Health Insurance Claims Data as a Means of Assessing Reduction in Co-morbidities 6 Months after Bariatric Surgery

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Background: We measured the very short-term change in obesity-related co-morbidities following bariatric surgery.

Methods: Claims data were analyzed for 933 patients aged 18-62 who were covered by one of 11 New York State health plans and underwent bariatric surgery during calendar year 2002. Data covered 6 months before to 6 months after surgery. Logit regression and fixed effects logit regressions were estimated, to analyze change in the following co-morbidities after bariatric surgery: diabetes, hyperlipidemia, hypertension, asthma, sleep apnea, degenerative joint disease, gastroesophageal reflux, and depression.

Results: There were statistically significant post-surgery decreases in each outcome studied. Controlling for individual fixed effects, the probability of a diabetes diagnosis fell by 20% after bariatric surgery. The probability of sleep apnea fell by 33%, and the probability of the other obesity-related co-morbidities fell by 11 to 19% at 6 months.

Conclusion: Claims data are useful for assessing changes in a wide range of co-morbidities following bariatric surgery. The data indicate significant decreases in obesity-related co-morbidities after bariatric surgery, although considerably smaller than those found in previous studies, which underscores the need for randomized controlled trials of bariatric surgery. Limitations of this study include: follow-up only at 6 months, non-experimental data, and an unknown degree of underreporting of co-morbidities in claims data.

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Introduction

Bariatric surgery, which restricts the size of the stomach and limits the volume intake that a patient can tolerate, is increasingly performed to treat morbid obesity. Between 1990 and 1997, the number of bariatric operations in the United States rose from 4,925 to 12,541.[1] From 1998 to 2003, the number of such procedures continued to rise, from 13,365 to an estimated 102,794.[2]

Before 1999, most evaluations of bariatric surgery focused on amount of excess weight loss or change in BMI as the primary outcome. More recently, with the recognition that even relatively modest weight loss can lead to improvements in obesity-related co-morbidities,[3] investigators are increasingly studying the change in obesity-related co-morbidities after surgery. Significant obesity-related co-morbidities include diabetes mellitus, hypertension, stroke, gallbladder disease, cardiovascular disease, respiratory disease, cancer, arthritis, and gout.[4,5]

Two recent meta-analyses documented dramatic changes after bariatric surgery in four obesity-related co-morbidities: diabetes, hypertension, dyslipidemia, and sleep apnea.[6,7] Across the studies reviewed, the median percentage of patients with the co-morbidity who experienced improvement in their co-morbidity following bariatric surgery was: 100% for diabetes, 89% for hypertension, and 88% for dyslipidemia.[6] In addition, 83.6% of patients experienced improvement in obstructive sleep apnea after bariatric surgery.[7]

Many of the published studies used in these meta-analyses had samples of <100 subjects.[6,7] Notable exceptions include papers that use data from the Swedish Obese Subjects study, which includes 641 patients who underwent bariatric surgery.[8]

This paper contributes to the literature by examining a wide range of obesity-related co-morbidities (diabetes, hyperlipidemia, hypertension, asthma, sleep apnea, degenerative joint disease, gastroesophageal reflux disease – GERD, and depression) in a large dataset (N=933) of patients who underwent bariatric surgery. The large sample size should enable more precise estimates of the extent to which bariatric surgery is associated with reductions in these co-morbidities.

Studies of changes in co-morbidities after bariatric surgery have long relied on chart review.[6,7,9] This paper examines a relatively untapped data source: the claims data of private health insurance plans. In particular, this paper examines claims data from 11 New York State health insurance plans and examines whether analyses based on private health insurance claims data confirm the dramatic decreases in co-morbidities found by studies that were based on chart review.

Materials and Methods

The analyses in this paper are based on claims data from 11 New York State health insurance plans: Affinity, AmeriChoice, Capital District Physicians Health Plan (CDPHP), CenterCare, Fidelis, HealthNet, Health Insurance Plan of New York (HIP), Hudson Health Plan, Independent Health, MVP Health Care, and Oxford. The data cover patients who underwent bariatric surgery between January 1, 2002 and December 31, 2002. To be represented in the data, the patients who underwent bariatric surgery had to be between the ages of 18 and 62 on the date of the operation, and had to be continuously enrolled in the plan from at least 6 months before until at least 6 months after the surgery (two patients who died within the 6 months after surgery were excluded from the sample). The choice of 6-month follow-up, which is recognized as very short-term, was based on the practical consideration that there is considerable turnover of enrollment in the health plans, and to restrict the sample to individuals who remained with the same plan for longer, e.g. 2 years, would have considerably reduced the sample size. Weighing the competing priorities of maintaining a sample large enough to provide statistical power against the desire for longer-term follow-up, the decision was made to compare patients 6 months before to 6 months after bariatric surgery. Health-plan enrollees were defined as having undergone bariatric surgery on the basis of a Current Procedural Terminology (CPT) code of either 43842, 43843, 43846, 43847, or 43848. All product lines (e.g. commercial, Medicaid) were included.

This paper compares diagnoses before and after bariatric surgery, based on codes of the International Classification of Diseases (ICD-9) recorded by physicians. A limitation is that even if a patient had a specific obesity-related co-morbidity, the physician may not have listed it as the primary condition, which is subjective. For example, if a morbidly obese patient reported sleep apnea and asthma, it may be somewhat arbitrary which of those codes the physician recorded.

This paper presents results for 8 diagnoses: diabetes, hyperlipidemia, hypertension, asthma, sleep apnea, degenerative joint disease, GERD, and depression. Arthritis (distinct from osteoarthritis, i.e. degenerative joint disease – DJD) appears so rarely in the data (only one person was diagnosed with it before surgery and no one after) that it is impossible to study. While there are important differences in type of bariatric operation (gastric bypass or restriction) and method (open or laparoscopic), and these differences may affect outcomes,[10] we do not have sufficient variation to estimate effects separately by type and method.

This paper documents the changes in co-morbidities after bariatric surgery for those who elected to undergo such surgery. This has two limitations relative to a randomized trial. First, patients in the data were not randomly assigned to receive bariatric surgery, but chose it. Because those who sought bariatric surgery may differ in important ways from the overall population of morbidly obese individuals (e.g. they may be wealthier, better educated, or more aggressive about receiving the latest treatments), their change in outcomes associated with bariatric surgery may differ from that for the population of morbidly obese as a whole. This implies that it may be difficult to generalize the results of this analysis to the universe of obese persons. The second limitation is that there is no control group in the data with whom to compare the treatment group; only those who received bariatric surgery appear in the data. This makes it impossible to say how co-morbidities after bariatric surgery differ from what the experience would have been if the treatment group had not undergone the surgery. Given these limitations, the change in co-morbidies after bariatric surgery cannot be interpreted as caused by, although they are certainly influenced by, the surgery.

This paper uses logit regression, an appropriate method when the outcome is binary,[11] which is the case for all diagnoses: the patient was either coded with that diagnosis during the relevant period, or was not. Models were estimated in two ways. First, they were estimated controlling for age, gender, and health insurance plan. This allows one to view how older patients' outcomes differ from those for younger patients, and how outcomes vary across gender and plan. Second, models were estimated controlling for individual fixed effects. This is equivalent to dropping age, gender, and plan as control variables, and adding an indicator variable for each individual but one. The "fixed effects" method identifies the change in outcomes using only variation within patients. The former method compares average outcomes across all patients before the operation with average outcomes across all patients after the operations, whereas the fixed effects method uses the average of the individual change in outcomes after the operation. The advantage of the fixed effects method is that it eliminates the influence of all time-invariant unobserved heterogeneity. A limitation of the fixed effects method is that it cannot be used to measure how time-invariant observed characteristics, such as gender or insurance plan, relate to differences in outcomes. All regression models were estimated using the statistical software package STATA version 8.2.[12]

Each person who received surgery appears twice in the data: once corresponding to the 6 months before the surgery, and once corresponding to the 6 months after surgery (including the day of surgery). The coefficient of interest is that on the indicator variable for "after bariatric surgery".

Results

Summary statistics of the sample for before and after bariatric surgery are listed in columns 1 and 2 of Table 1: 83% of the sample is female and the average age of the sample is 42. Before surgery (column 1), the most common diagnoses were hypertension (32.5%) and sleep apnea (16.3%). Roughly 12% of the sample was diagnosed with asthma and 11% with GERD. Less common are joint disease (7.3%), hyperlipidemia (7.0%), depression (4.4%) and diabetes (3.8%). These frequencies were lower

Table 1. Summary statistics: patient characteristics before and after bariatric surgery

Variable	Before Surgery	After Surgery
Female	.834 (.37)	
Age (years)	41.52 (9.76)	
Diabetes	.038 (.19)	.026 (.16)
Hyperlipidemia	.070 (.25)	.051 (.22)
Hypertension	.325 (.47)	.263 (.44)
Asthma	.123 (.33)	.084 (.28)
Sleep Apnea	.163 (.37)	.095 (.29)
Degenerative Joint Disease (DJD)	.073 (.26)	.053 (.22)
Gastroesophageal Reflux Disease (GERD)	.111 (.31)	.062 (.24)
Depression	.044 (.21)	.032 (.18)

Listed in each cell are the mean of the variable and the standard deviation in parentheses.
Diagnoses are based on the International Classification of Diseases (ICD-9) codes recorded by physicians.

than those observed in studies that used chart review.[7] This is likely due to the nature of claims data: while patients may have many obesity-related co-morbidities, they may not see a physician about each of them in a given 6-month period. Moreover, for any visit, the physician may have choice about which diagnosis to list as the reason for the visit.

A comparison of the numbers in columns 1 and 2 of Table 1 indicates that the prevalence of each of these conditions fell after the operation. This initial comparison was unconditional; ie., it does not control for characteristics of the patients. Multiple regression techniques were next used to estimate the conditional expectation of the change in conditions after surgery.

Regression results for each outcome are provided in Tables 2 and 3. Table 2 presents results for models that control for plan fixed effects but not individual fixed effects; these results are useful for seeing how age and gender correlate with outcomes. Table 3 presents results for regressions that control for individual fixed effects; ie., they use only the variation within patients before and after surgery (not the variation across patients).

In each cell of each table, three numbers are presented. The top number is the logit regression coefficient and the middle number in parentheses is the standard error of the coefficient estimate. An asterisk next to the coefficient indicates whether the coefficient is statistically significant at the 10% level. The regression coefficients are not themselves useful in understanding the magnitude of the effect of a variable on the outcome of interest; for that, one must look to the third and bottom number in the table cell, which is the marginal change in the probability of the co-morbidity after bariatric surgery.

In some cases, even when the coefficient is statistically significant, the marginal effect is so small as to be essentially zero. This is a reminder that statistical significance (the statistical test of whether the true coefficient is different from zero) is different than real-world significance.[13] The marginal effects listed in the tables were rounded to zero when they were estimated to be <.00005 in absolute magnitude.

In general, Table 2 indicates statistically significant decreases after bariatric surgery in the probability of each of the 8 co-morbidities, but the magnitude of the decrease is relatively small; for 5 of the co-morbidities, this decrease is <1 percentage point. The largest decreases after bariatric surgery are of 7.4 percentage points for hypertension, 2.98 percentage points for GERD, and 1.49 percentage points for asthma.

However, when fixed effects are controlled for (Table 3), the decrease is consistently larger, in each case >10 percentage points. The greatest decrease is found for sleep apnea, the probability of which fell by 34.61 percentage points after bariatric surgery. The next largest decreases were found for diabetes (20.37 percentage points), GERD (18.55 percentage points), and asthma (16.09 percentage points). The probabilities of the remaining co-morbidities

Table 2. Logit regressions

Variable	Diabetes	Hyperlipidemia	Hypertension	Asthma	Sleep Apnea	DJD	GERD	Depression
After bariatric surgery	-.8894* (.43) 0	-.4980* (.25) 0	-.5041* (.13) -.0743	-.6682 * (.20) -.0149	-1.6131* (.27) 0	-.4368* (.22) -.0086	-.7758* (.19) -.0298	-.5592* (.33) -.0004
Age	.1277* (.04) 0	.0370* (.02) 0	.0870* (.01) .0128	.0011 (.01) 0	.0615* (.03) 0	.1025* (.02) .0020	.0020 (0) 0	.0071 (.02) 0
Female	-1.1480 (.96) 0	-.1362 (.46) 0	-.6789* (.57) -.1146	1.1195* (.44) .0179	-2.0005* (.58) 0	-.1263 (.33) .0026	-.3948 (.28) -.0168	.7443 (.75) .0005

Listed in each cell are: logit regression coefficient, standard error, and the marginal effect of a one-unit change in the variable on the probability of the outcome.
* Asterisk indicates that the coefficient is statistically significant at the 10% level.
Regression also controls for indicator variables for health insurance plan (coefficients not shown).

Table 3. Fixed effects logit regressions

Variable	Diabetes	Hyperlipidemia	Hypertension	Asthma	Sleep Apnea	DJD	GERD	Depression
After bariatric surgery	-.8650* (.42) -.2037	.5031* (.25) -.1231	-.5018* (.13) -.1229	-.6671* (.20) -.1609	-1.7047* (.29) -.3461	-.4336* (.22) -.1067	-.7791* (.19) -.1855	-.5500* (.32) -.1341

Listed in each cell are: logit regression coefficient, standard error, and the marginal effect of a one-unit change in the variable on the probability of the outcome.
* Asterisk indicates that the coefficient is statistically significant at the 10% level.

(hyperlipidemia, hypertension, degenerative joint disease, and depression) fell by between 10.67 and 13.41 percentage points after bariatric surgery.

The models that do not control for individual fixed effects (Table 2) control for age and gender. While age was positively correlated with each of the 8 co-morbidities, the correlation was statistically significant only for 5 co-morbidities, and even in most of those cases the marginal effect of a single year of age was essentially zero. The exception is that an additional year of age was associated with a 1.28 percentage point higher probability of hypertension in this population. In general, there was little correlation between gender and the co-morbidities. The exception was that women were 11.5 percentage points less likely to be hypertensive and 1.8 percentage points more likely to have asthma.

It was not possible to estimate the difference in outcomes associated with the type of procedure because 87.4% of all operations involved gastric bypass, and for some plans the percentage was even higher, which made it impossible to separate the "effect" of bariatric surgery in general from that of gastric bypass in particular while controlling for the plan.

It also proved impossible to estimate the difference in outcomes associated with service line of insurance. Again, the reason is that there was little variation. Over 90% of all patients had commercial coverage. Medicaid enrollees represented 4.3% of the sample, the self-insured 2.5%, and those on Medicare and Unicare <1% of the sample each. Patients with non-commercial coverage were included in the data, but it is not possible to estimate how their outcomes differ from those with commercial coverage.

Discussion

Claims data from 11 New York State health plans confirm that there are significant decreases in a wide range of obesity-related co-morbidities just 6 months after bariatric surgery. There were statistically significant postoperative decreases in each outcome studied: diabetes, hyperlipidemia, hypertension, asthma, sleep apnea, degenerative joint disease, GERD, and depression. However, the magnitude of these changes was considerably less than that found in previous studies.[6,7] For example, a recent meta-analysis calculated that, across previous studies, diabetes was completely resolved in 76.8% of patients;[7] in contrast, a comparison of columns 1 and 2 in Table 1 indicates that the unconditional decrease in diabetes diagnoses after bariatric surgery in these data is less than half that – only 37%. Likewise, the decrease in hypertension in previous studies was 61.7% versus 19.1% in these data, and the decrease in sleep apnea in previous studies was 85.7% versus 42% in these data.[7] Part of this difference is undoubtedly due to the difference in length of follow-up: 2 years versus only 6 months in this study. However, the discrepancy in results may also be due to other factors and underscores the importance of studying various types of data; studies in the past have typically relied on chart review, and studying health plan claims data provides a different perspective. It also underscores the need for randomized controlled trials of bariatric surgery.

The estimated change in obesity-related co-morbidities after bariatric surgery is consistently greater in the models that control for individual fixed effects than in those that control instead for age and gender. This difference in magnitude is due in part to the fact that the former uses only the variation within individuals to calculate the estimate, while the latter uses both variation within individuals and variation across individuals. The models that control for individual fixed effects (and which study the change in co-morbidities for each person) are a more appropriate comparison for studies that used chart review.

This paper uses claims data to provide a different perspective on the change in obesity-related co-morbidities following bariatric surgery than has been provided in previously-published studies that were based on chart review. Broadly, the results of this paper are consistent with those based on chart review, in that both find significant decreases in obesity-related co-morbidities following bariatric surgery, which confirms that claims data are useful for assessing changes in a wide range of co-morbidities following bariatric surgery.

The limitations of this study include: the use of non-experimental data, under-reporting of co-morbidities in claims data, and lack of long-term follow-up data. The use of non-experimental data is a limitation because it is not known how those who underwent bariatric surgery might have fared in its absence, which makes it impossible to estimate the *causal* impact of bariatric surgery on outcomes. There also may be different types of selection bias in the results. People who choose bariatric surgery may differ in important ways from the overall population of morbidly obese, and these differences may make it difficult to generalize the results of this paper to the population of morbidly obese. Because all patients in this data have health insurance, there may be biases due to any differences between insured and uninsured bariatric surgery patients, and any differences among the insured patients that are correlated with the willingness of their insurance companies to participate in this project. A stronger research design would be a randomized trial in which morbidly obese patients were randomized into either a treatment group that receives bariatric surgery or a control group that does not.[14]

When studying the outcomes associated with bariatric surgery, claims data have the advantage that data on large numbers of patients can be retrieved quickly and cheaply, but the disadvantage of being less rich than data built from chart review.[15] In particular, obesity-related co-morbidities are only recorded in claims if they are indicated by the physician as a reason for visit or treatment, so there is an unknown degree of false negatives – people who truly have an obesity-related co-morbidity but the code for that co-morbidity was never recorded by the physician during the period covered by the data. For example, the likelihood of a CPT code for diabetes is quite low in these data – 3.8% in the 6 months before bariatric surgery and 2.6% in the 6 months after surgery. The differences between claims data and data based on chart review may partly explain why the decrease in type II diabetes found in the claims data studied here is less than that found in other studies based on chart review. One way for a future study to measure the extent of under-reporting of co-morbidities in claims data would be to conduct chart review and then pull health insurance plan claims for the same individuals.

In these data, patients were only followed for 6 months after bariatric surgery. In assessing the impacts of bariatric surgery, up to 2 years is considered short-term, so this analysis is limited to very short-term changes. At 6 months after surgery, there will usually still be a significant amount of additional weight loss followed by continued improvement in co-morbidities.[14,16] A recent review of the literature on the change in co-morbid conditions after bariatric surgery found that the median follow-up time was roughly 3 years.[6] Future research using claims data should include a longer follow-up period. The deficiency will be a loss of statistical precision due to a smaller sample size because of turnover of membership in health plans, but the benefit will be information about longer-term changes in co-morbidities following bariatric surgery.

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