

Health Services Use and Health Care Costs of Obese and Nonobese Individuals

Marsha A. Raebel, PharmD; Daniel C. Malone, PhD; Douglas A. Conner, PhD; Stanley Xu, PhD; Julie A. Porter, PharmD; Frances A. Lanty, PharmD

Background: Obesity has clinical and economic consequences. Few studies have compared health care resource utilization between age- and sex-matched obese and nonobese persons.

Methods: We conducted a retrospective study in obese and nonobese individuals matched by age, sex, medical clinic, and selected exclusionary diagnoses. Data collected included hospitalizations, outpatient visits, professional claims, and prescriptions over 1 year. Costs were assigned to medical resources based on market prices using publicly available costs. Comorbid conditions were determined using a chronic disease score (CDS) index. Groups were compared on types and costs of resources consumed. Regression models were used to examine the effect of body mass index (BMI) on costs while controlling for age and chronic diseases.

Results: A total of 539 obese and 1225 nonobese per-

sons were examined. Obese patients had more hospitalizations ($P < .001$), prescription drugs ($P < .001$), professional claims ($P < .001$), and outpatient visits ($P = .005$). Obese patients used more cardiovascular, intranasal allergic rhinitis, asthma, ulcer, diabetes, thyroid, and analgesic drugs. Total costs between groups were different (median of \$585.44 for obese and \$333.24 for nonobese patients; $P < .001$). Cost differences were primarily due to medications ($P < .001$). Predictors of total costs were age, sex, BMI, and CDS. For each unit BMI increase, costs increased 2.3% ($P < .001$). For each CDS unit increase, costs increased 52.9% ($P < .001$).

Conclusion: Over 1 year, health care costs for obese persons are higher than for nonobese persons, primarily because of prescription drugs.

Arch Intern Med. 2004;164:2135-2140

Author Affiliations: Clinical Research Unit (Drs Raebel, Conner, and Xu) and Department of Pharmacy (Drs Porter and Lanty), Kaiser Permanente of Colorado, Denver; University of Colorado School of Pharmacy, Denver (Drs Raebel, Porter, and Lanty); and University of Arizona College of Pharmacy, Tucson (Dr Malone). Dr Porter is now with Aventis Pharmaceuticals, Denver, in addition to the University of Colorado School of Pharmacy.

Financial Interest: None.

THE PREVALENCE OF OBESITY is increasing. Data from the National Health and Nutrition Examination Surveys (NHANES II, NHANES III, and NHANES Continuous) show that the prevalence of obesity (body mass index [BMI; calculated as weight in kilograms divided by the square of height in meters] ≥ 30) increased between 1976 and 1980, 1988 and 1991, and 1999 and 2000 from 15.0% to 23.3% to 30.9% of adults aged 20 to 74 years.^{1,2} Almost 65% of adults in the United States aged 20 years or older are overweight (BMI ≥ 25).² The incidence of chronic diseases increases in persons who are overweight or obese.^{3,4} Obesity is a major risk factor for hypertension, hypercholesterolemia, type 2 diabetes mellitus, coronary artery disease, stroke, gallbladder disease, musculoskeletal disorders, and certain cancers, as well as all-cause mortality.⁴ Obesity in adulthood is associated with a shortened life expectancy.^{5,6} Peeters and colleagues⁵ found that

in nonsmokers at age 40 years, obesity was associated with a 7-year decrease in life expectancy in women and a 6-year decrease in men. The decrease in life expectancy was 13 to 14 years in patients who were both obese and smokers compared with normal weight nonsmokers.⁵ Fontaine and colleagues⁶ found that for patients 20 to 30 years old with severe obesity (BMI ≥ 45), the maximum estimated number of years of life lost was 13 for white men, 8 for white women, 20 for black men, and 5 for black women.

In 1995, the total costs of obesity were estimated to exceed \$99 billion.⁷ Wolf and Colditz⁷ estimated that the direct health care costs for chronic diseases related to obesity were \$51.6 billion in 1995 dollars, representing 5.7% of US health care expenditures. Indirect costs associated with obesity were estimated at \$47.6 billion.⁷ Five obesity-related diseases (hypertension, hyperlipidemia, type 2 diabetes mellitus, coronary artery disease, and stroke) accounted for approximately 85% of the

economic burden of obesity.³ Using 1990 examples, 57% of the total cost of type 2 diabetes mellitus (\$8.8 billion) was estimated to be due to obesity, and \$29 billion of cardiovascular disease costs were estimated to be obesity related.⁸

We were interested in health care consumption between obese and nonobese health plan members. Few studies have compared health care resource utilization between obese and nonobese patients who are similar in age, sex, or socioeconomic status. To our knowledge, no previous study has controlled for chronic diseases in obese and nonobese patients who are similar in age, sex, or socioeconomic status. The purpose of this study was to compare health care resource utilization (ie, outpatient visits, outpatient surgery, emergency department visits, prescriptions, and inpatient services) between obese and nonobese Kaiser Permanente of Colorado (KPCO) members over a 1-year period. We hypothesized that the mean or median number of medical resources used by obese persons differed from nonobese persons. We further hypothesized that the average or median total cost of medical care incurred by obese patients differed from non-obese subjects.

METHODS

We matched overweight and obese patients with a BMI of 27.9 to 68.6 with members who were nonobese (normal weight: BMI, 18.5-24.9). Obese patients were matched with nonobese members by age within 5 years, sex, primary outpatient medical office, and absence of selected diagnoses (eg, pregnancy, coronary artery disease, congestive heart failure, and cardiac arrhythmia). Medical office matching was used as a surrogate for socioeconomic status because, at KPCO, medical offices are located throughout the Denver-Boulder-Longmont metropolitan area and the medical office where members seek nonspecialist medical care is primarily the medical office nearest the members' residence.

For each obese person, BMI was calculated from measured height and weight using data obtained when the individual enrolled in a clinical trial between January 1, 1999, and June 30, 2000 (the Long-term Outcomes of Sibutramine Effectiveness on Weight [LOSE Weight] Study).⁹⁻¹² However, the utilization data used in the present study were from the 12-month period prior to date of clinical trial enrollment for each obese individual to avoid confounding by clinical trial participation. Non-obese members were identified using the Health Risk Appraisal (HRA) database, a database that contains general health information collected via mailed questionnaire on approximately 60% of KPCO members. Data collected for the non-obese member sample were from the same period as described previously for obese members.

After matching, persons with total expenditures exceeding the 99th percentile were excluded from both groups to reduce the influence of outliers. All study data elements were captured from the KPCO databases used for treatment, payment, and operations and were evaluated from the perspective of the managed care organization. Data collected for utilization and cost analyses included hospitalizations, outpatient visits (composed of clinic office visits, outpatient surgical procedures, and emergency department visits), professional claims, and drug dispensing.

Costs considered included direct medical care costs. Indirect costs, such as those associated with lost productivity, were not evaluated. Costs were assigned to medical resources utili-

zation based on current market prices for goods and services using publicly available cost estimates for physician, emergency department, and hospitalization costs, which were estimated using Medicare's resource-based relative value scale fee schedule and diagnosis-related groups. For prescription medications, the average wholesale price at the time of dispensing was used. Kaiser Permanente of Colorado contracts with local health care providers for certain medical services such as home health services, some specialty care, and ambulance services. The billed amount was used as the value for contracted services. Chronic diseases were determined using the chronic disease score (CDS) method of Clark et al.¹³ For bivariate analyses, each comorbidity was assigned a value of 1 and summed at the patient level. In regression models, the empirical weights reported by Clark et al.¹³ were used.

The groups were compared with respect to total resource consumption, and subanalyses were conducted for each type of resource consumed. Descriptive statistics for each variable evaluated included number of observations, number of missing observations, mean, SD, median, mode, and minimum and maximum observed values. We used the 2-tailed *t* test to evaluate age matching and the χ^2 test to evaluate sex matching. Statistical software used for the *t* test and χ^2 test was SAS version 8.2 (SAS Institute Inc, Cary, NC).

Because the 2 groups were matched by age and sex, the assumption of independent groups no longer held. We therefore used statistical methods appropriate for possible correlations among the matched obese and nonobese patients. We used a linear mixed model to fit the BMI data.^{14,15} Conditional Poisson regression models were used to fit CDS, outpatient visits, professional service claims, and prescription drug use.¹⁶ Conditional logistic regression models were used to model hospitalization resource consumption and the use of selected therapeutic drug classes,¹⁷⁻¹⁹ while the Wilcoxon rank sum test was used to evaluate hospitalization length of stay. Because most patients had no hospitalization costs, the economic analysis used a 2-part model to compare correlated health care cost data with zeros between the 2 groups.²⁰ Variables evaluated in the models of costs included outpatient visits, professional service claims, hospitalizations, prescription drug use, and total costs. In the multiple regression predicting total costs, independent variables included patient age, sex, BMI, and CDS. A conditional logistic regression model was fitted to evaluate the risk of hospitalization as a dependent variable with risk factors BMI, age, and CDS as independent variables. Age was included in both regression models because, although age was a matching criterion, the 2 groups were matched by age in 5-year groupings. For the linear mixed model, conditional Poisson regression models, and conditional logistic regression models, Stata version 7 (Stata Corporation, College Station, Tex) was used. The Kaiser Foundation Research Institute institutional review board approved this study.

RESULTS

A total of 545 obese patients were matched with 1229 nonobese patients; 462 obese individuals were matched with 2 or 3 nonobese individuals, while 83 obese individuals were matched with 1 nonobese individual. Ten persons (6 obese and 4 nonobese) were excluded from analysis because their medical costs exceeded the 99th percentile for total cost. Therefore, 539 obese and 1225 nonobese persons were included in analyses.

The 2 groups had similar age and sex distribution. The mean (SD) age in years was 48.2 (10.4) for obese persons and 49.1 (10.3) for nonobese individuals (*P* = .07).

The age range was 21 to 79 years for obese persons and 22 to 84 years for nonobese persons. Of obese patients, 18% were male, while 21.8% of nonobese patients were male ($P=.06$), a difference that resulted from the matching ratio. Comparisons of BMI and CDS for obese patients and nonobese patients are given in **Table 1**. Mean BMI for obese patients was 37.9 (95% confidence interval [CI], 37.3-38.4) with a range of 27.9 to 68.6. For nonobese persons, the mean BMI was 22.4 (95% CI, 22.3-22.5), with a range of 18.5 to 24.9 ($P<.001$). Both obese and nonobese patients had a median of 1 chronic disease ($P=.17$).

New and refill prescription utilization was significantly greater in obese patients (median, 11 prescriptions) than in nonobese persons (median, 6 prescriptions) ($P<.001$) (**Table 2**). The 5th to 95th percentile for number of prescriptions was 0 to 39 for obese patients and 0 to 27 for nonobese individuals. An obese individual obtained 1.81 times more prescription drugs than did a nonobese individual during this 1-year period. Compared with nonobese individuals, obese individuals used more antihypertensive medications, calcium channel blockers, β -blockers, diuretics, intranasal allergic rhinitis preparations, asthma medications, ulcer medications, antidiabetic drugs, thyroid drugs, and nonnarcotic and narcotic analgesics (**Table 3**).

Most individuals in both groups had no hospitalizations (Table 2); however, there was a statistically significant difference in the rate of hospitalization between the 2 groups ($P<.001$). An obese individual was 3.85 times more likely to have been hospitalized during the year of the study than was a nonobese individual. When an obese individual was hospitalized, the length of stay was similar to a nonobese individual (median, 1.86 days vs 1.84 days; $P=.51$). The mean age of an obese individual who was hospitalized was younger than the mean age of a nonobese individual who was hospitalized (49 vs 56 years).

The median number of outpatient visits was 3 for the obese group and 2 for the nonobese group ($P=.005$). There was greater variability in the number of outpatient visits in the nonobese group (5th-95th percentile: obese 0-7; nonobese 0-9). The obese group also had a higher median number of professional service claims (398 claims for 539 patients vs 550 claims for 1225 patients; $P<.001$) and an 80% greater chance of having a professional services claim during the year than did the nonobese group.

Table 4 displays costs for health care services. Total costs between groups were significantly different ($P<.001$). The median total costs for obese persons were \$585.44 compared with \$333.24 for nonobese persons. This difference was primarily due to greater prescription medication costs in the obese group, although obese patients had significantly higher costs for hospitalizations ($P=.01$) as well. Median prescription costs were \$357.65 for obese patients compared with \$157.86 for nonobese persons ($P<.001$). Median outpatient visit costs were less for obese patients (\$79.58) than for nonobese persons (\$91.82; $P<.001$). Professional service claims costs were not statistically different between groups ($P=.20$).

Table 5 displays the results from the 2-part regression model predicting total direct health care costs, with age, sex, BMI, and CDS as predictor variables. All 4 vari-

Table 1. Demographics of Obese and Nonobese Patients

Item	Obese Patients (n = 539)*	Nonobese Patients (n = 1225)*	P Value
BMI, mean (SD)	37.9 (6.6)	22.4 (1.6)	<.001†
BMI, range	27.9-68.6	18.5-24.9	
CDS, median (5th-95th percentile)	1 (0-4)	1 (0-4)	.17‡
CDS, range	0-6	0-9	

Abbreviations: BMI, body mass index (calculated as weight in kilograms divided by the square of height in meters); CDS, Chronic Disease Score.

*The number of patients within each BMI category is 109 for BMI of 18.5 to 19.9; 1116 for BMI of 20 to 24.9; 218 for BMI of 27 to 34.9; 153 for BMI of 35 to 39.9; and 168 for BMI of 40 or greater.

†Linear mixed model.

‡Conditional Poisson regression.

ables were significant predictors of total costs. For each additional unit increase in CDS, total costs increased by 52.9% ($P<.001$). For each unit increase in BMI, total costs increased 2.3% ($P<.001$). For each year increase in age, total costs increased by 1.3% ($P<.001$). Finally, on average, men consumed 21% less in health care dollars than did women ($P<.001$).

Body mass index and the number of chronic diseases were significant predictors of increased risk of hospitalization (OR, 1.11 [95% CI, 1.05-1.16; $P<.001$] and OR, 1.40 [95% CI, 1.07-1.82; $P=.01$], respectively). Each unit increase in the BMI increased the risk of hospitalization by 11%, while each additional chronic disease increased the risk of hospitalization by 40%. Age (OR, 0.93 [95% CI, 0.66-1.31; $P=.69$]) was not associated with increased risk of hospitalization in these patients.

COMMENT

The results of this study indicate that obese persons consume greater numbers of prescription medications and have higher prescription drug costs, higher hospitalization costs, and higher overall health care costs compared with nonobese persons. Increased prescription drug costs are the most important contributor to increased health care costs for obese persons over a 1-year period. After controlling for age, sex, and chronic diseases, a person with a BMI of 40 is likely to consume \$115 more in health care costs per year compared with a person with a BMI of 25. Internal data from the current HRA survey of KPCO suggest that 22% of the adult members of KPCO are obese. When extrapolated to the adult KPCO population, KPCO has approximately 65 000 adult members who are overweight or obese—4000 who have a BMI of 40 or greater. These 4000 persons account for an estimated \$460 000 in extra medical care costs each year compared with persons with a BMI of 25. These cost estimates are conservative because they do not include the cost contributions of additional chronic diseases experienced by obese individuals. Each additional chronic disease contributes an estimated extra \$177 per year to the health care costs of an obese individual.

Our finding that an obese individual had a 3.85 times greater risk of hospitalization than did a nonobese indi-

Table 2. Medical Resource Utilization of Obese and Nonobese Patients

Outcome	Obese Patients (n = 539)		Nonobese Patients (n = 1225)		IRR/OR (95% CI), Obese vs Nonobese Patients	P Value
	Total	Statistic	Total	Statistic		
Outpatient visits	1803	3 (0-7)*	3781	2 (0-9)*	1.09 (1.03-1.15)	.005
Hospitalization	26	4.81%	18	1.47%	3.85 (2.02-7.37)	<.001
Length of stay for hospitalizations, d	64	2 (1-5)*	72	2 (1-15)*	NA	.51†
Professional service claims	398	0 (0-4)*	550	0 (0-2)*	1.80 (1.58-2.05)	<.001
Prescription drugs	7868	11 (0-39) *	9900	6 (0-27)*	1.81 (1.75-1.86)	<.001

Abbreviations: CI, confidence interval; IRR, incidence rate ratio for outpatient visits, professional service claims, and prescription drugs from conditional Poisson regressions; OR, odds ratio for hospitalization from conditional logistic regression; NA, not applicable.

*Median (5th-95th percentile).

†Wilcoxon rank sum test.

Table 3. Use of Selected Therapeutic Drug Classes by Obese and Nonobese Patients

Therapeutic Class	Obese Patients, Total No. (%) (n = 539)	Nonobese Patients, Total No. (%) (n = 1225)	OR (95% CI),* Obese vs Nonobese Patients	P Value*
Antidiabetic agents	36 (6.7)	5 (0.4)	16.52 (6.46-42.27)	<.001
Antihyperlipidemic medications	26 (4.8)	68 (5.6)	0.90 (0.50-1.47)	.40
Antihypertensive medications	73 (13.5)	59 (4.8)	3.70 (2.49-5.49)	<.001
Asthma medications	111 (20.6)	38 (3.1)	8.57 (5.60-13.12)	<.001
β-Blockers	67 (12.4)	44 (3.6)	4.06 (2.67-6.19)	<.001
Calcium channel blockers	23 (4.3)	3 (0.2)	18.75 (5.61-62.67)	<.001
Diuretic medications	121 (21.5)	10 (0.8)	39.43 (18.37-84.63)	<.001
Narcotic analgesics	117 (21.7)	197 (16.1)	1.43 (1.09-1.86)	.009
Intranasal allergic rhinitis preparations	130 (24.1)	58 (4.7)	6.64 (4.64-9.47)	<.001
Nonnarcotic analgesics	25 (4.6)	9 (0.7)	6.96 (3.10-15.61)	<.001
Progestins	24 (4.5)	51 (4.2)	1.10 (0.65-1.87)	.71
Thyroid preparations	68 (12.6)	24 (2.0)	6.53 (4.05-10.53)	<.001
Ulcer medications	101 (18.7)	68 (5.6)	3.87 (2.74-5.45)	<.001

*Conditional logistic regression.

Table 4. Costs of Medical Resource Use for Obese and Nonobese Patients

Item	Obese Patients (n = 539)		Nonobese Patients (n = 1225)		P Value*
	Total	Median (5th-95th Percentile)	Total	Median (5th-95th Percentile)	
Outpatient visits, \$	51 759	79.58 (0-227.25)	174 507	91.82 (0-489.71)	<.001
Hospitalizations, \$	81 992	0 (0-0)	73 018	0 (0-0)	.01
Professional service claims, \$	102 444	0 (0-1151.26)	172 698	0 (0-764.50)	.20
Prescription drugs, \$	337 973	357.65 (0-2061.11)	447 998	157.86 (0-1361.27)	<.001
Total costs, \$	574 167	585.44 (51.11-4137.41)	868 221	333.24 (0-2431.73)	<.001

*Two-part regression model (Berk and Lachenbruch,²⁰ 2002).

vidual is particularly interesting because the mean age of the hospitalized nonobese individuals was older (56 years) than the mean age of the hospitalized obese individual (49 years). Because only patients who were hospitalized were included in the hospitalization analysis, we were initially concerned that we were comparing the outcome between 2 different populations in terms of age and that the difference in hospitalization risk could be caused by the difference in age, not the difference in obesity status. We know that for KPCO members overall, the rate of hospitalization increases with increasing age (un-

published data, 2003). However, because the younger, obese population actually had the higher hospitalization rate in our study, we believe that age did not contribute to the increased hospitalization risk in the obese subjects.

Other studies have found relationships between obesity and increased medical care costs.^{21,22} Thompson and colleagues²¹ assessed the relationship between BMI and health care costs in a retrospective cohort study. Costs of care for study subjects who responded to a health survey in 1990 and were stratified by BMI at that time were

evaluated from 1990 through 1998. In comparison with persons with a BMI of 20 to 24, costs for persons with a BMI of 25 to 29.9 and 30 or greater were significantly higher for prescription drugs and for all medical care. While costs for outpatient services and inpatient care were higher for the higher BMI levels, the findings were not statistically significant.²¹ Our study similarly found that the increase in total health care costs for obese individuals was primarily from prescription drug costs.

Narbro et al²² evaluated both the types and costs of medications more often taken by obese individuals via a cross-sectional comparison of the use of prescription medications in 1286 obese individuals in the Swedish Obese Subjects (SOS) study and 958 reference individuals. Compared with the reference persons, in the SOS study obese individuals took more medications for cardiovascular disease, nonsteroidal anti-inflammatory drugs, other pain medications, drugs for diabetes mellitus, and asthma medications. Costs for medications for obese individuals were more than 50% higher than for the reference population. Our results also demonstrate that obese individuals use more cardiovascular medications, drugs for diabetes, analgesics, and asthma medications than did nonobese individuals. In addition, more obese patients in our study used ulcer medications, thyroid drugs, and intranasal allergic rhinitis preparations.

A retrospective database analysis of patients completing a membership health survey at Kaiser Permanente (KP) in Northern California also demonstrated increased health care resource utilization and costs among obese members.²³ In this study by Quesenberry et al,²³ 8893 (52%) of 17 118 members had a BMI of 25 or greater (BMI of 25-29.9 [n=6003], BMI of 30-34.9 [n=1994], and BMI \geq 35 [n=896]). Health services use data were evaluated over a 12-month period. Total health care costs were increased in patients with a BMI in the range of 30.0 to 34.9 and 35 or greater. Mean annual costs were 25% greater among those with BMI of 30.0 to 34.5 and 44% higher among those with BMI of 35 or greater compared with those with a BMI of 20.0 to 24.9 ($P=.003$). The presence of coronary heart disease, hypertension, and diabetes was associated with increased costs. It was estimated that the cost of obesity in 1994 for the KP Northern California Region was \$220 million.²³ One limitation of the study by Quesenberry et al²³ was that the study population was selected from members who chose to complete a survey. An additional limitation of this study was that self-reported heights and weights were used. A validation study of 111 medical charts of patients included in the study indicated that weights were underreported, resulting in underreporting of BMI. Finally, because of database issues, they used a different sampling time-frame to ascertain use of outpatient radiology and pharmacy services from the time frame used for the other services evaluated.

Strengths of our study include that the obese and non-obese patient samples were matched with regard to age, sex, a surrogate for socioeconomic status, and chronic disease score. To our knowledge, no previous study has controlled for chronic diseases in the evaluation of health care costs and utilization. In addition, we used publicly available costs in our economic evaluations.

Table 5. Factors Predicting Total Direct Health Care Costs

Item	Coefficient (β)	E ^b	P Value*
Age	0.013	1.013	<.001
Sex (male)	-0.236	0.789	<.001
Body mass index	0.023	1.023	<.001
Chronic Disease Score	0.425	1.529	<.001

*Two-part regression model (Berk and Lachenbruch,²⁰ 2002).

A potential limitation of our study was excluding the 10 individuals who represented expenditures exceeding the 99th percentile for total costs. Another potential limitation of our study was that the costs estimates used were based on national fee schedules and publicly available prices. Therefore, these cost estimates may not reflect experiences for a given health plan or other payer entity. A third limitation was that the BMI measurements in our study groups were derived differently. The BMI for non-obese persons was drawn from height and weight data these individuals self-reported in the HRA (with the potential for underreporting of BMI), whereas the BMI of the obese patients was from measured height and weight. However, if this had biased our results, the bias should have been toward the null because there would have been less difference between the 2 groups in BMI. It is feasible that subjects who responded to the HRA survey (from which the nonobese sample was drawn) are somehow different from individuals who chose not to respond to the HRA survey and different from the obese sample studied in this project. Survey responders are generally considered to be more concerned about their health. Because 60% of the KPCO membership has responded to the HRA survey, we do not believe the HRA response/nonresponse factor contributed to selection bias in a meaningful way. It could also be posited that individuals in the obese group, who participated in the LOSE Weight study, were more concerned about their health, had more health complaints, and were more likely to seek medical care than the overall population of obese individuals. Finally, we did not capture smoking status for the groups. It would have been desirable to know whether the percentage of smokers was similar between groups because of potential differences in health care resource utilization between smokers and nonsmokers.

Our study examined health care consumption over only a 1-year period. We did not examine long-term costs or reduced life expectancy due to obesity.^{5-8,21,24-27} Although the long-term consequences of obesity are costly in terms of medical resources consumed,^{21,24-27} many of the cost consequences have been estimated using predicted rather than actual data.²⁵⁻²⁷ Furthermore, very few studies have evaluated the long-term effects of weight loss on drug costs or use in obese patients.²⁸ Perhaps the best data available to date is from the SOS study in which subjects were followed for 6 years.²⁸ In the SOS study, changes in the use and costs of medications for 510 surgically and 455 conventionally treated obese patients were analyzed in relation to treatment and weight change.²⁸ Over the 6 years, medication costs for diabetes and cardiovascular disease drug therapy increased by 96% for pa-

tients with weight loss of less than 5%, whereas the costs decreased by 8% for subjects with weight loss 15% or greater. A 10% or greater weight loss was needed to reduce costs of medication for cardiovascular disease and diabetes for patients who had these diseases at baseline. To reduce need for new treatment of these 2 diseases, a weight loss of 15% or greater was necessary.

Our study did not examine the indirect costs of obesity or the effect of obesity on quality of life. Research has previously documented that as BMI increases, so do the number of sick days, short-term disability, and other indirect costs.²⁹ Sturm³⁰ asserted that, based on data from Healthcare for Communities (a national household telephone survey in 1997-1998), the effects of obesity on physical health-related quality of life are similar to 30 years of aging. Sturm³⁰ further claimed that obesity has a stronger association with reduced health-related quality of life and increased health care spending than do either problem drinking or smoking.³⁰

The economic burden of obesity is significant, even over the relatively short-time period of 1 year. Our study documents the association between health care expenditures and level of obesity using individual-level data, while taking age, sex, and chronic diseases into consideration. Further study is needed to establish the economic burden of obesity using data from a longer period.

Accepted for Publication: December 17, 2003.

Correspondence: Marsha A. Raebel, PharmD, Kaiser Permanente of Colorado, Clinical Research Unit, PO Box 378066, Denver, CO 80237-8066 (Marsha.A.Raebel@kp.org).

Funding/Support: This study was supported by funding from the KPCO Clinical Research Unit.

Acknowledgments: Ella Lyons, MS, provided statistical consulting guidance on the design of this study. We also want to acknowledge, with thanks, the assistance of Lynn Stevens, BS, with the Health Risk Appraisal data. Daniel C. Malone, PhD, provided paid pharmacoeconomic consultation for this work. Statistical evaluation was conducted by Stanley Xu, PhD, Biostatistician at the KPCO Clinical Research Unit.

REFERENCES

- Centers for Disease Control and Prevention. Update: prevalence of overweight among children, adolescents, and adults—United States, 1988-1994. *MMWR Morb Mortal Wkly Rep.* 1997;46:198-202.
- Flegal KM, Carroll MD, Ogden CL, et al. Prevalence and trends in obesity among US Adults, 1999-2000. *JAMA.* 2002;288:1723-1727.
- Pi-Sunyer FX. Medical hazards of obesity. *Ann Intern Med.* 1993;119:655-660.
- National Institutes of Health. Clinical guidelines on the identification, evaluation and treatment of overweight and obesity in adults: the evidence report. *Obes Res.* 1998;6(suppl 2):51S-209S.
- Peeters A, Barendregt JJ, Willekens F, et al. Obesity in adulthood and its consequences for life expectancy: a life-table analysis. *Ann Intern Med.* 2003;138:24-32.
- Fontaine KR, Redden DT, Wang C, et al. Years of life lost due to obesity. *JAMA.* 2003;289:187-193.
- Wolf AM, Colditz GA. Current estimates of the economic cost of obesity in the United States. *Obes Res.* 1998;6:97-106.
- Wolf AM, Colditz GA. The cost of obesity: the US perspective. *Pharmacoeconomics.* 1994;5(suppl 1):34-37.
- Porter JA, Raebel MA, Lanty FA, et al. The long-term outcomes of sibutramine effectiveness on weight (LOSE Weight) study in a managed care organization: six month clinical outcomes in a naturalistic clinical setting: American Heart Association Scientific Sessions 2001, Anaheim, California, November 11, 2001 [abstract]. *Circulation.* 2001;104:11793. Abstract 3727.
- Gay EC, Conner DA, Porter JA, et al. The long-term outcomes of sibutramine effectiveness on weight (LOSE Weight) study in a managed care organization: six month psychosocial outcomes in a naturalistic clinical setting. *Obes Res.* 2001;9(suppl 3):187S [abstract].
- Lanty FA, Vogel EA, Malone DC, et al. Demographic and medication use of the Long-term Outcomes and Sibutramine Effectiveness for Weight (LOSE Weight) Study in a managed care organization [abstract]. *Pharmacotherapy.* 2000;20:1239. Abstract 55.
- Porter JA, Raebel MA, Conner DA, et al. The long-term outcomes of sibutramine effectiveness on weight (LOSE Weight) study: evaluating the role of drug therapy within a weight management program in a group-model health maintenance organization. *Am J Manag Care.* 2004;10:369-376.
- Clark DO, Von Korff M, Saunders K, et al. A chronic disease score with empirically derived weight. *Med Care.* 1995;33:783-795.
- Harville DA. Maximum likelihood approaches to variance component estimation and to related problems. *J Am Stat Assoc.* 1977;72:320-338.
- Laird N, Ware JH. Random effects models for longitudinal data. *Biometrics.* 1982;38:963-974.
- Farrington CP. Relative incidence estimation from case series for vaccine safety evaluation. *Biometrics.* 1995;51:228-235.
- Cox DR. *The Analysis of Binary Data.* London, England: Methuen; 1970.
- Cox DR, Hinkley DV. *Theoretical Statistics.* London, England: Chapman Hall; 1974.
- Breslow NE, Day NE. *Statistical Methods in Cancer Research, Vol 1: The Analysis of Case-control Studies.* Lyon, France: International Agency on Cancer, 1980.
- Berk KN, Lachenbruch PA. Repeated measures with zeros. *Stat Methods Med Res.* 2002;11:303-316.
- Thompson D, Brown JB, Nichols GA, et al. Body mass index and future health-care costs: a retrospective cohort study. *Obes Res.* 2001;9:210-218.
- Narbro K, Agren G, Jonsson E, et al. Pharmaceutical costs in obese individuals: comparison with a randomly selected population sample and long-term changes after conventional and surgical treatment: the SOS intervention study. *Arch Intern Med.* 2002;162:2061-2069.
- Quesenberry CP, Caan B, Jacobson A. Obesity, health services use, and health care costs among members of a health maintenance organization. *Arch Intern Med.* 1998;158:466-472.
- Allison DB, Zannolli R, Narayan KMV. The direct health care costs of obesity in the United States. *Am J Public Health.* 1999;89:1194-1199.
- Oster G, Edelsberg J, O'Sullivan AK, et al. The clinical and economic burden of obesity in a managed care setting. *Am J Manag Care.* 2000;6:681-689.
- Thompson D, Edelsberg J, Colditz GA, et al. Lifetime health and economic consequences of obesity. *Arch Intern Med.* 1999;159:2177-2183.
- Oster G, Thompson D, Edelsberg J, et al. Lifetime health and economic benefits of weight loss among obese persons. *Am J Public Health.* 1999;89:1536-1542.
- Agren G, Narbro K, Naslund I, et al. Long-term effects of weight loss on pharmaceutical costs in obese subjects: a report from the SOS intervention study. *Int J Obes Relat Metab Disord.* 2002;26:184-192.
- Burton WN, Chen CY, Schultz AB, et al. The economic costs associated with body mass index in a workplace. *J Occup Environ Med.* 1998;40:786-792.
- Sturm R. The effects of obesity, smoking, and drinking on medical problems and costs. *Health Aff (Millwood).* 2002;21:245-253.