A Cost-benefit Simulation Model of Coverage for Bariatric Surgery Among Full-time Employees

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Objective: To use a simulation model to estimate the costs and benefits of bariatric surgery among full-time employees.

Study Design: Multivariate regression analysis of nationally representative survey data sets to estimate the costs of obesity and a simulation model of the number of years until breakeven under alternate assumptions about the costs and benefits of bariatric surgery.

Methods: We used a 2-part model to estimate medical costs of obesity based on the 2000-2001 Medical Expenditure Panel Survey. We estimated work loss with a negative binomial regression based on the 2002 National Health Interview Survey. Using these results, we simulated the expected number of years required for a bariatric surgery procedure to become cost saving.

Results: Nine percent of the full-time US workforce, or 29% of the obese workforce, is eligible for bariatric surgery. Obese workers eligible for bariatric surgery have 5.1 ($P < .01$) additional days of work loss and $2230 (in 2004 dollars) ($P < .01$) higher annual medical costs than persons of normal weight.

Conclusion: Although the cost implications of bariatric surgery among full-time employees depend on many factors, the simulations reveal that 5 or more years of follow-up are most likely required for these operations to become cost saving unless the employee bears a significant fraction of the total costs of the surgery.

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The increased prevalence of obesity and obesity-related diseases among Americans is well documented.[1-3] The overall rate of obesity in adults grew to 30.5% in 1999-2000, from 22.9% in 1988-1994 and less than 15% in the 1970s.[1] The prevalence of morbid, or severe, obesity has increased at a much faster rate than obesity in general.[4] A substantial body of literature has also shown large financial consequences from obesity. For example, obese adults incur 36% greater annual medical expenditures than normal-weight persons,[5] and overweight and obesity account for 9.1% of total annual medical expenditures.[6]

Increased prevalence of obesity among the workforce may have several financial consequences for employers.[7] As increased rates of obesity contribute to rising medical costs, this will likely exacerbate health insurance costs. Recent research has shown that 12% of the rise in inflation-adjusted per capita medical spending between 1987 and 2001 was attributable to the increased prevalence of obesity.[8] Obese employees have also been shown to be absent from work more often than their nonobese counterparts.[7,9] Thompson et al[7] found that obese men were absent 2.7 more days per year than normal-weight men, and obese women missed 5.1 more days per year than normal-weight women.

With attention focused on the costs and prevalence of obesity, bariatric surgery—in particular, Roux-en-Y gastric bypass and gastric banding—has recently become a common form of treatment for severe obesity.[10,11] Employers and insurers have, in turn, been forced to make or revisit decisions about coverage for bariatric surgery and other obesity treatments.[12]

Although surgical operations have been shown to be effective in reducing weight and resolving or reducing comorbidities,[13,14] few investigations have addressed potential cost savings resulting from the surgery.[15] Three studies[16-18] applied the conventional cost-effectiveness framework to compute the cost per quality-adjusted life-year for surgery; results ranged from –$4000 per quality-adjusted life-year (net savings)[18] to $35 600 per quality-adjusted life-year.[16]

Other studies[19-22] looked at reductions in specific cost components resulting from the surgery, but only 1 study[23] reported the number of years before bariatric surgery results in cost savings, and this study was limited to medical costs in the Canadian healthcare system. The study reported that Roux-en-Y gastric bypass and vertical banded gastroplasty were cost saving after 3.5 years. However, because the Canadian healthcare system is different from the US healthcare system, results may not be generalizable across borders.

In this study, we use nationally representative data for the US full-time employed population to quantify the increase in annual medical costs and work loss associated with obesity among the bariatric surgery–eligible and bariatric surgery–ineligible obese populations. We then use these results in a simulation model to estimate

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the potential benefits associated with coverage for bariatric surgery under various assumptions. We are aware of no available randomized controlled trial or quasiexperiment with sufficient data to permit a detailed cost-benefit analysis of bariatric surgery. In the absence of such data, a simulation model is feasible and appropriate for providing base-case estimates.

DATA

We used 2 nationally representative data sets of the civilian noninstitutionalized population to quantify annual work loss and medical costs attributable to obesity. We used the 2002 National Health Interview Survey (NHIS) to analyze work loss due to illness or injury and the 2000-2001 Medical Expenditure Panel Survey (MEPS) for medical costs. We applied common sample selection criteria to both data sets. We restricted the sample to individuals aged 18 to 64 years who reported working full time (≥ 35 h/wk) for the entire year. We also excluded pregnant women and individuals with missing body mass index (BMI) data, calculated as weight in kilograms divided by the square of height in meters.

The NHIS is the principal source of information on the health of the household population of the United States. Besides self-reported height, weight, and health conditions, the NHIS includes information on workdays missed due to illness or injury and sociodemographic characteristics, including race and ethnicity, sex, age, education, family size, employment status, occupation, hours of work per week, and income. For analysis of work loss, we began with the 31 044 adults in the 2002 NHIS. After applying the sample restrictions, the final data set included 12 019 full-time employed adults (6641 men and 5378 women) with sampling weights to generate nationally representative estimates. Forty-six percent of the weighted regression population (41% of men and 53% of women) reported missing at least 1 day of work due to illness or injury.

The MEPS sample is a subset of the NHIS participants. The MEPS provides additional details on health conditions and annual medical expenditures, and each individual's data can be merged with his or her responses to the NHIS survey. We used the MEPS and pooled data from 2000-2001 to increase the sample size. Applying the sample selection criteria already detailed reduced the 41 217 (unweighted) adults (17 558 in 2000 and 23 659 in 2001) to the final data set of 20 329 full-time employed adults (11 849 men and 8480 women).

Surgery-eligible obesity was defined as a BMI of 40 or greater, or a BMI of 35 to less than 40 with angina, asthma, osteoarthritis, diabetes mellitus, or hypertension. This approximated the guidelines set by a National Institutes of Health panel on bariatric surgery,[24] although the guidelines included other comorbidities that we were unable to measure in our data. Surgery-ineligible obesity was defined as a BMI of 30 to less than 35, or a BMI of 35 to less than 40 without the comorbidities just listed. All other BMI values were considered to represent nonobesity. In the analyses, we included dummy variables for overweight (BMI, 25 to < 30) and underweight (BMI, < 18).

METHODS

Work Loss

Because the dependent variable (workdays missed) is discrete, we used a negative binomial regression with a log link to estimate work loss. We conducted separate analyses for men and women when reporting results by sex and a pooled analysis (controlling for sex) when reporting overall estimates. We included binary variables for BMI categories (underweight, overweight, surgery ineligible, and surgery eligible) to estimate the effect of excess body weight on annual missed workdays; normal (BMI, 18 to < 25) weight constituted the omitted reference category. The regressions controlled for other factors expected to affect the number of missed workdays, including race and ethnicity, age, education, family size, marital status, income, hourly or salaried employee, class of occupation, years at current job, smoking status, alcohol use, and any functional limitations not self-reported as obesity related (eg, difficulty walking, standing, sitting, stooping, reaching, or grasping). Our method allowed us to estimate the increase in work loss associated with obesity among the surgery-eligible and surgery-ineligible populations.

We used the regression estimates to predict annual missed workdays for each employee. We then generated a second prediction after setting the 2 binary obesity variables to zero, thus predicting the number of missed workdays for a hypothetical nonobese employee with all other characteristics equivalent to those of an obese employee.[25] The difference between these 2 predictions reflects annual obesity-attributable missed workdays.

Medical Costs

We used a standard 2-part model to estimate annual medical costs attributable to obesity for the surgery-eligible and surgery-ineligible populations.[25,26] We conducted separate analyses for men and women and a pooled analysis (controlling for sex) when reporting overall estimates. We used the same main set of independent variables as for estimation of work loss, adding a categorical variable for census region and excluding variables not directly captured in the MEPS, namely, family size, hourly or salaried employee, class of occupation, years at current job, and functional limitations. Predicted costs were generated as for work loss: we extrapolated one set of predictions using the observed values and another with the binary obesity variables set to zero so that the difference reflects estimated obesity-attributable medical costs. These methods followed those used in a recent study[6] that quantified national medical expenditures attributable to obesity. Medical costs were adjusted to 2004 dollars using the medical care component of the Bureau of Labor Statistics Consumer Price Index.

Statistical Computation

All regressions were performed using Stata 8.2 (StataCorp LP, College Station, Tex) with sampling weights that allowed for generating nationally representative estimates of the full-time employed population. We computed standard errors by bootstrapping using the bsample procedure in Stata.

Bariatric Surgery Simulation

Using the work loss and medical cost estimates, we simulated the cost implications associated with coverage for bariatric surgery from a self-insured employer's perspective (ie, the employer bears all medical and work loss costs). Using this perspective, a bariatric surgery procedure would achieve breakeven when the savings resulting from the procedure become equal to the costs of the procedure. Algebraically, this occurs when the following equation holds true: $An = B + Cn$, where n indicates the number of years since the procedure; A, the mean annual costs if the procedure is not performed; B, the fixed costs associated with the procedure; and C, the mean annual costs after the procedure has been performed. From a self-insured employer's perspective, A, B, and C include medical costs and work loss costs due to illness or injury (we assume that 100% of these costs accrue to the firm).

Annual work loss and medical costs in the absence of bariatric surgery, A, were drawn from the 75th and 90th percentiles of the predicted distribution of medical costs and work loss for the surgery-eligible population as estimated using the NHIS and MEPS data. We also used the estimated mean values for this population in **Table 1** and **Table 2.** However, the 75th and 90th percentiles are likely more representative of expected costs for those who elect surgery, as they have been shown to have poorer health and presumably higher costs than the average of all surgery-eligible employees.[13,19,27] For example, the mean BMI was 46.9 among 16 944 patients in 105 extracted studies of bariatric surgery.[13] In contrast, the surgery-eligible population in the MEPS sample used for our estimation had a mean BMI of 41.7; the 75th percentile of BMI was 44.1, and the 90th percentile of BMI was 48.4.

Table 1. Obesity-attributable Work Loss in 2002*

Group	Surgery Ineligible	Surgery Eligible
Overall	0.8 (0.4 to 1.3)	5.1 (3.3 to 6.9)
Men	0.4 (–0.2 to 0.9)	4.1 (1.2 to 7.1)
Women	1.8 (1.0 to 2.7)	5.5 (3.4 to 7.5)

*Data are given as mean (95% confidence interval) number of days.

Fixed costs, B, depend on the employer's share of the medical costs of the procedure and the value of days missed from work for employees who undergo the surgery. The employer's share of the medical costs will vary depending on the cost of the procedure and the employee copayment. For our base case, we show results using \$20 000 for B, based on a cost of \$25 000 for the bariatric surgery procedure[16] and a 20% employee copayment. We assumed that 15 workdays were required for recovery[28] and multiplied the number of missed days by the mean hourly wage (including benefits) among full-time employees to calculate the value of workdays lost. The hourly wage, \$26.50, was the national mean in 2004 for all US full-time employees[29] and equals an annual salary of \$42 140, before including the value (30.8%) of benefits.[30] For our base case, we assume that bariatric surgery reduces obesity-attributable costs for the surgery-eligible population by 75%. A recent meta-analysis[13] reported that patients lost a mean of 61% of excess weight after bariatric surgery; as a result, 77% of diabetes mellitus cases were resolved, 62% of hypertension cases were resolved, and 86% of sleep apnea cases were resolved.

Sensitivity Analysis

In addition to the base case, we simulated a 100% elimination of obesity-attributable costs for the surgery-eligible population, as well as a 50% elimination. We also simulated results in which the employer pays only 50%

Table 2. Obesity-attributable Medical Costs in 2001-2002*

Group	Surgery Ineligible	Surgery Eligible
Overall	550 (389-720)	2230 (1769-2698)
Men	310 (64-562)	2020 (1230-2801)
Women	890 (644-1129)	2360 (1789-2922)

*Data are given as mean (95% confidence interval) 2004 dollars.

of the costs of the surgery (perhaps through a large coinsurance rate), as well as results in which those who undergo the procedure have about 2½ times the mean wage rate, or a $100 000 annual salary, before benefits. Higher wage rates will reduce the time to breakeven because of the higher costs that accrue to the firm as a result of work loss. Last, we simulated the results if individuals are able to return to work in 5 workdays, as opposed to 15 workdays. All scenarios use a 3% annual discount rate to convert future savings to present value. The simulations were performed using Microsoft Excel 2002 (Microsoft Corp, Redmond, Wash).

RESULTS

Work Loss Estimates

Table 1 gives predicted annual work loss attributable to obesity among full-time employees. The difference in work loss between surgery-eligible and surgery-ineligible employees was striking. Overall, less severe, surgery-ineligible obesity increased work loss by 0.8 days ($P < .01$) over normal weight, 1.8 days for women ($P < .01$) and 0.4 days for men ($P = .08$). Surgery-eligible obese employees, on the other hand, missed 5.1 more days of work on average than employees of normal weight, 4.1 more days among men and 5.5 more days among women ($P < .01$ for all). When both sexes were evaluated together, the difference between surgery-eligible and surgery-ineligible employees was statistically significant ($P = .02$). When the sexes were evaluated separately, the difference between surgery-eligible and surgery-ineligible employees was insignificant for men ($P = .22$) and women ($P = .10$).

Medical Cost Estimates

Predicted annual per capita obesity-attributable medical costs are given in Table 2. Obesity increased medical costs substantially relative to normal-weight employees; all comparison values in the table were statistically significant ($P < .01$). Obese employees ineligible for bariatric surgery had, on average, $550 ($P < .01$) higher medical costs than normal-weight employees, while employees in the surgery-eligible group incurred an estimated $2230 ($P < .01$) in additional medical costs. The difference in costs between surgery-eligible and surgery-ineligible employees was significant ($P < .01$) within each sex group and for overall obesity.

Bariatric Surgery Simulation

In **Table 3**, we report the number of years until the benefits of bariatric surgery become equal to the employer's medical and work loss costs. Our base case assumes that 75% of obesity-attributable medical and work loss costs would be reduced as a result of bariatric surgery. For an eligible employee in the 90th percentile of the cost distribution, 5.0 years were required to break even, and focusing solely on medical costs, 6.6 years were required; for an eligible employee in the 75th percentile of the cost distribution, these numbers increase to 7.1 and 8.9 years, respectively. For a surgery-eligible employee with average medical costs and work loss, 10.3 years were required to break even (13.5 years for medical costs only) (Tables 2 and 3).

In **Table 4**, we report the results of the sensitivity analyses. In the best-case scenario in which 100% of obesity-attributable costs are eliminated, 3.7 years were required to break even (4.9 years for medical costs only). In a less optimistic case, 7.9 to 17.0 years were required when only 50% of costs are reduced (10.5-23.0 years for medical costs only), depending on what levels of costs were assumed before surgery. A 50% coinsurance rate would reduce the break-even period in the base case from 5.0 to 3.3 years for an individual in the 90th percentile and from 7.1 to 4.6 years for an individual in the 75th percentile.

Increasing wages from the base-case mean of $42 140 to $100 000 (before benefits) reduces the number of years to breakeven in the base case from 5.0 to 4.0 years for an individual in the 90th percentile and from 7.1 to 5.9 years for an individual in the 75th percentile. If individuals are able to return to work in 5 (as opposed to 15) days, this reduces the number of years to breakeven in the base case from 5.0 to 4.6 years for an individual in the 90th percentile and from 7.1 to 6.4 years for an individual in the 75th percentile. Although increases in the wage rate and reductions in work loss due to surgery reduce the break-even period, even large changes in these inputs result in small changes in the time required to break even.

Table 3. Time to Breakeven From Bariatric Surgery (Assuming a 75% Reduction in Obesity-Attributable Costs)*

	Time to Breakeven, y	
Cost Distribution	Medical Costs Only	Medical and Work Loss Costs
90th Percentile	6.6	5.0
75th Percentile	8.9	7.1
Mean	13.5	10.3

*The mean numbers of days of obesity-attributable work loss are 10.2 in the 90th percentile of the cost distribution and 6.7 in the 75th percentile. The mean obesity-attributable medical costs in 2004 dollars are $4370 in the 90th percentile and $3360 in the 75th percentile.

DISCUSSION

Results from the NHIS and MEPS analyses confirm the substantial medical and work loss costs incurred by obese individuals, especially by the bariatric surgery–eligible population. Although no previous articles, to our knowledge, reported costs separately by eligibility status for bariatric surgery, our estimates are similar to those in the existing literature. We found that obesity caused an additional 5.1 days of work loss for persons eligible for surgery and 0.8 days for persons ineligible for surgery. Thompson et al[7] reported that obese men aged 25 to 54 years missed 0.2 to 2.7 more days per year than normal-weight men and that obese women aged 25 to 64 years missed 2.3 to 5.1 more days per year than normal-weight women. Finkelstein et al[6] reported that among privately insured individuals obesity increased costs by approximately $540 (in 2004 dollars). This is nearly identical to our estimate for the surgery-ineligible population but less than our combined estimate for surgery-eligible and surgery-ineligible individuals. However, because their estimate includes all individuals with private insurance and ours is limited to full-time employees (with or without insurance), the estimates are not directly comparable.

Table 4. Sensitivity Analysis of Time to Breakeven From Bariatric Surgery

Variable	Time to Breakeven, y: Medical Costs Only	Time to Breakeven, y: Medical and Work Loss Costs
Assuming a 100% reduction in obesity-attributable costs		
90th Percentile	4.9	3.7
75th Percentile	6.5	5.2
Mean	9.5	7.4
Assuming a 50% reduction in obesity-attributable costs		
90th Percentile	10.5	7.9
75th Percentile	14.5	11.3
Mean	23.0	17.0

Because of the high prevalence of severe obesity among full-time employees, the aggregate costs of severe obesity are substantial. We estimate that 9% of all full-time employees, or 29% of obese (BMI, ≥30) employees, are eligible for bariatric surgery (calculated from the 1999-2000 National Health and Nutrition Examination Survey). Although surgery-eligible obese individuals make up only about one third of the full-time employed obese population, approximately two thirds of all medical and work loss costs attributable to obesity are incurred by those eligible for bariatric surgery. This is particularly concerning for employers because survey data continue to show an increase in the rates of severe obesity among full-time employees.[1,4]

Bariatric surgery is one proposed solution for treating severe obesity. We use a simulation model to assess the financial effect of an employer's decision to offer coverage for bariatric surgery. Based on the simulation results, 5 to 10 years were required in the base case for bariatric surgery to break even. Although some scenarios resulted in breakeven in less than 4 years, these required complete resolution of obesity-attributable costs or substantial cost-sharing arrangements.

Using Canadian medical cost data, Sampalis et al[23] reported that 3.5 years were required to break even when focusing only on medical costs. In our base case, a break-even period of 3.5 years for medical costs would require the employer's cost of bariatric surgery to be $8500. Costs in their study are not directly comparable to ours because costs in the Canadian healthcare system do not reflect US market prices.

There are several limitations to our study. We strove to base the assumptions of our model on findings from the MEPS and NHIS analyses and those in the literature, but the results of the simulation model are based largely on assumptions of the medical and work loss costs incurred with or without the bariatric surgery procedure. We used sensitivity analyses to gauge the effect of these assumptions on our results; however, the experience for any particular individual undergoing the procedure may be substantially different from the results reported herein.

Our base case of a 75% reduction in obesity-attributable costs as a result of undergoing a bariatric surgery procedure was based on estimates of the reduction in comorbidities reported in the medical literature.[13] Even if the surgery were to reduce excess weight by 75%, it may reduce costs by a greater or lesser degree. Several market factors relating to coverage and costs for bariatric surgery procedures will also affect the results. We assumed the price of the procedure to be $25 000. A reduction in this price, or an increase in employee cost-sharing, would reduce the time to breakeven.

The simulations are also restricted to medical and work loss costs among full-time employees. Costs that we were unable to include because of lack of data were those associated with "presenteeism" (ie, reduced productivity) and others (eg, disability costs) that may accrue to employers as a result of obesity.[7,31] Inclusion of these costs could reduce the time to breakeven associated with bariatric surgery.

We used self-reported height and weight data to derive the costs of obesity from the NHIS and MEPS data sets. Other researchers showed self-reported weight to be underestimated and self-reported height to be somewhat overestimated.[32,33] We also assumed that the difference in costs between those who do and do not undergo bariatric surgery is constant over time. If costs escalate faster among those who do not undergo the surgery, then the cost savings would be greater than our model suggests.

The scope of our analysis is relevant for the full-time employed population but should not be extended to the population at large. Obese individuals with full-time employment may be healthier than the general population and thus may have lower healthcare costs in the absence of bariatric surgery. In fact, differences in the population scope could be an additional reason why our results deviate from the findings of Sampalis et al,[23] whose data are not restricted to full-time employees.

We estimated the net benefits of bariatric surgery by considering a hypothetical obese employee. Before making a decision on whether to provide coverage for bariatric surgery, firms ideally would also have information on the number of bariatric surgery procedures that would be required by employees at specific cost-sharing arrangements and the cost profile of these employees before surgery. Moreover, we acknowledge that clinical guidelines and medical necessity often drive coverage decisions and that financial considerations may be of secondary importance. Nevertheless, our results suggest 3 important findings. First, the costs of obesity among full-time employees are disproportionately concentrated among those eligible for bariatric surgery, even though they make up only about one third of the obese working population. Second, increased work loss among the surgery-eligible population represents a significant cost of obesity to employers. Last, while bariatric surgery may pay for itself in less than 4 years, as suggested by Sampalis et al,[23] our simulations reveal that the most likely breakeven occurs 5 or more years after surgery. Future studies based on a randomized controlled trial or quasiexperiment and actual cost and outcome data will ultimately determine the accuracy of our simulation results for the US employed population.

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REFERENCES

1. Flegal KM, Carroll MD, Ogden CL, Johnson CL. Prevalence and trends in obesity among US adults, 1999-2000. *JAMA.* 2002;288:1723-1727.

2. Calle EE, Rodriguez C, Walker-Thurmond K, Thun MJ. Overweight, obesity, and mortality from cancer in a prospectively studied cohort of US adults. *N Engl J Med.* 2003;348:1625-1638.

3. Must A, Spadano J, Coakley EH, Field AE, Colditz G, Dietz WH. The disease burden associated with overweight and obesity. *JAMA.* 1999;282:1523-1529.

4. Sturm R. Increases in clinically severe obesity in the United States, 1986-2000. *Arch Intern Med.* 2003;163:2146-2148.

5. Sturm R. The effects of obesity, smoking, and drinking on medical problems and costs: obesity outranks both smoking and drinking in its deleterious effects on health and health costs. *Health Aff (Millwood).* 2002;21(2):245-253.

6. Finkelstein EA, Fiebelkom IC, Wang G. National medical spending attributable to overweight and obesity: how much, and who's paying? *Health Aff (Millwood).* 2003;Jan-Jun(suppl Web exclusives):W3-219-226.

7. Thompson D, Edelsberg J, Kinsey KL, Oster G. Estimated economic costs of obesity to U.S. business. *Am J Health Promot.* 1998;13:120-127.

8. Thorpe KE, Florence CS, Howard DH, Joski P. The impact of obesity on rising medical spending. *Health Aff (Millwood).* 2004;Jul-Dec(suppl Web exclusives):W4-480-486.

9. Tucker LA, Friedman GM. Obesity and absenteeism: an epidemiologic study of 10 825 employed adults. *Am J Health Promot.* 1998;12:202-207.

10. Steinbrook R. Surgery for severe obesity. *N Engl J Med.* 2004;350:1075-1079.

11. Pope GD, Birkmeyer JD, Finlayson SR. National trends in utilization and in-hospital outcomes of bariatric surgery. *J Gastrointest Surg.* 2002;6:855-861.

12. Stein R. As obesity surgeries soar, so do safety, cost concerns. *Washington Post.* April 11, 2004:A1.

13. Buchwald H, Avidor Y, Braunwald E, et al. Bariatric surgery: a systematic review and meta-analysis. *JAMA.* 2004;292:1724-1737.

14. Shekelle PG, Morton SC, Maglione M, et al. *Evidence Report/Technology Assessment Number 103: Pharmacological and Surgical Treatment of Obesity.* Rockville, Md: Agency for Healthcare Research and Quality; 2004. AHRQ publication 04-E028-1.

15. Salem L, Jensen CC, Flum DR. Are bariatric surgical outcomes worth their cost? a systematic review. *J Am Coll Surg.* 2005;200:270-278.

16. Craig BM, Tseng DS. Cost-effectiveness of gastric bypass for severe obesity. *Am J Med.* 2002;113:491-498.

17. Clegg A, Colquitt J, Sidhu M, Royle P, Walker A. Clinical and cost effectiveness of surgery for morbid obesity: a systematic review and economic evaluation. *Int J Obes Relat Metab Disord.* 2003;27:1167-1177.

18. van Gemert WG, Adang EM, Kop M, Vos G, Greve JW, Soeters PB. A prospective cost-effectiveness analysis of vertical banded gastroplasty for the treatment of morbid obesity. *Obes Surg.* 1999;9:484-491.

19. Christou NV, Sampalis JS, Liberman M, et al. Surgery decreases long-term mortality, morbidity, and health care use in morbidly obese patients. *Ann Surg.* 2004;240:416-424.

20. Monk JS Jr, Dia Nagib N, Stehr W. Pharmaceutical savings after gastric bypass surgery. *Obes Surg.* 2004;14:13-15.

21. Snow LL, Weinstein LS, Hannon JK, et al. The effect of Roux-en-Y gastric bypass on prescription drug costs. *Obes Surg.* 2004;14:1031-1035.

22. Potteiger CE, Paragi PR, Inverso NA, et al. Bariatric surgery: shedding the monetary weight of prescription costs in the managed care arena. *Obes Surg.* 2004;14:725-730.

23. Sampalis JS, Liberman M, Auger S, Christou NV. Impact of weight reduction surgery on health-care costs in morbidly obese patients. *Obes Surg.* 2004;14:939-947.

24. Consensus Development Conference Panel. Gastrointestinal surgery for severe obesity. *Ann Intern Med.* 1991;115:956-961.

25. Manning WG, Newhouse JP, Duan N, Keeler EB, Leibowitz A, Marquis MS. Health insurance and the demand for medical care: evidence from a randomized experiment. *Am Econ Rev.* 1987;77:251-277.

26. Manning WG. The logged dependent variable, heteroscedasticity, and the retransformation problem. *J Health Econ.* 1998;17:283-295.

27. Livingston EH, Ko CY. Socioeconomic characteristics of the population eligible for obesity surgery. *Surgery.* 2004;135:288-296.

28. Fisher BL. Comparison of recovery time after open and laparoscopic gastric bypass and laparoscopic adjustable banding. *Obes Surg.* 2004;14:67-72.

29. US Bureau of the Census. Table 628, employer costs for employee compensation per hour worked: 2004. In: *Statistical Abstract of the United States, 2004-2005.* Washington, DC: US Bureau of the Census; 2004.

30. Grosse S. Productivity loss tables (appendix I). In: Haddix A, Teutsch S, Corso P, eds. *Prevention Effectiveness: A Guide to Decision Analysis and Economic Evaluation.* 2nd ed. London, England: Oxford University Press; 2003:245-257.

31. Burton WN, Conti DJ, Chen CY, Schultz AB, Edington DW. The role of health risk factors and disease on worker productivity. *J Occup Environ Med.* 1999;41:863-877.

32. Stewart AW, Jackson RT, Ford MA, Beaglehole R. Underestimation of relative weight by use of self-reported height and weight. *Am J Epidemiol.* 1987;125:122-126.

33. Kuczmarski MF, Kuczmarski RJ, Najjar M. Effects of age on validity of self-reported height, weight, and body mass index: findings from the Third National Health and Nutrition Examination Survey, 1988-1994. *J Am Diet Assoc.* 2001;101:28-34.