicare and Medicaid. Obesity prevalence among Medicare recipients and the percentage of Medicare expenditures attributable to obesity are similar to those for the privately insured population. However, as a percentage of the total, Medicaid enrolls a more obese population and incurs greater obesity-attributable costs. Self-reported obesity prevalence among adult Medicaid recipients is roughly 50% higher than that for the general population, ranging from 8% higher in Wisconsin to 241% higher in Arizona. As a result, the percentage of U.S. adult Medicaid expenditures that are devoted to treating obesity-related medical conditions (11%) is nearly double the percentage for non-Medicaid medical expenditures.

To put these results into perspective, if all obesity-attributable medical expenditures were financed through taxes levied at the national level, the tax would need to be set at approximately $350 per adult to fully recover the costs. This tax would be reduced by about one-half if limited to obesity-attributable expenditures financed by Medicare and Medicaid.

The dramatic increase in obesity prevalence over the past two decades is well documented. As a result of this increase in obesity prevalence, the cost of treating obesity-related diseases has also been increasing. In addition, methods for treating obesity, as opposed to obesity-related diseases, are becoming more widespread. It has been estimated that there were ~80,000 bariatric surgeries performed on obese patients in 2002, with an average cost of between $15,000 and $30,000 (15). In the long run, it is possible that these treatments will reduce the burden of obesity. In the short run, however, obesity treatments have the potential to substantially increase obesity-attributable costs, suggesting that these costs are likely to continue to increase over the next several years.

This analysis estimates the financial burden of obesity on states. Whereas all sectors of the economy should be concerned about the medical and financial implications of obesity, the fact that government, and ultimately the tax payer, is responsible for financing roughly one-half of obesity-attributable medical expenditures should strengthen the need for government interventions to reduce obesity rates. This is especially true among Medicaid beneficiaries, for whom obesity is the most prevalent. The estimates presented in this analysis will help state policy makers determine appropriate funding levels to reduce obesity rates and provide additional information concerning the economic burden of obesity on states. Although the relative burden of disease and the extent to which this burden falls on the public sector should not be the only factors that influence priority setting in health policy, these expenditure estimates should be considered, along with other factors, in determining the allocation of scarce public health resources.

Our analysis has several limitations. First, both BRFSS and MEPS rely on self-reported data. For the MEPS regression analysis, under-reporting of weight may bias the regression coefficients, although the direction of the bias is uncertain. Under-reporting of weight in BRFSS implies that obesity prevalence is under-reported; therefore, our expenditure estimates may be conservative (16).

Second, both BRFSS and MEPS are limited to the non-institutionalized population; however, the resulting obesity-attributable fractions are applied to expenditure estimates that include both institutionalized and non-institutionalized populations. If these fractions are different for the institutionalized population, our expenditure estimates would be biased. This would have the largest effect on Medicaid, which finances the majority of institutionalized expenditures, primarily for nursing home recipients.

Third, data limitations precluded us from quantifying obesity-attributable medical expenditures for children. Although obesity among children has increased (17), the chronic nature of many obesity-related diseases suggests that expenditures for children are only a small fraction of total obesity-attributable expenditures.

Fourth, our analysis is limited to medical expenditures and, therefore, does not address other costs (e.g., decreased productivity, absenteeism) resulting from obesity. Wolf and Colditz (18) estimate these costs at the national level and show them to be nearly as high as direct medical costs.

Finally, even after pooling 3 years of BRFSS data, the obese sample (and especially the obese Medicaid sample) is

Table 1. Estimated adult obesity-attributable percentages and medical expenditures by state (BRFSS 1998 to 2000)

	Total population		Medicare population		Medicaid population	
State	(%)	(Millions $)	(%)	(Millions $)	(%)	(Millions $)
Alabama	6.3	$1320	7.7	$341	9.9	$269
Alaska	6.7	$195	7.7	$17	8.2	$29
Arizona	4.0	$752	3.9	$154	13.5*	$242
Arkansas	6.0	$663	7.0	$171	11.5	$180
California	5.5	$7675	6.1	$1738	10.0	$1713
Colorado	5.1	$874	5.1	$139	8.7	$158
Connecticut	4.3	$856	6.5	$246	11.0	$419
Delaware	5.1	$207	9.8	$57	13.8	$66
District of Columbia	6.7	$372	6.5	$64	12.5	$114
Florida	5.1	$3987	6.1	$1290	11.6	$900
Georgia	6.0	$2133	7.1	$405	10.1	$385
Hawaii	4.9	$290	4.8	$30	11.2	$90
Idaho	5.3	$227	5.6	$40	12.0	$69
Illinois	6.1	$3439	7.8	$805	12.3	$1045
Indiana	6.0	$1637	7.2	$379	15.7	$522
Iowa	6.0	$783	7.5	$165	9.4	$198
Kansas	5.5	$657	6.4	$138	10.2*	$143
Kentucky	6.2	$1163	7.5	$270	11.4	$340
Louisiana	6.4	$1373	7.4	$402	12.9	$525
Maine	5.6	$357	5.7	$66	10.7	$137
Maryland	6.0	$1533	7.7	$368	12.9	$391
Massachusetts	4.7	$1822	5.6	$446	7.8	$618
Michigan	6.5	$2931	7.8	$748	13.2	$882
Minnesota	5.0	$1307	6.6	$227	8.6	$325
Mississippi	6.5	$757	8.1	$223	11.6	$221
Missouri	6.1	$1636	7.1	$413	11.9	$454
Montana	4.9	$175	6.2	$41	9.8	$48
Nebraska	5.8	$454	7.0	$94	10.3	$114
Nevada	4.8	$337	5.0	$74	10.1*	$56
New Hampshire	5.0	$302	5.4	$46	8.6*	$79
New Jersey	5.5	$2342	7.1	$591	9.8	$630
New Mexico	4.8	$324	4.6	$51	8.5	$84
New York	5.5	$6080	6.7	$1391	9.5	$3539
North Carolina	6.0	$2138	7.0	$448	11.5	$662
North Dakota	6.1	$209	7.7	$45	11.7	$55
Oklahoma	6.0	$854	7.0	$227	9.9	$163
Ohio	6.1	$3304	7.7	$839	10.3	$914
Oregon	5.7	$781	6.0	$145	8.8	$180
Pennsylvania	6.2	$4138	7.4	$1187	11.6	$1219
Puerto Rico	7.4		8.1		10.1	
Rhode Island	5.2	$305	6.5	$83	7.7	$89
South Carolina	6.2	$1060	7.7	$242	10.6	$285
South Dakota	5.3	$195	5.9	$36	9.9	$45
Tennessee	6.4	$1840	7.6	$433	10.5	$488

Table 1. (*Continued*)

State	Total population		Medicare population		Medicaid population	
	(%)	(Millions $)	(%)	(Millions $)	(%)	(Millions $)
Texas	6.1	$5340	6.8	$1209	11.8	$1177
Utah	5.2	$393	5.8	$62	9.0	$71
Vermont	5.3	$141	6.9	$29	8.6	$40
Virginia	5.7	$1641	6.7	$320	13.1	$374
Washington	5.4	$1330	6.0	$236	9.9	$365
West Virginia	6.4	$588	7.3	$140	11.4	$187
Wisconsin	5.8	$1486	7.7	$306	9.1	$320
Wyoming	4.9	$87	5.9	$15	8.5	$23
Total	5.7	$75,051	6.8	$17,701	10.6	$21,329

* Estimates based on fewer than 20 observations.

small in some states (most notably Arizona, Kansas, Nevada, and New Hampshire). Therefore, there is likely to be substantial variation around our state-level estimates. Because our focus was not to test statistically whether obesity-attributable expenditures were larger in some states than others, we did not calculate SEs at the state level. Finkelstein et al. (6) presented bootstrapped SEs for national medical expenditures attributable to obesity at 49%, 52%,

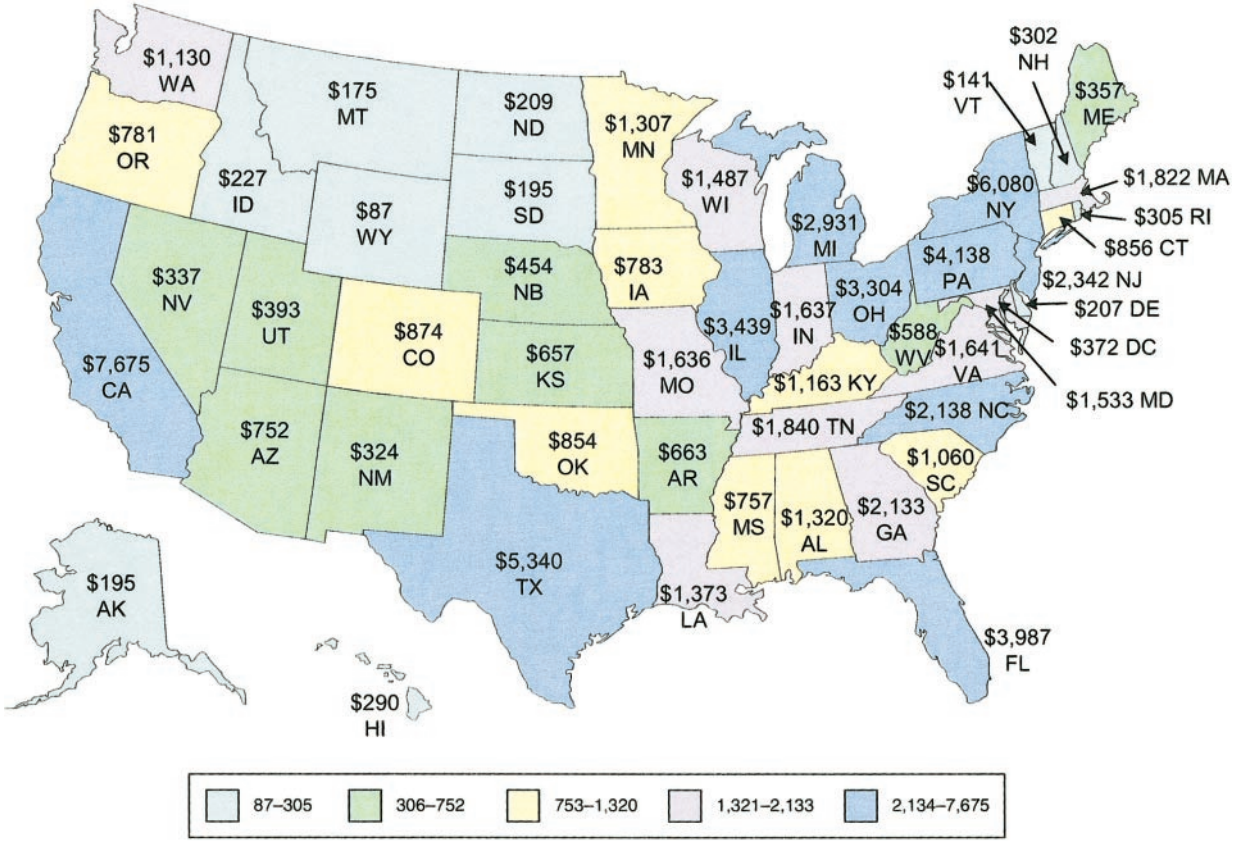

Figure 1: Estimated adult obesity-attributable medical expenditures (2003 dollars in millions).

and 43% of the mean for the total, Medicare, and Medicaid populations, respectively. The state-level estimates, although unbiased, are likely to be associated with larger SEs and, therefore, should not be used to make comparisons across states or among payers within states.

Acknowledgments

This work was supported by Contract 200-97-0621 from the Centers for Disease Control and Prevention (CDC), Division of Nutrition and Physical Activity. The authors thank David Thompson, Innovus; Frank Sloan, Duke University; Graham Colditz, Harvard University; Roland Sturm, RAND; Anne Wolf, University of Virginia; Kyumin Shim, CDC; and Deb Galuska, CDC, for participating in the obesity cost workshop; and Susan Murchie for editorial support.

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