CHARACTERISTICS AND TRENDS IN BARIATRIC SURGERY IN THE U.S., 1999-2004, AND A COMPARISON OF SURGICAL PATIENTS TO THOSE ELIGIBLE FOR SURGERY

by

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Severe obesity (BMI $\geq$ 40 kg/m^2) increases risk for many diseases (e.g., hypertension, diabetes). Bariatric surgery is the treatment with the greatest long-term success for severe obesity, sustaining weight loss and improving health. The number of bariatric surgeries has increased tremendously in recent years, although the percentage of adults eligible for surgery that receive the surgery is very small.

Using the National Hospital Discharge Survey (1999-2004), patient, surgical, and hospital characteristics were analyzed over this six year time period. Using the National Health and Nutrition Examination Survey (NHANES), severely obese adults were compared to bariatric surgical patients with respect to age, sex, and health insurance for the years 2003 and 2004. Chi-square tests were used to test for differences in characteristics, and tests for trend were performed to test for temporal trends. Poisson regression was used to model length of hospital stay.

From 1999 to 2004, most bariatric surgical patients were 30-49 years old, female, and were expected to pay with private insurance only. The most common comorbidities among bariatric surgical patients were hypertension (45.5%), sleep apnea (25.8%), and diabetes (21.8%). The majority of bariatric surgeries performed were high gastric bypasses. The number of bariatric surgeries increased more than 15-fold from 2000 to 2003. Length of hospital stay decreased from 1999 to 2004. Those who had gastroplasty were more likely to have a shorter hospital stay compared to other procedures.

Only about 2.3% of severely obese individuals in the United States received bariatric surgery in 2003-2004. Males, younger and older adults, and those with public insurance were under-represented among bariatric surgical patients in 2003 and 2004.

Because obesity is a major public health concern, discrepancies in characteristics of adults who are eligible for bariatric surgery compared to those receiving the surgery need to be addressed. Clinical practices should make sure everyone eligible is aware and well-informed of bariatric surgery. Healthcare policies should eventually allow every candidate the choice of having bariatric surgery, to improve health and reduce healthcare costs.

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1.0 INTRODUCTION

Over the past three decades, there has been a marked increase in the prevalence of obesity in the United States, making it a major public health concern (Davis et al., 2002). Obesity, defined as a body mass index (BMI) of 30 kg/m^2 or higher, has increased from 13.3% among U.S. adults in 1960 to 30.9% in 2000 (Trus et al., 2005). Obesity increases risk of hypertension, diabetes mellitus, sleep apnea, heart problems, stroke, and some forms of cancer (Buchwald et al., 2004). It is also associated with large decreases in life expectancy (Wang et al., 2007).

Severe (or morbid) obesity is defined as a BMI of 40 kg/m^2 or higher. For an adult male of average height, this is roughly 100 pounds overweight. Severe obesity has even worse effects on health than obesity (Hensrud et al., 2006), and it is becoming more common, increasing in prevalence, from 2.9% among U.S. adults (1988-1994) to 4.8% (2003-2004) (Flegal et al., 2002; Ogden et al., 2006; Hensrud et al., 2006). Approximately three out of four severely obese adults in the United States have at least one obesity-related comorbidity (e.g., hypertension, diabetes mellitus, sleep apnea) (Hensrud et al., 2006). Among bariatric surgical patients, the prevalence of comorbidities increases as BMI increases (LABS, 2008).

Non-surgical weight loss methods such as diet, exercise, and medication have not been effective in achieving sustained weight loss in severely obese individuals (Trus et al., 2005; Dansinger et al., 2005). Bariatric surgery has been acknowledged since 1991 as the treatment with the greatest long-term success for severe obesity (Buddeberg-Fischer et al., 2006), and is currently the only treatment that generates significant, sustained weight loss (Trus et al., 2005; Flum et al., 2007). Evidence includes a meta-analysis of 147 studies, which found that surgery is more effective than nonsurgical treatment for both weight loss and controlling comorbidities of severely obese individuals (Maggard et al., 2005). Further, bariatric surgery can improve or even cure comorbidities and can increase quality of life (Van Hout et al., 2006).

In 1991, representatives from the National Institutes of Health (NIH) Consensus Development Conference developed guidelines recommending that people considering bariatric surgery be carefully screened by a multidisciplinary team, consisting of a surgeon, primary care physician, psychiatrist, and nutritionist to determine eligibility and preparedness (NIH, 1991). People should be considered eligible if they have a BMI over 40 kg/m^2, or have a BMI between 35 and 40 kg/m^2 and have "high-risk comorbid conditions". In addition, they should be "well-informed and motivated" and should have failed an established diet and exercise program.

Over the last decade, the use of bariatric surgery has increased dramatically. For example, the estimated annual number of gastric bypass surgeries increased from 14,089 in 1998 to 82,636 in 2002 (Smoot et al., 2006). However, surgeries were performed on only 0.6% of the 11.5 million eligible adults in the United States in 2002, using data from the Nationwide Inpatient Sample (Encinosa et al., 2005).

1.1 STATEMENT OF THE PROBLEM

1.1.1 Temporal Trends

Because the number of bariatric surgeries in the United States has been increasing tremendously in recent years and health insurance policies regarding coverage and eligibility for bariatric surgery have changed (Shinogle et al., 2005), it is important to study trends in bariatric surgery (Hensrud, McMahon, 2006). Specifically, it is of interest to determine whether it is the same kind of patients having bariatric surgery in larger numbers, or whether different kinds of patients are now having surgery. This analysis will help answer that question.

1.1.2 Length of Hospital Stay

Length of hospital stay is an important outcome of any surgery as length of stay is a "major determinant of the cost of medical care" (Clark et al., 2002). A longer length of stay is also associated with an increased risk for hospital infections (e.g., Methicillin-resistant Staphylococcus aureus [MRSA]) (Bowrey et al., 2007). Length of hospital stay may differ by hospital region, may be influenced by patient characteristics and by the type of surgical procedure. It may also be related to the type of health insurance since coverage can vary among providers.

1.1.3 Comparing those Eligible for Bariatric Surgery

Few studies have compared characteristics of surgical patients to those eligible for bariatric surgery in the general population. Comparing bariatric surgical patients with severely obese adults in the general population is instrumental to provide clinicians and policymakers with the information about who, among those eligible, is not getting bariatric surgery. Understanding what kinds of patients are not getting weight-loss surgery is vital to creating a "rational and equitable approach to bariatric surgery" (Flum et al., 2007).

1.1.4 Specific Aims

The specific aims of this thesis are 1) to examine hospital characteristics where bariatric surgeries were performed between the years of 1999 and 2004; 2) to describe patients who underwent bariatric surgery between the years of 1999 and 2004; 3) to look at time trends in bariatric surgery from 1999 to 2004; 4) to evaluate which variables were associated with length of hospital stay (1999-2004); and 5) to compare characteristics of bariatric surgical patients with severely obese individuals in the general population (2003-2004).

Because bariatric surgery has been shown to be the most effective way to lose weight, sustain weight loss, and improve health for severely obese adults (Buddeberg-Fischer et al., 2006; Trus et al., 2005; Flum et al., 2007), it is important to make sure everyone is aware and well-informed of the surgery and also to eventually allow every candidate an option for surgery. Studying the treatment of obesity has vast public health significance in the U.S. and worldwide, because obesity has become a major public health concern and has been called a pandemic

(Hensrud, McMahon, 2006). Not only are rates of obesity and severe obesity increasing in the United States, obesity is becoming more prevalent worldwide. Because obesity is a risk factor for many diseases including leading causes of death such as heart disease, cancer, and stroke (Ogden, 2007; CDC, 2008), weight loss often improves one's health and reduces risk for numerous diseases. Thus, weight loss increases quality of life and reduces long-term health care costs.

Using the National Hospital Discharge Survey (NHDS, 1999-2004), patient, surgical, and hospital characteristics are analyzed over this six year time period. Using the National Health and Nutrition Examination Survey (NHANES), severely obese individuals are compared to bariatric surgical patients by age, sex, and health insurance for the years 2003 and 2004. Because trends may be changing, only the last 2 years (2003-2004) are compared to determine how surgical patients may differ from those eligible for surgery.

2.0 LITERATURE REVIEW

2.1 BARIATRIC SURGICAL PROCEDURES

Although the popularity of bariatric surgery has grown substantially in recent years, it has been performed for decades. Kremen et al. reported the first bariatric surgical procedure in 1954 which was a jejunoileal bypass (JIB) (Salameh, 2006). JIB, which entails bonding the "proximal jejunum to the distal ileum", bypassing most of the small intestine was originally done to treat disease in the small intestine. However, surgeons soon discovered patients experienced "short-gut syndrome" and lost weight after the surgery (Review of Bariatric Surgery Procedures, 2006).

In 1966, Dr. Edward Mason developed the gastric bypass procedure (GBP), which reduces the size of the stomach and connects it to the jejunum, bypassing the duodenum (Review of Bariatric Surgery Procedures, 2006). This surgery stems from gastroenterostomy, which is a procedure that connects the stomach to the small intestine. It is also used for certain cancers such as pancreatic and stomach cancers. In 1976, Nicola Scopinaro introduced the biliopancreatic diversion (Figure 1), which involves removing part of the stomach (partial gastrectomy) with a Roux-en-Y gastroenterostomy (Korenkov et al., 2007).

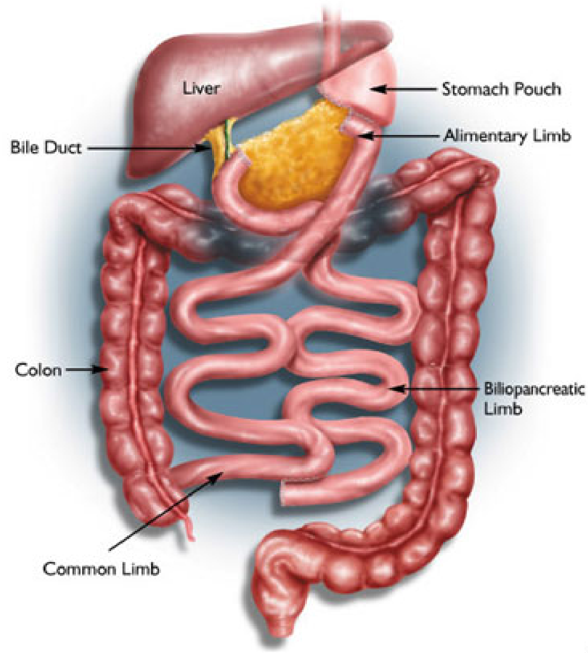

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Figure 1. Biliopancreatic Diversion

The same year (1976), Dr. Ward Griffen improved Mason's GBP procedure by reconfiguring the small intestine into a "Y" with two limbs (Roux and biliopancreatic) forming a "common channel", which reduced the risk of ulcers. This variation, called the Roux-en-Y gastric bypass procedure (RYGBP) (Figure 2) (Review of Bariatric Surgery Procedures, 2006), is the most common bariatric surgical procedure in the United States (Salameh, 2006).

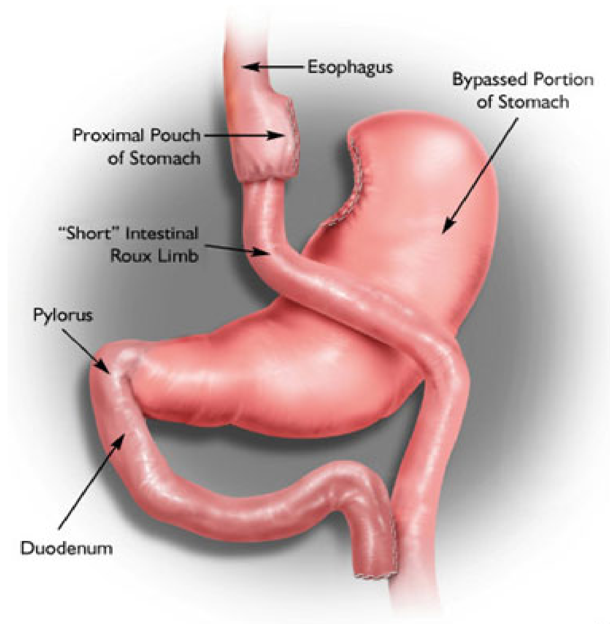

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Figure 2. Roux-en-Y Gastric Bypass

Gastroplasty is a newer technique that is the first purely restrictive procedure. It was developed with the hope of eliminating the long-term effects of nutritional deficiencies, common with RYGBP. Gastroplasty decreases the size of the stomach with the use of a band and/or staples. It is also indicated to correct defects of the stomach and lower esophagus such as gastroesophageal reflux disease (GERD) and hiatal hernia. Vertical banded gastroplasty (VBG) as seen in Figure 3 creates a small stomach pouch in the upper portion of the stomach using staples. A band allows for only a small opening in the outlet for food to enter the lower part of the stomach. Laparoscopic adjustable gastric banding (LAGB) was introduced in 1993 and uses an adjustable band to decrease the size of the stomach requiring no permanent restricting of the stomach as shown in Figure 4. It is probably the most common bariatric surgery worldwide, outside of the United States (Salameh, 2006).

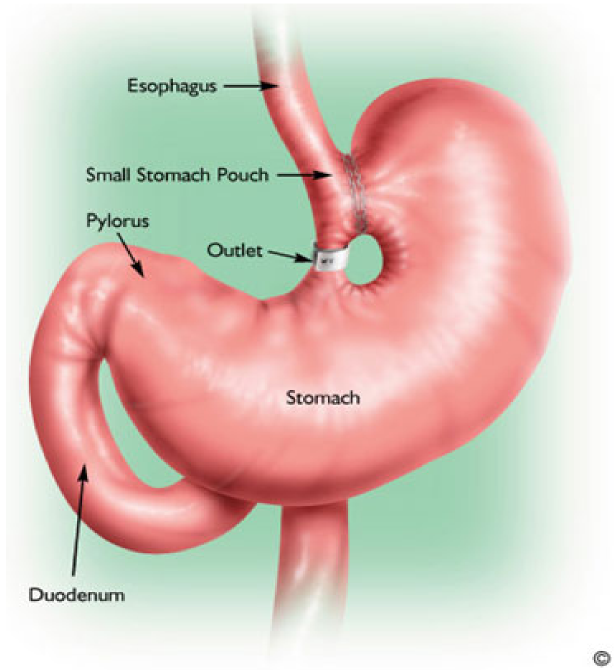

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Figure 3. Vertical Banded Gastroplasty

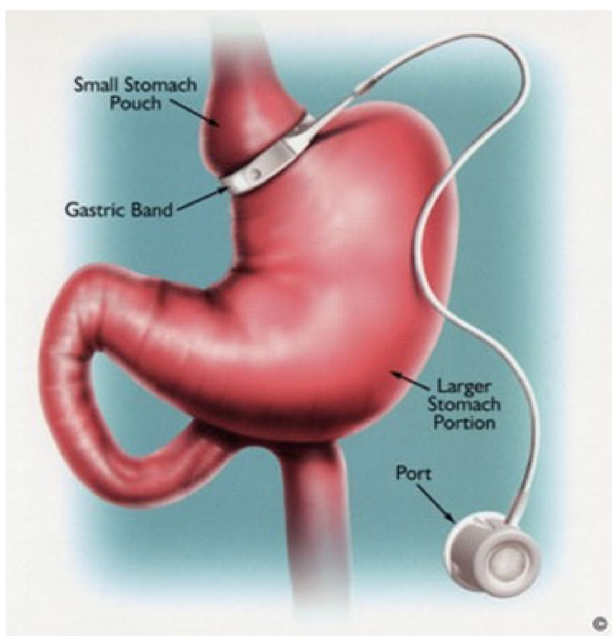

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Figure 4. Adjustable Gastric Banding

Bariatric surgeries may be performed as open procedures, requiring the abdomen to be opened, or laparoscopic procedures, in which surgeons make only small incisions to gain access to the abdomen and use a video camera (Encinosa et al., 2005). Gastric banding is almost always performed laparoscopically, and there is a growing trend toward performing other bariatric procedures laparoscopically (Samuel et al., 2006).

2.2 COMORBIDITIES

The main goal of bariatric surgery is to improve health (Collazo-Clavell et al., 2006). Not only is surgery proven to result in weight loss, but common comorbidities to severe obesity (e.g., hypertension, diabetes mellitus, sleep apnea, asthma, other chronic pulmonary disease, lipid disease, liver disease, heart disease, and kidney disease) are likely to improve with weight loss (Kushner et al., 2006; Buchwald et al., 2004; Pope et al., 2002).

In a meta-analysis of 136 studies with more than 22,000 patients, 86.0% of patients showed a resolution or improvement in diabetes, 78.5% of patients had hypertension resolved or improved, and obstructive sleep apnea was resolved or improved in 83.6% of patients (Buchwald et al., 2004). Improvement of comorbidities varied by type of surgical procedure. For example, 83.7% of gastric bypass patients showed resolution in diabetes compared to 71.6% of those who had gastroplasty.

While obesity-related comorbidities are likely to improve after weight loss, some medical and psychiatric conditions are contraindications for surgery (e.g., severe coronary artery disease, severe eating disorders, and untreated psychiatric disorders) (Laville et al., 2005). Thus, it is crucial to consider all of a patient's diseases, disorders, and medications to determine whether a patient is a good candidate for bariatric surgery. However, there are no uniform guidelines on what diseases or disorders should be used as exclusion criteria for bariatric surgery, so it is often left to the discretion of a multi-disciplinary team to review the risks and benefits of the surgery to determine whether surgery should be performed.

2.3 BARIATRIC SURGERY CHARACTERISTICS AND TRENDS

2.3.1 Temporal Trends

Previous studies that examined trends in bariatric surgery in the U.S. have found that, as a group, patients have gotten older, heavier, have more comorbidities, and a larger proportion are privately insured (Trus et al., 2005; Davis et al, 2006; Samuel et al., 2006; Santry et al., 2005). Over time, there has been an increase in the number of surgeries performed and a decrease in length of hospital stay (Smoot et al., 2006; Trus et al., 2005; Davis et al, 2006; Samuel et al., 2006).

Several studies used the Nationwide Inpatient Sample (NIS). Trus et al., 2005, studied trends in bariatric surgery in the United States, from 1990 to 2000. While Trus et al. identified the ICD-9 codes used for patient comorbidities, they studied different comorbidities than will be examined in this thesis. For instance, they did not examine hypertension or sleep apnea. They only reported how many patients had at least 1 major comorbidity and did not give the prevalence of each comorbidity. Davis et al., 2006 studied national trends in bariatric surgery from 1996-2002, while Santry et al., 2005 studied trends from 1998-2002, using the Nationwide Inpatient Sample, but they did not provide the ICD-9 codes they used to determine comorbidities. Smoot et al., 2006, looked at trends in gastric bypass surgery in the United States from 1998-2002, using the National Hospital Discharge Survey (NHDS). They found the annual rate of gastric bypass surgeries increased from 7.0 to 38.6 per 100,000 adults from 1998 to 2002 (Smoot et al., 2006). About 80% of the gastric bypass surgical patients were female, and the most prevalent comorbidities were diabetes (19.9%) and chronic pulmonary disease (12.2%).

This thesis, which also uses the NHDS, builds on the results of Smoot et al., by including the years 2003 and 2004, bariatric procedures not previously included(e.g., gastroplasty), and additional patient and surgical variables (e.g., additional comorbidities and length of stay). Smoot et al. did not indicate the ICD-9 codes used to determine comorbidities. For that reason, results from this thesis are expected to be similar, but not the same as those of Smoot et al. for the years that overlap (1999-2002).

2.3.2 Length of Hospital Stay

Carbonell et al., 2005, found hospital stay was longer for patients who were older, male, and publicly insured. Encinosa et al., 2005, concluded that a longer length of stay was associated with older age, but it was not significantly associated with type of health insurance even though they found coverage varied among private and public insurances.

2.3.3 Who is Getting Bariatric Surgery Compared to those Eligible

Livingston and Ko, 2004, examined who had baratric surgery using data from the Healthcare Cost and Utility Project (HCUP) and who was eligible for surgery using data from the NIS. They estimated that 4,646,810 adults in the United States had a BMI greater than 40 kg/m^2 and 9,169,914 adults had a BMI of 35 to 40 kg/m^2 in year 2000. BMI was calculated using self-reported weight, which may underestimate BMI, and thus the number of obese and severely obese individuals. They considered all patients with a BMI of 40 kg/m^2 or more and those with a BMI between 35 and 40 kg/m^2 with functional limitations related to obesity to be "surgery-eligible", for a total of 5,324,123 people (2.8% of the U.S. population). They reported 28,590 gastric bypass surgeries in the same year, that is 0.5% of those they considered eligible for surgery (2000). From their analyses, Livingston and Ko, 2004, concluded that males, blacks, and publicly-insured patients were under-represented in the bariatric surgery population.

2.4 NATIONAL HOSPITAL DISCHARGE SURVEY (NHDS)

Part of the National Center for Health Statistics (NCHS), the National Hospital Discharge Survey (NHDS) is a national probability sample survey of discharges from short-stay non-Federal hospitals designed to obtain national estimates (Dennison et al., 2000). It has been conducted every year since 1965 and was redesigned in 1988. About 500 hospitals are sampled annually, with data for over 300,000 discharges (CDC, 2006). The survey response rate ranges between 92 and 95 percent each year.

The NHDS includes medical and demographic information from a sample of patients' discharge records selected from a national sample of hospitals. Selected from all 50 states and the District of Columbia, only noninstitutional hospitals with at least 6 beds and an average length of hospital stay less than 30 days, or hospitals whose specialty is general (medical or surgical) regardless of bed size and average length of hospital stay are included in the survey.

The most notable changes from the 1988 redesign include employing a 3-stage stratified cluster sample design and automated data entry (Dennison et al., 2000). The 3 stages are: 1) geographic areas such as zip codes or counties as Primary Sampling Units (PSU's), 2) hospitals within PSU's, and 3) discharges within hospitals. The first stage includes 112 PSU's. The 26 PSU's with the largest population are selected with certainty, and half of the next 26 largest PSU's are sampled. One PSU is sampled from each of the 73 PSU's strata formed from the remaining PSU's. The second stage is a systematic random sample of noncertainty hospitals selected from the PSU's with probability proportional to their annual number of discharges. This design ensures that the largest PSU's and hospitals are selected. Since 1987, the sampling frame has consisted of hospitals that were listed in the Speciality Medical Group (SMG) Hospital Market Database.

Variables collected in the NHDS include: age, sex, race, discharge diagnoses using ICD-9-CM codes, procedures using ICD-9-CM codes, dates of admission and discharge (length of stay), discharge status, expected source of payment, hospital bed size, hospital ownership, and hospital region. Diagnoses are discharge (or final) diagnoses which are diseases or injuries listed by the attending physician on the medical record of a patient (NHDS, 2004). Procedures are surgical, nonsurgical, diagnostic, or special treatments reported on the medical record.

Hospital personnel are instructed to enter narrative information for diagnoses and procedures, using information from the medical records. If hospitals are unable or unwilling to provide personnel to complete the surveys, a Census Field Representative will travel to the hospital to abstract the data from the medical records onto the survey forms (Dennison et al., 2000). Trained medical coding personnel code the narrative diagnoses and procedures using the ICD-9-CM. A maximum of seven diagnostic codes and a maximum of four procedure codes are assigned for each patient. If more diagnoses and procedures are listed in the medical records, the first seven diagnostic codes and the first four procedure codes are used. Thus, order is preserved from the medical records to the survey forms.

"Days of care" is defined as the total number of days discharged patients stay in the hospital (i.e., length of hospital stay) (CDC, 2006). The admission day is counted, but not the discharge day. Thus, all stays are counted as at least 1 day. A "length of stay flag" variable was included in the dataset to differentiate a length of stay of "1 day" (i.e., an overnight stay) and "less than 1 day" (i.e., same day release), since dates of admission and discharge are not publicly released. Hospital ownership is defined as the type of organization that controls and operates the hospital. A "government" hospital is operated by state or local government (federal hospitals are excluded from NHDS). A "proprietary" hospital is operated by individuals, partnerships, or corporations for profit. Hospitals are grouped into one of four geographic regions of the United States used by the U.S. Census Bureau: Northeast, Midwest, South, and West.

To achieve unbiased estimates, weights are used when analyzing the data. Weights were calculated by NCHS using a "population weighting ratio". An adjustment was made within each of 16 noncertainty hospital groups defined by region and hospital bed size group to adjust for undersampling or oversampling of discharges. Weights of discharges from hospitals similar to nonrespondent hospitals (e.g., same region, same bed size group) were inflated to account for discharges represented by the nonrespondent hospitals. The adjustment is a multiplicative factor for which the numerator is the number of admissions reported for the year at sampling frame hospitals within each region and bed size group and the denominator is the estimated number of admissions for the same hospital group. The ratio numerators were based on annual statistics from the SMG Hospital Market Database and the ratio denominators were obtained by inflating the SMG numbers for the NHDS sample hospitals.

2.5 NATIONAL HEALTH AND NUTRITION EXAMINATION SURVEY (NHANES)

Also part of the National Center for Health Statistics (NCHS), the National Health and Nutrition Examination Survey (NHANES) is a national sample survey designed "to assess the health and nutrition of adults and children in the United States" (NHANES, 2003). The target population is the civilian, noninstitionalized population (NHANES, 2005).

NHANES is a 4-stage, stratified probability sample. The stages are: 1) PSU's (counties or small groups of adjacent counties), 2) clusters of households, 3) households, and 4) one or more persons within households (NHANES, 2005). Fifteen PSU's are visited each year. Adolescents aged 12-19 years and older adults aged 60 years and older are oversampled to produce reliable statistics (NHANES, 2005). African Americans, Mexican Americans, and low-income individuals are also oversampled. For NHANES 2003-2004, 12,761 people were selected for the sample. Of those, 10,122 (79%) were interviewed, and 9,643 (76%) had a physical examination (NHANES, 2006).

NHANES is instrumental in producing vital and health statistics for the country. Results from this survey are used to determine prevalence of diseases and risk factors for diseases. National standards for measurements including height, weight, and blood pressure are derived from NHANES (NHANES, 2003). Health research uses NHANES data to help develop public health policies, design health programs, and increase health awareness for the country.

The survey began in the early 1960s. From 1971 to 1994, NHANES was conducted periodically. Since 1999, the survey has been conducted as a continuous survey. Data are now released as public-use data files in two-year increments. Beginning in 2003, the survey content was held constant for each two-year period for consistency.

NHANES data are collected via questionnaires, examinations, and laboratory tests. The interview portion of NHANES is done in the participants' homes and includes information on demographics (e.g., age, sex), socioeconomics, dietary, and health-related questions (including types of health insurance) (NHANES, 2003). The physical examination is done in a Mobile Examination Center (MEC), which travels to survey locations around the country with a trained staff including a physician, dietician, medical technicians, and interviewers. Medical and dental exams, physiological measurements and laboratory tests are performed in the MEC.

Height and weight are measured using standard procedures (NHANES, 2004). Calibrated stadiometer and digital weight scale are used to measure height and weight respectively. Weight in kilograms divided by the square of height in meters is body mass index (BMI).

Sampling weights for NHANES 2003-2004, were provided by NCHS and were adjusted for unequal probabilities of selection, and non-response. These weights must be used in analysis to provide unbiased national estimates.

3.0 METHODS

3.1 DATASETS CREATED

3.1.1 National Hospital Discharge Survey (NHDS)

NHDS data are available at the NCHS website (http://www.cdc.gov/nchs/about/major/hdasd/nhds.htm). Public-use data files (micro-data) via ftp for the years 1999-2004 were downloaded. A text file for each year was read into SAS, version 9.1 (SAS Institute Inc, Cary, NC). SAS datasets were then merged to create one SAS dataset. Only adults (18 years of age and over) were included in the analyses.

Using the merged dataset for years 1999-2004, a dataset was created that only included discharge data for bariatric surgeries, defined by the following ICD-9 procedure codes: 44.31, 44.38, 44.39, 44.68, 44.69, 44.95, 44.96, and 44.97 (see Appendix A for labels of the ICD-9 codes). Only 3 of these 8 procedure codes were found in the sample: 44.31 (High gastric bypass), 44.39 (Other gastroenterostomy), and 44.69 (Other gastroplasty). Gastroenterostomy includes bypass procedures: gastroenterostomy, gastroduodenostomy (the stomach is connected to the duodenum), gastrogastrostomy (two parts of the stomach are connected). It also includes gastrojejunostomy without gastrectomy (the stomach is connected to the jejunum without removing part of the stomach). Gastroplasty includes adjustable banding and vertical banded gastroplasty (VBG).

Comorbidities associated with obesity were included in the analyses using the ICD-9 discharge diagnoses codes. Yes/no variables were created for: hypertension (401, 401.0, 401.1, 401.9), sleep apnea (327.23, 780.51, 780.53, 780.57), diabetes mellitus (250, 250.0 to 250.9), lipid disease (272.0 to 272.9), asthma (493.0 to 493.9), other chronic pulmonary disease (415.0, 416.8. 416.9, 491 to 492, 494, 491.0 to 492.9, 494.0 to 494.9), liver disease (571, 571.4 to 571.6, 571.8, 571.9, 572, 572.0, 572.8), congestive heart failure (428, 428.0 to 428.4, 428.9), ischemic heart disease (410 to 414), and kidney disease (585, 585.0 to 585.9, 586).

In accordance with the 1991 NIH Consensus Conference guidelines of who is eligible for weight loss surgery, patients were included if they had an ICD-9 code for morbid obesity (278.01), or if they had an ICD-9 code for obesity (278.0, 278.00) and an indication of at least one obesity-related comorbidity. Because bariatric surgical procedures can be used for purposes other than weight loss, such as cancer, anyone with a malignant abdominal neoplasm (codes 150.0-159.9) was excluded from the analysis (7.3% of those with the included bariatric procedures). After exclusions, 98.3% of the patients included in the analysis had an ICD-9 code for morbid obesity, and 1.7% of the patients had an ICD-9 code for obesity and at least 1 comorbidity.

Race was missing for 31.9% of bariatric surgical patients (and for 29.0% of all adults) in the NHDS dataset for years 1999 to 2004, so race was not included in the analyses. Categorical variables were created for patient age (years) (18-29, 30-39, 40-49, 50-59, and 60 and over); expected source of payment (combining primary and secondary sources into categories for private insurance only, public insurance only, private and public insurance, and self-pay only); and length of hospital stay (greater than 7 days were combined).

3.1.2 National Health and Nutrition Examination Survey (NHANES)

NHANES data are available at the NCHS website (http://www.cdc.gov/nchs/about/major/nhanes/datalink.htm). Public-use data files (micro-data) were downloaded for years 2003-2004. The files were text files which were read into SAS (v.9.1). Only adults (18 years of age and over) with a BMI at least 40 kg/m^2 were included in the analytical dataset. Determining those in the general population with a BMI of 35 to 40 kg/m^2 that are eligible for bariatric surgery is difficult because they need to have "high risk" comorbid conditions, and the severity of each individual comorbidity can be subjective. Because there are no concrete guidelines, it is often up to the primary care physician or surgeon to determine eligibility. Age, sex, and health insurance were the only variables in both NHDS and NHANES. The respondent identification number, age, sex, and sampling weights were obtained from the demographic files. Health insurance was acquired from the questionnaire files.

Age in NHANES was grouped into the same categories as NHDS. NHANES recorded multiple types of insurances for participants. Categories for health insurance in NHANES were created to be consistent with those in NHDS with the exception that for NHANES, a category was created for no health insurance, whereas NHDS had a category for self-pay only.

Many of the comorbidities obtained from NHDS were not available in NHANES and the few that were available were assessed differently; in NHANES, participants were asked whether they ever had the disease. Thus, a comparison of comorbidities between those getting surgery and those eligible for surgery was not possible. A variable was created to indicate which survey the data were from, and then the NHANES dataset was combined with the NHDS data for years 2003-2004. Because only severe obese adults were included in the NHANES created dataset, to be consistent with the comparison only those in the NHDS created dataset that have an ICD-9 code for morbid obesity (278.01) were included.

3.2 STATISTICAL METHODS

3.2.1 Descriptive Analyses

Unweighted frequencies including missing data were examined by year for NHDS variables to show numbers of surgeries upon which analyses were based. Weights were used in all other analyses. Weighted frequencies and 95% confidence intervals for percentages were calculated for all variables by year, and select variables by length of hospital stay, using the surveyfreq procedure in SAS (v.9.1). Exact confidence intervals were computed using STATA (v.8) for binomial proportions of 0. Confidence intervals for percentages are given for every weighted two-way table. Summary statistics (means and medians) were calculated for continuous variables using proc univariate.

3.2.2 Chi-square

Chi-square tests were used to test for differences in proportions for two or more groups. Chi-square tests of homogeneity were performed to test for differences in hospital and patient characteristics among bariatric surgical patients, and between characteristics of surgical patients and severely obese adults. Chi-square tests were also used to test for differences over time in the nominal variables (e.g., expected payment source, surgery type) from 1999 to 2004. Data are organized in $R \ x \ C$ contingency tables, with R rows and C columns. O_{ij} is the observed frequency in the (i, j) cell; $E_{ij} = \frac{n_{.i} n_{.j}}{n_{..}}$ is the expected frequency in the (i,j) cell, where $n_{..}$ is the grand total, $n_{i.}$ is the i^{th} row total, and $n_{.j}$ is the j^{th} column total. The chi-squared statistic is calculated as: $\mathrm{X}^2 = \sum_{i=1}^{R} \sum_{j=1}^{C} \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$ (Rosner, 2000). Under the null hypothesis, this test statistic follows a chi-square distribution with $(R-1) \ x \ (C-1)$ degrees of freedom. The null hypothesis (there is no difference in proportions) is rejected if $\mathrm{X}^2 > \chi^2_{(R-1)(C-1),1-\alpha}$, where α is the significance level.

3.2.3 Test for Trend

The Jonckheere-Terpstra trend test is a test for ordered differences among ordinal variables (i.e., both the response variable and the explanatory variable are ordinal), that was used to test for temporal trends for all ordinal patient, hospital, and surgical characteristics. It is a non-parametric test (a distribution-free test that does not rely on assumptions that data follow a given probability distribution) (Jonckheere, 1954). The Jonckheere-Terpstra trend test is based on a sum of Mann-Whitney tests (Mann-Whitney is also known as Wilcoxon Rank-Sum). Mann-Whitney tests are used to determine whether medians are equal between two independent samples. To obtain the Jonckheere-Terpstra test statistic, $R(R-1)/2$ Mann-Whitney counts $M_{i,i'}$ are formed, where R is the number of rows and $i < i'$ for pairs of rows (SAS, 2004).

$M_{i,i'} = \{\, number\ of\ times\ X_{i,j} < X_{i',j'} \,\} + \frac{1}{2}\{\, number\ of\ times\ X_{i,j} = X_{i',j'} \,\}$, where $j = 1,...,n_{i.}$, $j' = 1,...,n_{i'.}$, and $X_{i,j}$ is response j in row i. The Jonckheere-Terpstra test statistic is $J = \sum_{1 \le i < i' \le R}\sum M_{i,i'}$.

3.2.4 Poisson Regression

Poisson regression is used to model count data, and was used to model length of hospital stay. The Poisson regression model is a loglinear model. The response variable, *Y*, has a Poisson distribution with mean μ. The mean function is $E(Y) = \mu = \exp\{\alpha + \beta_1 x_1 + ... + \beta_k x_k\}$, where α is the intercept, $x_1,...,x_k$ are the values of the predictor variables, and $\beta_1,...,\beta_k$ are the values of the regression coefficients. The relative risks (RR) are $RR = e^{\beta}$ (Kleinbaum et al., 1998). Proc genmod in SAS was used to find the best-fitting model that predicted the outcome. Variables thought to be predictors of length of stay were entered into the model one at a time, starting with the variable with the lowest p-value and then with the lowest deviance (i.e., if variables had the same p-value). Model deviance measures discrepancy between observed and fitted models, and was compared between models to help determine the best-fitting model.

Relative risks (RR) and their associated confidence intervals were calculated. The observed and predicted values were plotted to observe the overall goodness-of-fit for the final model. All analyses were conducted using SAS software, version 9.1 (SAS Institute Inc, Cary, NC).

4.0 RESULTS

4.1 UNWEIGHTED NHDS FREQUENCIES BY YEAR

Unweighted frequencies for variables obtained from NHDS are shown by year in Tables 1-5. These frequencies show that the number of surgeries in the NHDS sample grew significantly over the six year period from 1999-2004. Because there were so few bariatric surgeries in NHDS in 1999 and 2000, some categories have no, or very few, surgeries. As a result, percentages can change substantially from year to year. Overall, there were very little missing data. However, expected source of payment was missing in 7-11% of surgeries depending on the year.

Table 1. Unweighted Frequencies for Hospital Characteristics, by Year

	1999 (n=47)		**2000** (n=79)		**2001** (n=466)		**2002** (n=818)		**2003** (n=1,161)		**2004** (n=1,286)		**Total** (N=3,857)	
	n	**%**	**n**	**%**	**N**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Geographic region														
Northeast	10	21.3	13	16.5	82	17.6	161	19.7	283	24.4	356	27.7	905	23.5
Midwest	4	8.5	40	50.6	167	35.8	275	33.6	395	34.0	357	27.8	1,238	32.1
South	27	57.4	22	27.8	179	38.4	327	40.0	389	33.5	444	34.5	1,388	36.0
West	6	12.8	4	5.1	38	8.2	55	6.7	94	8.1	129	10.0	326	8.5
Ownership														
Proprietary	17	36.2	20	25.3	101	21.7	150	18.3	124	10.7	151	11.7	563	14.6
Government	5	10.6	8	10.1	36	7.7	50	6.1	86	7.4	88	6.8	273	7.1
Nonprofit	25	53.2	51	64.6	329	70.6	618	75.6	951	81.9	1,047	81.4	3,021	78.3
	n	**Cum. %**	**n**	**Cum. %**	**N**	**Cum. %**	**n**	**Cum. %**	**n**	**Cum. %**	**n**	**Cum. %**	**n**	**Cum. %**
Bed size grouping														
6-99	6	12.8	4	5.1	17	3.7	26	3.2	80	6.9	83	6.5	216	5.6
100-199	5	23.4	5	11.4	130	31.6	216	29.6	318	34.3	232	24.5	906	29.1
200-299	19	63.8	42	64.6	84	49.6	158	48.9	236	54.6	406	56.1	945	53.6
300-499	9	83.0	21	91.1	177	87.6	329	89.1	385	87.8	332	81.9	1,253	86.1
500+	8	100.0	7	100.0	58	100.0	89	100.0	142	100.0	233	100.0	537	100.0

Table 2. Unweighted Frequencies for Patient Age and Sex, by Year

	1999 (n=47)		**2000** (n=79)		**2001** (n=466)		**2002** (n=818)		**2003** (n=1,161)		**2004** (n=1,286)		**Total** (N=3,857)	
	n	**Cum. %**	**n**	**Cum. %**	**N**	**Cum. %**	**n**	**Cum. %**	**n**	**Cum. %**	**n**	**Cum. %**	**n**	**Cum. %**
Age group (yrs)														
18-29	4	8.5	12	15.2	69	14.8	113	13.8	136	11.7	164	12.8	498	12.9
30-39	15	40.4	27	49.4	161	49.4	250	44.4	363	43.0	405	44.3	1,221	44.6
40-49	12	66.0	28	84.8	134	78.1	258	75.9	362	74.2	378	73.6	1,172	75.0
50-59	13	93.6	12	100.0	88	97.0	176	97.4	269	97.3	279	95.3	837	96.7
60+	3	100.0	0	100.0	14	100.0	21	100.0	31	100.0	60	100.0	129	100.0
	n	**%**	**n**	**%**	**N**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Sex														
Male	6	12.8	17	21.5	66	14.2	131	16.0	191	16.5	215	16.7	626	16.2
Female	41	87.2	62	78.5	400	85.8	687	84.0	970	83.5	1,071	83.3	3,231	83.8

Table 3. Unweighted Frequencies for Comorbidities, by Year

	1999 (n=47)		**2000** (n=79)		**2001** (n=466)		**2002** (n=818)		**2003** (n=1,161)		**2004** (n=1,286)		**Total** (N=3,857)	
	n	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Comorbidities														
Hypertension	19	40.4	30	38.0	183	39.3	362	44.3	523	45.0	607	47.2	1,724	44.7
Sleep Apnea	7	14.9	15	19.0	83	17.8	174	21.3	296	25.5	403	31.3	978	25.4
Diabetes Mellitus	9	19.1	15	19.0	94	20.2	163	19.9	254	21.9	308	24.0	843	21.9
Lipid Disease	0	0.0	8	10.1	60	12.9	133	16.3	191	16.5	261	20.3	653	16.9
Asthma	1	2.1	6	7.6	69	14.8	91	11.1	165	14.2	181	14.1	513	13.3
Other Chronic Pulmonary Disease	0	0.0	1	1.3	10	2.1	14	1.7	19	1.6	22	1.7	66	1.7
Liver Disease	3	6.4	1	1.3	28	6.0	42	5.1	64	5.5	79	6.1	217	5.6
Congestive Heart Failure	1	2.1	1	1.3	4	0.9	11	1.3	22	1.9	17	1.3	56	1.5
Ischemic Heart Disease	0	0.0	1	1.3	0	0.0	4	0.5	12	1.0	18	1.4	35	0.9
Kidney Disease	0	0.0	1	1.3	0	0.0	0	0.0	1	0.1	8	0.6	10	0.3
	n	**Cum. %**	**n**	**Cum. %**	**n**	**Cum. %**	**n**	**Cum. %**	**n**	**Cum. %**	**n**	**Cum. %**	**n**	**Cum. %**
Number of comorbidities														
0	23	49.0	35	44.3	156	33.5	238	29.1	323	27.8	299	23.3	1074	27.9
1	12	74.5	19	68.4	155	66.7	281	63.5	352	58.1	394	53.9	1213	59.3
2	9	93.6	15	87.3	102	88.6	197	87.5	301	84.1	340	80.3	964	84.3
3	2	97.9	10	100.0	42	97.6	90	98.5	148	96.8	190	95.1	482	96.8
4	1	100.0	0	100.0	9	99.6	11	99.9	36	99.9	55	99.4	112	99.7
5	0	100.0	0	100.0	2	100.0	1	100.0	1	100.0	8	100.0	12	100.0

Table 4. Unweighted Frequencies for Surgery Type and Length of Stay, by Year

	1999 (n=47)		**2000** (n=79)		**2001** (n=466)		**2002** (n=818)		**2003** (n=1,161)		**2004** (n=1,286)		**Total** (N=3,857)	
	n	**%**	**n**	**%**	**N**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
Type of Surgery														
High Gastric Bypass	20	42.6	54	68.4	322	69.1	572	69.9	828	71.3	235	18.3	2,031	52.7
Other Gastroenterostomy	8	17.0	10	12.7	82	17.6	140	17.1	191	16.5	871	67.7	1,302	33.8
Other Gastroplasty	19	40.4	15	19.0	62	13.3	106	13.0	142	12.2	180	14.0	524	13.6
	n	**Cum. %**	**n**	**Cum. %**	**N**	**Cum. %**	**n**	**Cum. %**	**n**	**Cum. %**	**n**	**Cum. %**	**n**	**Cum. %**
Days of care														
Less than 1 day	0	0.0	0	0.0	0	0.0	0	0.0	4	0.3	3	0.2	7	0.2
1 day	1	2.1	0	0.0	6	1.3	76	9.3	124	11.0	158	12.5	365	9.6
2 days	4	10.6	7	8.9	75	17.4	177	30.9	319	38.5	365	40.9	947	34.2
3 days	19	51.1	41	60.8	210	62.5	334	71.8	461	78.2	437	74.9	1,502	73.1
4 days	6	63.8	13	77.2	81	79.8	129	87.5	128	89.2	164	87.6	521	86.7
5 days	5	74.5	6	84.8	45	89.5	50	93.6	52	93.7	65	92.7	223	92.4
6 days	5	85.1	3	88.6	23	94.4	17	95.7	24	95.8	41	95.9	113	95.4
7 days	5	95.7	3	92.4	6	95.7	11	97.1	14	97.0	15	97.1	54	96.8
More than 7 days	2	100.0	6	100.0	20	100.0	24	100.0	35	100.0	38	100.0	125	100.0

Table 5. Unweighted Frequencies for Discharge Status and Expected Source of Payment, by Year

	1999 (n=47)		2000 (n=79)		2001 (n=466)		2002 (n=818)		2003 (n=1,161)		2004 (n=1,286)		Total (N=3,857)	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%
Discharge status														
Routine/discharged home	44	95.7	60	75.9	375	80.5	805	98.4	1138	98.2	1254	97.6	3,676	95.4
Left against medical advice	1	2.2	0	0.0	1	0.2	0	0.0	0	0.0	1	0.1	3	0.1
Discharged/transferred to short-term facility	0	0.0	1	1.3	0	0.0	0	0.0	0	0.0	2	0.2	3	0.1
Discharged/transferred to long-term care institution	1	2.2	0	0.0	1	0.2	2	0.2	3	0.3	1	0.1	8	0.2
Alive, disposition not stated	0	0.0	17	21.5	88	18.9	9	1.1	15	1.3	26	2.0	155	4.0
Dead	0	0.0	1	1.3	1	0.2	2	0.2	3	0.3	1	0.1	8	0.2
Missing	1	2.1	0	0.0	0	0.0	0	0.0	2	0.2	1	0.1	4	0.1
Expected source of payment														
Private only	31	73.8	60	82.2	347	83.2	632	86.8	940	87.9	969	81.3	2,979	84.6
Public only	9	21.4	10	13.7	53	12.7	63	8.7	90	8.4	140	11.7	365	10.4
Private and Public	1	2.4	0	0.0	7	1.7	13	1.8	17	1.6	33	2.8	71	2.0
Self-pay	1	2.4	3	4.1	10	2.4	20	2.7	23	2.1	50	4.2	107	3.0
Missing	5	10.6	6	7.6	49	10.5	90	11.0	91	7.8	94	7.3	335	8.7

4.2 BARIATRIC SURGERY CHARACTERISTICS

4.2.1 Hospital Characteristics

Weighted frequencies and percentages for hospital region, bed size, and ownership for all years combined are shown in Table 6. More than a third of the bariatric surgeries were in the southern region of the United States. The Midwest and the West had the fewest surgeries. Almost three quarters of bariatric surgeries were performed at nonprofit hospitals. Less than 10 percent of bariatric surgeries were performed at hospitals with fewer than 100 beds. More than half of the surgeries were performed in a hospital with 100-299 beds.

Table 6. Weighted Frequencies of Hospital Characteristics

	Total (N=364,873)	
	n	**%**
Geographic region		
Northeast	85,439	23.4
Midwest	67,967	18.6
South	140,589	38.5
West	70,878	19.5
Ownership		
Proprietary	76,488	21.0
Government	19,013	5.2
Nonprofit	269,372	73.8
	n	**Cum. %**
Bed size grouping		
6-99	35,254	9.7
100-199	83,927	32.7
200-299	106,496	61.9
300-499	87,373	85.8
500+	51,823	100.0

4.2.2 Patient Characteristics

4.2.2.1 Age and Sex

Almost three quarters of bariatric surgical patients were under 50 years of age, and only 3.6% of the patients were 60 years old or older (Table 7). The average (median) age was 41.6 (41) years. The oldest bariatric surgery patient was 72 years old. A large majority (84.3%) of those having surgery were female.

Table 7. Weighted Frequencies for Age Group, and Sex

	Total (N=364,873)	
	n	**Cum. %**
Age group (years)		
18-29	46,039	12.6
30-39	111,627	43.2
40-49	114,125	74.5
50-59	79,927	96.4
60+	13,155	100.0
Age, mean, median		41.6, 41
	n	**%**
Sex		
Male	57,187	15.7
Female	307,686	84.3

4.2.2.2 Comorbidities

Table 8 shows the burden of comorbidities among bariatric surgical patients between 1999-2004. The most prevalent comorbid condition was hypertension, followed by sleep apnea, and diabetes mellitus. Table 9 shows that 27.3% of the patients had no comorbidities, whereas 3.2% had four or more of the ten comorbidities considered.

Table 8. Weighted Frequencies of Comorbidities

	Total (N=364,873)	
	n	%
Comorbidities		
Hypertension	165,842	45.5
Sleep Apnea	94,151	25.8
Diabetes Mellitus	79,358	21.8
Lipid Disease	55,988	15.3
Asthma	45,603	12.5
Other Chronic Pulmonary Disease	7,208	2.0
Liver Disease	20,122	5.5
Congestive Heart Failure	4,668	1.3
Ischemic Heart Disease	3,965	1.1
Kidney Disease	861	0.2

Table 9. Weighted Frequencies of Number of Comorbidities

	Total (N=364,873)	
	n	Cum. %
Number of comorbidities		
0	99,585	27.3
1	119,356	60.0
2	91,828	85.2
3	42,581	96.8
4 or more	11,523	100.0

4.2.2.3 Surgery Type

Table 10 shows that the majority of the bariatric procedures were high gastric bypass surgeries. Only 8.7% of the surgical patients had gastroplasty.

Table 10. Weighted Frequencies of Surgery Type

	Total (N=364,873)	
	n	%
Type of Surgery		
High Gastric Bypass	202,315	55.5
Other Gastroenterostomy	130,774	35.8
Other Gastroplasty	31,784	8.7

4.2.2.4 Expected Source of Payment

Approximately, 80% of patients were expected to pay for their surgery with private insurance only, and another 14% were expected to pay with public insurance only. Only 4.0% were expected to pay out of pocket (Table 11). It is not clear whether these patients had no health insurance or whether their health insurance would not cover their bariatric surgery.

Table 11. Weighted Frequencies of Expected Source of Payment

	Total (N=341,532)	
	n	%
Expected source of payment		
Private only	272,609	79.9
Public only	48,826	14.3
Private and Public	6,278	1.8
Self-pay	13,819	4.0

4.3 TEMPORAL TRENDS IN BARIATRIC SURGERY (1999-2004)

Table 12 shows the number of surgeries for each year, and also the confidence intervals for weighted frequencies. The number of surgeries in 1999 and 2000 was essentially the same with the number of surgeries increasing more than 15-fold over the next three years. After such huge increases from 2000 to 2003, the number of surgeries in 2004 was essentially the same as in 2003.

Table 12. Weighted Frequencies and Confidence Intervals of Bariatric Surgeries, by Year

	1999	2000	2001	2002	2003	2004	Total
Number of surgeries	7,265	7,227	44,438	83,714	110,471	111,758	**364,873**
95% CI for # of surgeries	[5187, 9343]	[4932, 9522]	[38793, 50083]	[74784, 92644]	[99551, 121391]	[102556, 120960]	[346849, 382897]

4.3.1 Hospital Characteristics

The percentage of surgeries in the Midwest decreased from a high of 33.4% in 2000 to only 13.4% in 2004, with much of the difference taken up by the South where the percentage increased from 16.5% in 2000 to 39.0% in 2004 (Table 13). There was a decreasing trend in surgeries at proprietary hospitals and government (non-Federal) hospitals, and an increase in the percentage of surgeries at nonprofit hospitals. There was a decreasing trend of bariatric surgeries in hospitals with less than 100 beds, and an increasing trend in hospitals with a bed size of 100-199. Table 14 shows 95% confidence intervals for weighted percentages to see where differences are.

Table 13. Weighted Frequencies of Hospital Characteristics, by Year

	1999 (n=7,265)		2000 (n=7,227)		2001 (n=44,438)		2002 (n=83,714)		2003 (n=110,471)		2004 (n=111,758)		Total (N=364,873)		p value
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Geographic region															**<.0001***
Northeast	1,531	21.1	1,960	27.1	9,111	20.5	16,258	19.4	28,467	25.8	28,112	25.2	85,439	23.4	
Midwest	997	13.7	2,414	33.4	10,467	23.6	17,288	20.7	21,858	19.8	14,943	13.4	67,967	18.6	
South	2,712	37.3	1,193	16.5	15,556	35.0	36,238	43.3	41,252	37.3	43,638	39.0	140,589	38.5	
West	2,025	27.9	1,660	23.0	9,304	20.9	13,930	16.6	18,894	17.1	25,065	22.4	70,878	19.5	
Ownership															**<.0001***
Proprietary	1,680	23.1	2,666	36.9	11,364	25.6	21,271	25.4	21,187	19.2	18,320	16.4	76,488	21.0	
Government	905	12.5	506	7.0	3,312	7.4	2,465	2.9	6,153	5.6	5,672	5.1	19,013	5.2	
Nonprofit	4,680	64.4	4,055	56.1	29,762	67.0	59,978	71.7	83,131	75.2	87,766	78.5	269,372	73.8	
	n	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	
Bed size grouping															**<.0001****
6-99	1,326	18.2	992	13.7	4,908	11.0	7,041	8.4	10,252	9.3	10,735	9.6	35,254	9.7	
100-199	791	29.1	1,025	27.9	10,610	34.9	21,289	33.8	27,854	34.5	22,358	29.6	83,927	32.7	
200-299	2,557	64.3	2,689	65.1	10,609	58.8	20,941	58.9	34,014	65.3	35,686	61.5	106,496	61.9	
300-499	1,229	81.3	1,645	87.9	11,929	85.6	24,311	87.9	24,228	87.2	24,031	83.0	87,373	85.8	
500+	1,362	100.0	876	100.0	6,382	100.0	10,132	100.0	14,123	100.0	18,948	100.0	51,823	100.0	

* Chi-square test
** Jonckheere-Terpstra test for trend

Table 14. 95% Confidence Intervals (CI) for Weighted Percentages of Hospital Characteristics, by Year

	1999 (n=7,265)	**2000** (n=7,227)	**2001** (n=44,438)	**2002** (n=83,714)	**2003** (n=110,471)	**2004** (n=111,758)	**Total** (N=364,873)
	95% CI	**95% CI**	**95% CI**	**95% CI**	**95% CI**	**95% CI**	**95% CI**
Geographic region							
Northeast	[5.6, 36.6]	[11.4, 42.9]	[15.0, 26.0]	[15.5, 23.3]	[21.4, 30.1]	[21.3, 29.0]	[21.3, 25.6]
Midwest	[0.0, 27.6]	[17.0, 49.8]	[17.2, 29.9]	[16.1, 25.2]	[15.0, 24.6]	[11.0, 15.8]	[16.5, 20.8]
South	[18.6, 56.1]	[4.7, 28.3]	[27.6, 42.4]	[36.8, 49.8]	[31.7, 43.0]	[34.2, 43.9]	[35.6, 41.4]
West	[6.4, 49.3]	[0.7, 45.3]	[13.6, 28.3]	[11.5, 21.8]	[12.4, 21.8]	[17.5, 27.3]	[16.8, 22.1]
Ownership							
Proprietary	[6.7, 39.6]	[16.2, 57.6]	[18.1, 33.0]	[18.6, 32.2]	[13.8, 24.6]	[12.2, 20.6]	[18.1, 23.8]
Government	[0.5, 24.5]	[0.5, 13.5]	[3.2, 11.7]	[1.6, 4.3]	[3.5, 7.6]	[3.0, 7.2]	[4.1, 6.3]
Nonprofit	[45.5, 83.3]	[36.1, 76.1]	[59.2, 74.8]	[65.0, 78.3]	[69.7, 80.8]	[74.0, 83.0]	[70.9, 76.7]
Bed size grouping							
6-99	[3.3, 33.2]	[0.6, 26.8]	[5.0, 17.1]	[4.8, 12.0]	[6.1, 12.5]	[6.1, 13.2]	[7.8, 11.5]
100-199	[0.0, 21.9]	[0.0, 28.7]	[17.4, 30.4]	[19.5, 31.3]	[19.6, 30.8]	[15.9, 24.1]	[20.3, 25.7]
200-299	[14.1, 56.3]	[17.2, 57.2]	[16.9, 30.9]	[19.8, 30.3]	[25.1, 36.5]	[27.0, 36.9]	[26.4, 32.0]
300-499	[1.4, 32.4]	[8.6, 37.0]	[20.8, 32.9]	[23.2, 34.9]	[18.2, 25.6]	[18.1, 24.9]	[21.7, 26.2]
500+	[4.5, 33.0]	[2.1, 22.2]	[8.7, 20.0]	[8.8, 15.4]	[9.8, 15.7]	[13.9, 20.0]	[12.5, 15.9]

4.3.2 Patient Age and Sex

There is a statistically significant secular trend with respect to the age distribution of patients (Table 15), although the confidence intervals for percentages overlap for most of the years (Table 16). For years 1999-2002, the percentage in the youngest age group (under 30 years) increased, but decreased in 2003. In 2000, there were no patients who were at least 60 years old. In 2002, percentages were the highest in the age groups 18-29 years, 50-59 years, and 60 years or more, but the percentage decreased for year 2003 and was slightly lower for 2004. In 2003 and 2004, the mean and median age are smaller compared to 2001 and 2002. In 2004, there was a high percentage (nearly 50%) of younger patients (less than 40 years) compared to other years. In 2004, there was a high percentage of older patients (60 years or more), whereas earlier years had more patients in middle age groups, and smaller percentages of younger and older surgical patients. The percentage of males having bariatric surgery decreases from 2002 to 2004, from 16.7% to only 14.8%.

Table 15. Weighted Frequencies for Age Group and Sex, by Year

	1999 (n=7,265)		2000 (n=7,227)		2001 (n=44,438)		2002 (n=83,714)		2003 (n=110,471)		2004 (n=111,758)		Total (N=364,873)		p value*
	n	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	
Age group (years)															**<.0001**
18-29	168	2.3	799	11.1	5,455	12.3	12,370	14.8	11,107	10.1	16,140	14.4	46,039	12.6	
30-39	2,036	30.3	2,822	50.1	14,836	45.7	20,524	39.3	32,633	39.6	38,776	49.1	111,627	43.2	
40-49	1,829	55.5	2,453	84.1	13,952	77.1	26,892	71.4	40,686	76.4	28,313	74.5	114,125	74.5	
50-59	2,247	86.4	1,153	100.0	8,657	96.5	20,385	95.8	23,507	97.7	23,978	95.9	79,927	96.4	
60+	985	100.0	0	100.0	1,538	100.0	3,543	100.0	2,538	100.0	4,551	100.0	13,155	100.0	
Age, mean, median		47.2, 44		39.9, 39		41.3, 41		41.9, 42		42.0, 42		40.9, 40		41.6, 41	
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Sex															**<.0001**
Male	1,023	14.1	1,232	17.1	6,360	14.3	13,998	16.7	18,044	16.3	16,530	14.8	57,187	15.7	
Female	6,242	85.9	5,995	82.9	38,078	85.7	69,716	83.3	92,427	83.7	95,228	85.2	307,686	84.3	

* Jonckheere-Terpstra test for trend

Table 16. 95% Confidence Intervals (CI) for Weighted Percentages for Age Group and Sex, by Year

	1999 (n=7,265)	2000 (n=7,227)	2001 (n=44,438)	2002 (n=83,714)	2003 (n=110,471)	2004 (n=111,758)	Total (N=364,873)
	95% CI	95% CI	95% CI	95% CI	95% CI	95% CI	95% CI
Age group (years)							
18-29	[0.0, 6.0]	[0.5, 21.7]	[7.7, 16.8]	[9.8, 19.8]	[6.8, 13.4]	[11.1, 17.8]	[10.7, 14.6]
30-39	[9.5, 46.6]	[19.0, 59.0]	[25.8, 41.0]	[19.4, 29.6]	[24.5, 34.6]	[29.8, 39.6]	[27.9, 33.3]
40-49	[8.0, 42.3]	[15.9, 51.9]	[24.0, 38.8]	[26.1, 38.2]	[31.0, 42.7]	[21.2, 29.5]	[28.5, 34.1]
50-59	[12.6, 49.3]	[3.8, 28.1]	[13.6, 25.3]	[19.1, 29.6]	[17.1, 25.5]	[17.5, 25.4]	[19.6, 24.2]
60+	[0.0, 31.0]	[0.0, 0.0]	[0.7, 6.3]	[1.7, 6.8]	[1.1, 3.5]	[2.4, 5.8]	[2.6, 4.6]
Sex							
Male	[0.0, 28.4]	[3.2, 30.9]	[9.1, 19.5]	[11.6, 21.9]	[11.9, 20.8]	[11.4, 18.2]	[13.5, 17.9]
Female	[71.6, 100]	[69.1, 96.8]	[80.5, 90.9]	[78.1, 88.4]	[79.2, 88.1]	[81.8, 88.6]	[82.1, 86.5]

4.3.3 Comorbidities

The prevalence of nearly every comorbidity was the highest in 2004 compared to earlier years, especially for the two most prevalent comorbid conditions (hypertension and sleep apnea) (Table 17). The only comorbidity for which there was no statistically significant temporal trend from 1999 to 2004 was liver disease. The highest percentage of patients with liver disease was in 2001 (8.6%).

Table 17. Weighted Frequencies of Comorbidities, by Year

	1999 (n=7,265)		2000 (n=7,227)		2001 (n=44,438)		2002 (n=83,714)		2003 (n=110,471)		2004 (n=111,758)		Total (N=364,873)		p value*
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Comorbidities															
Hypertension	2,909	40.0	2,832	39.2	16,417	36.9	40,090	47.9	52,692	47.7	50,902	45.6	165,842	45.5	**<.0001**
Sleep Apnea	1,418	19.5	1,504	20.8	8,614	19.4	20,422	24.4	28,687	26.0	33,506	30.0	94,151	25.8	**<.0001**
Diabetes Mellitus	1,827	25.2	1,583	21.9	9,701	21.8	17,653	21.1	21,702	19.6	26,892	24.1	79,358	21.8	**<.0001**
Lipid Disease	0	0.0	20	2.9	4,665	10.5	13,200	15.8	15,003	13.6	22,914	20.5	55,988	15.3	**<.0001**
Asthma	15	0.2	661	9.1	5,164	11.6	8,579	10.2	13,530	12.2	17,654	15.8	45,603	12.5	**<.0001**
Other Chronic Pulmonary Disease	0	0.0	25	0.4	1,541	3.5	1,511	1.8	1,890	1.7	2,241	2.0	7,208	2.0	**<.0001**
Liver Disease	593	8.2	89	1.2	3,820	8.6	2,944	3.5	5,976	5.4	6,700	6.0	20,122	5.5	.12
Congestive Heart Failure	536	7.4	24	0.3	614	1.4	414	0.5	1,725	1.6	1,355	1.2	4,668	1.3	**.0003**
Ischemic Heart Disease	0	0.0	79	1.1	0	0.0	746	0.9	519	0.5	2,621	2.4	3,965	1.1	**<.0001**
Kidney Disease	0	0.0	11	0.2	0	0.0	0	0.0	53	0.1	797	0.7	861	0.2	**<.0001**

* Jonckheere-Terpstra test for trend

Table 18. 95% Confidence Intervals (CI) for Weighted Percentages of Comorbidities, by Year

	1999 (n=7,265)	2000 (n=7,227)	2001 (n=44,438)	2002 (n=83,714)	2003 (n=110,471)	2004 (n=111,758)	Total (N=364,873)
	95% CI	**95% CI**	**95% CI**	**95% CI**	**95% CI**	**95% CI**	**95% CI**
Comorbidities							
Hypertension	[19.8, 60.2]	[20.6, 57.8]	[29.5, 44.4]	[41.6, 54.2]	[42.0, 53.4]	[40.6, 50.4]	[42.5, 48.4]
Sleep Apnea	[1.9, 37.1]	[4.9, 36.7]	[13.1, 25.6]	[18.5, 30.2]	[21.4, 30.6]	[25.4, 34.6]	[23.3, 28.4]
Diabetes Mellitus	[6.1, 44.2]	[6.1, 37.7]	[15.1, 28.5]	[16.0, 26.1]	[15.5, 23.8]	[20.0, 28.1]	[19.4, 24.1]
Lipid Disease	[0.0, 0.0]	[0.6, 5.1]	[6.1, 14.9]	[11.5, 20.0]	[10.2, 17.0]	[16.6, 24.4]	[13.4, 17.3]
Asthma	[0.0, 0.6]	[0.0, 19.2]	[6.8, 16.4]	[6.9, 13.6]	[8.8, 15.7]	[12.0, 19.6]	[10.6, 14.4]
Other Chronic Pulmonary Disease	[0.0, 0.0]	[0.0, 1.0]	[0.5, 6.4]	[0.3, 3.3]	[0.5, 2.9]	[0.6, 3.5]	[1.2, 2.7]
Liver Disease	[0.0, 20.4]	[0.0, 3.7]	[3.6, 13.6]	[1.9, 5.1]	[3.0, 7.8]	[3.5, 8.5]	[4.2, 6.8]
Congestive Heart Failure	[0.0, 21.6]	[0.0, 1.0]	[0.0, 3.4]	[0.1, 0.9]	[0.6, 2.5]	[0.2, 2.2]	[0.7, 1.9]
Ischemic Heart Disease	[0.0, 0.0]	[0.0, 3.3]	[0.0, 0.0]	[0.0, 2.1]	[0.2, 0.8]	[0.0, 4.7]	[0.3, 1.9]
Kidney Disease	[0.0, 0.0]	[0.0, 0.5]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.1]	[0.1, 1.3]	[0.0, 0.4]

As a result of increasing prevalences of comorbidities, there is a decrease in the percentage of patients with 0 or 1 comorbidity over the years (Table 19). The confidence intervals in Table 20 also show a significant trend as many confidence intervals do not overlap. In 1999 and 2000, more than half of the patients had no comorbidities, and in 2004, less than one quarter had no reported comorbidities.

Table 19. Weighted Frequencies of Number of Comorbidities, by Year

	1999 (n=7,265)		2000 (n=7,227)		2001 (n=44,438)		2002 (n=83,714)		2003 (n=110,471)		2004 (n=111,758)		Total (N=364,873)		p value*
	n	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	
Number of comorbidities															**<.0001**
0	3,878	53.4	3,695	51.1	14,394	32.4	21,502	25.7	30,790	27.9	25,326	22.7	99,585	27.3	
1	1,162	69.4	1,353	69.9	15,593	67.5	31,581	63.4	35,816	60.3	33,851	53.0	119,356	60.0	
2	1,075	84.2	876	82.0	9,115	88.0	19,248	86.4	29,387	86.9	32,127	81.7	91,828	85.2	
3	614	92.6	1,303	100.0	4,724	98.6	10,306	98.7	10,817	96.7	14,817	95.0	42,581	96.8	
4 or more	536	100.0	0	100.0	612	100.0	1,077	100.0	3,661	100.0	5,637	100.0	11,523	100.0	

* Jonckheere-Terpstra test for trend

Table 20. 95% Confidence Intervals (CI) for Weighted Percentages of Number of Comorbidities, by Year

	1999 (n=7,265) 95% CI	2000 (n=7,227) 95% CI	2001 (n=44,438) 95% CI	2002 (n=83,714) 95% CI	2003 (n=110,471) 95% CI	2004 (n=111,758) 95% CI	Total (N=364,873) 95% CI
Number of comorbidities							
0	[32.8, 73.9]	[31.8, 70.5]	[25.2, 39.6]	[20.3, 31.1]	[22.5, 33.3]	[18.8, 26.5]	[24.7, 29.9]
1	[2.3, 29.7]	[6.3, 31.1]	[27.5, 42.7]	[31.4, 44.1]	[27.0, 37.9]	[25.8, 34.8]	[29.9, 35.5]
2	[2.0, 27.6]	[2.6, 21.7]	[14.6, 26.4]	[17.9, 28.1]	[21.7, 31.5]	[23.9, 33.6]	[22.6, 27.7]
3	[0.0, 21.0]	[2.3, 33.8]	[5.3, 16.0]	[8.4, 16.2]	[7.1, 12.5]	[10.3, 16.2]	[10.0, 13.4]
4 or more	[0.0, 21.6]	[0.0, 0.0]	[0.2, 2.6]	[0.1, 2.5]	[1.7, 4.9]	[3.0, 7.1]	[2.3, 4.1]

4.3.4 Surgery Type

Table 21 shows that the percentage of high gastric bypass procedures decreases over the years (2000-2004), while the percentage of gastroenterostomy increases (2000-2004). The frequencies and percentages for high gastric bypass and gastroenterostomy were nearly reversed from 2003 to 2004. The percentage of "high gastric bypass" changed from 69.6% in 2003 to 19.4% in 2004, while "other gastroenterostomy" changed from 24.3% in 2003 to 67.8% in 2004. The number of gastroplasty surgeries more than doubled from 2003 to 2004, while the number of total surgeries only increased by 1.2% from 2003 to 2004.

Table 21. Weighted Frequencies of Surgery Type, by Year

	1999 (n=7,265)		2000 (n=7,227)		2001 (n=44,438)		2002 (n=83,714)		2003 (n=110,471)		2004 (n=111,758)		Total (N=364,873)		p value*
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Type of Surgery															**<.0001**
High Gastric Bypass	4,822	66.4	5,631	77.9	33,265	74.9	60,071	71.8	76,897	69.6	21,629	19.4	202,315	55.5	
Other Gastroenterostomy	1,130	15.5	1,090	15.1	8,012	18.0	17,923	21.4	26,882	24.3	75,737	67.8	130,774	35.8	
Other Gastroplasty	1,313	18.1	506	7.0	3,161	7.1	5,720	6.8	6,692	6.1	14,392	12.9	31,784	8.7	

* Chi-square test

Table 22. 95% Confidence Intervals (CI) for Weighted Percentages of Surgery Type, by Year

	1999 (n=7,265)	2000 (n=7,227)	2001 (n=44,438)	2002 (n=83,714)	2003 (n=110,471)	2004 (n=111,758)	Total (N=364,873)
	95% CI	95% CI	95% CI	95% CI	95% CI	95% CI	95% CI
Type of Surgery							
High Gastric Bypass	[48.7, 84.1]	[65.4, 90.4]	[68.7, 81.0]	[66.7, 76.8]	[64.6, 74.6]	[15.5, 23.3]	[52.6,58.3]
Other Gastroenterostomy	[2.4, 28.7]	[4.1, 26.0]	[12.6, 23.4]	[16.9, 26.0]	[19.5, 29.2]	[63.1, 72.4]	[33.1, 38.6]
Other Gastroplasty	[5.1, 31.0]	[1.6, 12.4]	[3.8, 10.4]	[4.5, 9.1]	[4.5, 7.6]	[9.5, 16.3]	[7.3, 10.1]

4.3.5 Expected Source of Payment

There was no trend in the expected payment source from 1999 to 2004 as shown in Table 23. However, there were differences among types of health insurance in different years. In all years, private insurance was the large majority. In 1999, 37.3% were expected to pay with public insurance only; this is more than twice as high as any other year. Since 2000, 1-2% of bariatric surgical patients had both types of insurance, 2-6% paid out of pocket, and 10-15% were expected to pay with only public insurance. Also of note, 2004 had the highest percentage of bariatric surgical patients expected to pay out of pocket.

Table 23. Weighted Frequencies of Expected Source of Payment, by Year

	1999 (n=7,073)		2000 (n=7,086)		2001 (n=41,345)		2002 (n=77,706)		2003 (n=103,328)		2004 (n=104,994)		Total (N=341,532)		p value*
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Expected source of payment															**<.0001**
Private only	4,027	56.9	6,030	85.1	31,832	77.0	63,460	81.7	85,858	83.1	81,402	77.5	272,609	79.8	
Public only	2,638	37.3	812	11.5	6,502	15.7	10,463	13.5	12,768	12.4	15,643	14.9	48,826	14.3	
Private and Public	249	3.5	0	0.0	1,010	2.4	1,643	2.1	1,246	1.2	2,130	2.0	6,278	1.8	
Self-pay only	159	2.3	244	3.4	2,001	4.8	2,140	2.7	3,456	3.3	5,819	5.6	13,819	4.1	

* Chi-square test

Table 24. 95% Confidence Intervals (CI) for Weighted Percentages of Expected Source of Payment, by Year

	1999 (n=7,073)	2000 (n=7,086)	2001 (n=41,345)	2002 (n=77,706)	2003 (n=103,328)	2004 (n=104,994)	Total (N=341,532)
	95% CI	95% CI	95% CI	95% CI	95% CI	95% CI	95% CI
Expected source of payment							
Private only	[35.3, 78.5]	[75.1, 95.1]	[69.5, 84.5]	[76.0, 87.3]	[78.6, 87.5]	[72.9, 82.2]	[77.2, 82.4]
Public only	[15.5, 59.1]	[2.7, 20.2]	[9.7, 21.7]	[8.1, 18.8]	[8.7, 16.0]	[10.9, 18.9]	[12.1, 16.5]
Private and Public	[0.0, 10.6]	[0.0, 0.0]	[0.0, 5.8]	[0.4, 3.9]	[0.5, 2.0]	[1.2, 2.9]	[1.1, 2.5]
Self-pay only	[0.0, 6.8]	[0.0, 8.1]	[0.1, 9.5]	[1.0, 4.5]	[0.6, 6.1]	[2.6, 8.5]	[2.6, 5.5]

4.3.6 Discharge Status

There was an increasing trend toward routine discharges for which patients were discharged to their home between 1999 and 2002, thus a smaller percentage of patients were discharged to either short-term or long-term facilities (Table 25). In 1999, 584 patients (8.5%) left against medical advice; however, the unweighted frequency (Table 5) is only 1 patient. For all years combined (1999-2004), 97% of the bariatric surgical patients had a routine discharge and deaths were rare (0.2%), and the percentage was lower for the last two years (0.1%), although the confidence intervals overlap for all years. Less than 4% of patients were transferred to short-term or long-term care facilities in any year.

Table 25. Weighted Frequencies of Discharge Status, by Year

	1999 (n=6,830)		2000 (n=7,227)		2001 (n=44,438)		2002 (n=83,714)		2003 (n=110,070)		2004 (n=111,739)		Total (N=364,018)		p value*
	n	%	n	%	n	%	n	%	n	%	n	%	n	%	
Discharge status															**<.0001**
Routine/discharged home	5,997	87.8	6,655	92.1	41,385	93.1	82,441	98.5	107,422	97.6	109,048	97.6	352,948	97.0	
Left against medical advice	584	8.5	0	0.0	88	0.2	0	0.0	0	0.0	11	0.0	683	0.2	
Discharged/transferred to short-term facility	0	0.0	111	1.5	0	0.0	0	0.0	0	0.0	541	0.5	652	0.2	
Discharged/transferred to long-term care institution	249	3.7	0	0.0	24	0.1	72	0.1	843	0.8	330	0.3	1,518	0.4	
Alive, disposition not stated	0	0.0	435	6.0	2,905	6.5	687	0.8	1,743	1.6	1,741	1.5	7,511	2.1	
Dead	0	0.0	26	0.4	36	0.1	514	0.6	62	0.1	68	0.1	706	0.2	

* Chi-square test

Table 26. 95% Confidence Intervals (CI) for Weighted Percentages of Discharge Status, by Year

	1999 (n=6,830)	2000 (n=7,227)	2001 (n=44,438)	2002 (n=83,714)	2003 (n=110,070)	2004 (n=111,739)	Total (N=364,018)
	95% CI	95% CI	95% CI	95% CI	95% CI	95% CI	95% CI
Discharge status							
Routine/discharged home	[70.6, 100]	[87.0, 97.1]	[90.4, 95.8]	[97.2, 99.7]	[95.2, 100]	[96.3, 98.9]	[96.0, 98.0]
Left against medical advice	[0.0, 24.8]	[0.0, 0.0]	[0.0, 0.6]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.03]	[0.0, 0.5]
Discharged/transferred to short-term facility	[0.0, 0.0]	[0.0, 4.6]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 1.3]	[0.0, 0.4]
Discharged/transferred to long-term care institution	[0.0, 11.0]	[0.0, 0.0]	[0.0, 0.2]	[0.0, 0.2]	[0.0, 1.8]	[0.0, 0.9]	[0.0, 0.8]
Alive, disposition not stated	[0.0, 0.0]	[2.3, 9.7]	[3.9, 9.2]	[0.0, 1.7]	[0.0, 3.7]	[0.7, 2.4]	[1.3, 2.9]
Dead	[0.0, 0.0]	[0.0, 1.1]	[0.0, 0.2]	[0.0, 1.5]	[0.0, 0.1]	[0.0, 0.2]	[0.0, 0.4]

4.3.7 Length of Hospital Stay

The length of hospital stay decreased from 1999 to 2004 (Table 27). In 1999 to 2002, more than half of the patients had a hospital stay of 3 or 4 days. In 2003 and 2004, most of the patients had a hospital stay of either 2 or 3 days. Prior to 2002, no hospital stay was less than a day and very few were only 1 day. Since 2002, while it remained very rare to have a hospital stay of less than 1 day, the percentage of people staying only 1 day jumped dramatically in 2002, and then nearly doubled by 2004 to 11.0%. At the other extreme, the percentages of patients staying more than a week were relatively constant from 2000-2004, ranging from approximately 4% to 6%.

Table 27. Weighted Frequencies of Length of Stay, by Year

	1999 (n=7,265)		2000 (n=7,227)		2001 (n=44,438)		2002 (n=83,714)		2003 (n=110,471)		2004 (n=111,758)		Total (N=364,873)		p value*
	n	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	
Days of care															**<.0001**
Less than 1 day	0	0.0	0	0.0	0	0.0	0	0.0	261	0.2	103	0.1	364	0.1	
1 day	14	0.2	0	0.0	133	0.3	4,776	5.7	7,049	6.6	12,167	11.0	24,139	6.7	
2 days	928	13.0	633	8.8	8,610	19.7	20,380	30.1	37,577	40.6	41,978	48.5	110,106	36.9	
3 days	2,215	43.5	3,510	57.3	16,857	57.6	32,918	69.4	40,120	77.0	30,671	76.0	126,291	71.5	
4 days	1,608	65.6	1,773	81.9	8,201	76.1	13,722	85.8	12,902	88.6	13,685	88.2	51,891	85.7	
5 days	797	76.6	472	88.4	5,443	88.3	6,808	93.9	4,662	92.9	4,146	91.9	22,328	91.9	
6 days	672	85.8	300	92.5	1,974	92.8	3,169	97.7	3,337	95.9	3,885	95.4	13,337	95.5	
7 days	198	88.5	192	95.2	632	94.2	581	98.4	1,259	97.0	990	96.3	3,852	96.6	
More than 7 days	833	100.0	347	100.0	2,588	100.0	1,360	100.0	3,304	100.0	4,133	100.0	12,565	100.0	
Days of care, mean		4.7		4.7		4.4		3.3		3.2		3.1		3.4	

* Jonckheere-Terpstra test for trend

Table 28. 95% Confidence Intervals (CI) for Weighted Percentages of Length of Hospital Stay, by Year

	1999 (n=7,265)	2000 (n=7,227)	2001 (n=44,438)	2002 (n=83,714)	2003 (n=110,471)	2004 (n=111,758)	Total (N=364,873)
	95% CI	**95% CI**	**95% CI**	**95% CI**	**95% CI**	**95% CI**	**95% CI**
Days of care							
Less than 1 day	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.6]	[0.0, 0.2]	[0.0, 0.2]
1 day	[0.0, 0.6]	[0.0, 0.0]	[0.0, 0.6]	[3.7, 7.7]	[4.8, 8.0]	[7.8, 14.0]	[5.4, 7.8]
2 days	[0.0, 25.7]	[0.0, 17.8]	[13.5, 25.2]	[18.9, 29.7]	[28.4, 39.7]	[32.6, 42.6]	[27.4, 33.0]
3 days	[12.0, 49.0]	[29.0, 68.2]	[30.1, 45.7]	[33.2, 45.5]	[30.8, 41.9]	[23.3, 31.6]	[31.8, 37.4]
4 days	[3.5, 40.8]	[7.4, 41.7]	[12.7, 24.2]	[11.7, 21.1]	[8.3, 15.1]	[9.1, 15.4]	[12.2, 16.2]
5 days	[0.0, 22.1]	[0.0, 14.1]	[7.0, 17.5]	[3.8, 12.5]	[2.4, 6.0]	[2.5, 5.0]	[4.7, 7.5]
6 days	[0.0, 19.3]	[0.0, 9.3]	[1.8, 7.1]	[0.7, 6.9]	[0.6, 5.5]	[1.8, 5.2]	[2.4, 4.9]
7 days	[0.0, 6.3]	[0.0, 6.2]	[0.0, 3.0]	[0.2, 1.2]	[0.2, 2.0]	[0.1, 1.7]	[0.6, 1.5]
More than 7 days	[0.0, 27.8]	[0.2, 9.4]	[2.0, 9.6]	[0.5, 2.7]	[1.4, 4.5]	[1.8, 5.6]	[2.5, 4.4]

4.4 LENGTH OF HOSPITAL STAY

4.4.1 Hospital Region

Length of hospital stay was examined by region to see if there were geographical differences (Table 29). The differences among hospital region were for very short stays or long stays. For example, the Northeast had the largest percentage of patients with stays less than 2 days (11.7%). However, percentages for those with hospital stays of 2-5 days were similar between regions. Stays of more than a week were rare in all regions, ranging from less than 2% in the South to 6.3% in the West. These differences may be due to regional differences in length of stay in general, or may reflect regional variations in types of patients or procedures.

Table 29. Weighted Frequencies of Length of Stay, by Hospital Region

	Northeast (n=85,439)		Midwest (n=67,967)		South (n=140,589)		West (n=70,878)		Total (N=364,873)		p value*
	n	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	N	Cum. %	
Days of care											**<.0001**
Less than 1 day	0	0.0	23	0.0	341	0.2	0	0.0	364	0.1	
1 day	10,038	11.7	846	1.3	9,540	7.0	3,715	5.2	24,139	6.7	
2 days	19,957	35.1	19,086	29.4	50,378	42.9	20,685	34.4	110,106	36.9	
3 days	28,662	68.7	29,608	72.9	40,473	71.7	27,548	73.3	126,291	71.5	
4 days	12,924	83.8	9,253	86.5	19,301	85.4	10,413	88.0	51,891	85.7	
5 days	5,511	90.2	3,513	91.7	10,704	93.0	2,600	91.7	22,328	91.9	
6 days	3,426	94.2	2,915	96.0	5,758	97.1	1,238	93.4	13,337	95.5	
7 days	1,586	96.1	521	96.8	1,504	98.2	241	93.7	3,852	96.6	
> 7 days	3,335	100.0	2,202	100.0	2,590	100.0	4,438	100.0	12,565	100.0	

* Poisson regression

Table 30. 95% Confidence Intervals (CI) for Weighted Percentages of Length of Stay, by Hospital Region

	Northeast (n=85,439)	Midwest (n=67,967)	South (n=140,589)	West (n=70,878)	Total (N=364,873)
	95% CI	95% CI	95% CI	95% CI	95% CI
Days of care					
Less than 1 day	[0.0, 0.0]	[0.0, 0.1]	[0.0, 0.6]	[0.0, 0.0]	[0.0, 0.2]
1 day	[9.6, 13.9]	[0.4, 2.1]	[5.1, 8.4]	[0.9, 9.6]	[5.4, 7.8]
2 days	[19.0, 27.7]	[22.5, 33.7]	[31.0, 40.7]	[21.8, 36.6]	[27.4, 33.0]
3 days	[28.9, 38.2]	[37.3, 49.8]	[24.4, 31.2]	[31.2, 46.5]	[31.8, 37.4]
4 days	[11.9, 18.4]	[10.1, 17.1]	[10.2, 17.3]	[9.5, 19.9]	[12.2, 16.2]
5 days	[4.2, 8.7]	[3.2, 7.2]	[4.5, 10.7]	[1.7, 5.6]	[4.7, 7.5]
6 days	[2.2, 5.8]	[0.7, 7.8]	[1.8, 6.4]	[0.3, 3.2]	[2.4, 4.9]
7 days	[0.6, 3.1]	[0.3, 1.3]	[0.3, 1.9]	[0.0, 0.6]	[0.6, 1.5]
More than 7 days	[1.8, 6.0]	[1.5, 5.0]	[1.1, 2.6]	[2.5, 10.0]	[2.5, 4.4]

4.4.2 Patient Age

The length of hospital stay differs by age (Table 31). For example, among those at least 60 years old, 38.2% had a hospital stay of more than 3 days, while only 23.9% of those less than 30 years had a hospital stay that long. However, the shortest stays of a day or less were more common in the oldest patients (11.3% of those at least 60 years old vs. 6% for those less than 30 years old). Although older patients have a shorter length of stay, a larger percentage of older patients undergo gastroplasty compared to younger patients, which is associated with a shorter length of stay. About 15.4% of patients at least 60 years old underwent gastroplasty, compared to 8.5% of patients less than 60 years old.

Table 31. Weighted Frequencies of Length of Stay, by Age Group (years)

	18-29 (n=46,039)		30-39 (n=111,627)		40-49 (n=114,125)		50-59 (n=79,927)		60+ (n=13,155)		Total (N=364,873)		p value*
	n	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	
Days of care													**<.0001**
Less than 1 day	23	0.1	118	0.1	12	0.0	211	0.3	0	0.0	364	0.1	
1 day	2,738	6.0	7,697	7.0	6,210	5.5	6,012	7.8	1,482	11.3	24,139	6.7	
2 days	16,765	42.4	37,422	40.5	32,741	34.1	20,853	33.9	2,325	28.9	110,106	36.9	
3 days	15,513	76.1	38,324	74.9	41,406	70.4	26,729	67.3	4,319	61.8	126,291	71.5	
4 days	4,504	85.9	16,203	89.4	14,805	83.4	13,447	84.1	2,932	84.1	51,891	85.7	
5 days	2,766	91.9	5,273	94.1	7,999	90.4	5,040	90.5	1,250	93.6	22,328	91.9	
6 days	2,425	97.2	2,301	96.2	5,941	95.6	2,542	93.6	128	94.5	13,337	95.5	
7 days	499	98.3	534	96.6	1,374	96.8	1,059	95.0	386	97.5	3,852	96.6	
More than 7 days	806	100.0	3,755	100.0	3,637	100.0	4,034	100.0	333	100.0	12,565	100.0	

* Poisson regression

Table 32. 95% Confidence Intervals (CI) for Weighted Percentages of Length of Stay, by Age Group (years)

	18-29 (n=46,039)	30-39 (n=111,627)	40-49 (n=114,125)	50-59 (n=79,927)	60+ (n=13,155)	Total (N=364,873)
	95% CI	95% CI	95% CI	95% CI	95% CI	95% CI
Days of care						
Less than 1 day	[0.0, 0.1]	[0.0, 0.3]	[0.0, 0.03]	[0.0, 0.8]	[0.0, 0.0]	[0.0, 0.2]
1 day	[3.2, 8.7]	[4.6, 9.2]	[4.0, 6.9]	[4.3, 10.8]	[5.4, 17.1]	[5.4, 7.8]
2 days	[28.0, 44.8]	[28.4, 38.7]	[23.5, 33.9]	[21.0, 31.2]	[6.6, 28.8]	[27.4, 33.0]
3 days	[26.3, 41.1]	[29.4, 39.3]	[30.8, 41.8]	[28.1, 38.8]	[19.6, 46.0]	[31.8, 37.4]
4 days	[5.7, 13.9]	[10.9, 18.2]	[9.7, 16.2]	[12.0, 21.6]	[10.1, 34.5]	[12.2, 16.2]
5 days	[3.0, 9.0]	[2.9, 6.5]	[3.7, 10.3]	[3.7, 8.9]	[0.0, 20.0]	[4.7, 7.5]
6 days	[0.0, 10.5]	[1.1, 3.0]	[2.4, 8.0]	[1.4, 4.9]	[0.0, 2.3]	[2.4, 4.9]
7 days	[0.0, 2.6]	[0.1, 0.8]	[0.2, 2.2]	[0.6, 2.1]	[0.0, 7.4]	[0.6, 1.5]
More than 7 days	[0.5, 3.0]	[1.3, 5.4]	[1.6, 4.7]	[2.5, 7.5]	[0.0, 5.2]	[2.5, 4.4]

4.4.3 Diagnoses

Table 33 shows length of stay by the number of diagnoses, not including “obesity” or “morbid obesity”. Diagnoses are considered instead of comorbidities because patients may have diseases and disorders other than the obesity-related comorbidities examined in this thesis that influence length of stay, including more severe diseases or conditions, complications during or after surgery, and adverse drug reactions. For those who had at most 1 diagnosis, more than 80% had a hospital stay of 3 days or less, while for those who had at least 6 diagnoses, only 58.2% had a hospital stay of 3 days or less. Nearly all patients (99.8%) with 0 or 1 diagnosis had a hospital stay of less than 1 week, while 10% of patients with 6 diagnoses had a hospital stay of at least 1 week. Hospital stays were shortest for those with 0 or 1 diagnosis, and increased among patients with more diseases. Patients with 6 diagnoses had the longest length of stay.

Table 33. Weighted Frequencies of Length of Stay, by Number of Diagnoses

	0 (n=25,890)		1 (n=32,417)		2 (n=49,043)		3 (n=49,393)		4 (n=52,953)		5 (n=44,947)		6 (n=110,230)		Total (N=364,873)		p value*
	n	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	N	Cum. %	n	Cum. %	n	Cum. %	n	Cum. %	
Days of care																	**<.0001**
<1 day	11	0.0	92	0.3	15	0.0	223	0.5	0	0.0	0	0.0	23	0.0	364	0.1	
1 day	3,639	14.1	2,741	8.7	5,214	10.7	3,378	7.3	3,692	7.0	2,119	4.7	3,356	3.1	24,139	6.7	
2 days	9,224	49.7	11,969	45.7	13,133	37.4	18,014	43.8	18,899	42.7	12,788	33.2	26,079	26.7	110,106	36.9	
3 days	8,295	81.8	11,155	80.1	19,166	76.5	17,794	79.8	16,754	74.3	18,426	74.2	34,701	58.2	126,291	71.5	
4 days	3,096	93.7	4,023	92.5	5,482	87.7	4,758	89.4	9,026	91.4	5,699	86.8	19,807	76.2	51,891	85.7	
5 days	1,239	98.5	1,837	98.2	3,920	95.7	2,650	94.8	1,989	95.1	1,703	90.6	8,990	84.3	22,328	91.9	
6 days	296	99.7	558	99.9	1,149	98.0	1,317	97.5	1,852	98.6	1,934	94.9	6,231	90.0	13,337	95.5	
7 days	0	99.7	28	99.9	819	99.7	377	98.2	99	98.8	457	96.0	2,072	91.9	3,852	96.6	
>7 days	90	100.0	14	100.0	145	100.0	882	100.0	642	100.0	1,821	100.0	8,971	100.0	12,565	100.0	

* Poisson regression

Table 34. 95% Confidence Intervals (CI) for Weighted Percentages of Length of Stay, by Number of Diagnoses

	0 (n=25,890)	1 (n=32,417)	2 (n=49,043)	3 (n=49,393)	4 (n=52,953)	5 (n=44,947)	6 (n=110,230)	Total (N=364,873)
	95% CI	95% CI	95% CI	95% CI	95% CI	95% CI	95% CI	95% CI
Days of care								
Less than 1 day	[0.0, 0.1]	[0.0, 0.8]	[0.0, 0.1]	[0.0, 1.3]	[0.0, 0.0]	[0.0, 0.0]	[0.0, 0.1]	[0.0, 0.2]
1 day	[9.2, 19.0]	[5.0, 12.0]	[6.8, 14.5]	[4.6, 9.1]	[2.2, 11.7]	[2.3, 7.1]	[1.4, 4.7]	[5.4, 7.8]
2 days	[26.9, 44.4]	[26.8, 47.1]	[19.2, 34.4]	[29.3, 43.6]	[27.1, 44.2]	[20.1, 36.8]	[19.2, 28.1]	[27.4, 33.0]
3 days	[23.9, 40.2]	[25.4, 43.4]	[29.7, 48.5]	[29.6, 42.5]	[24.1, 39.2]	[32.6, 49.4]	[26.7, 36.3]	[31.8, 37.4]
4 days	[5.9, 18.0]	[6.1, 18.8]	[6.2, 16.1]	[6.1, 13.2]	[11.1, 23.0]	[7.0, 18.4]	[14.0, 22.0]	[12.2, 16.2]
5 days	[0.9, 8.7]	[1.8, 9.6]	[1.3, 14.7]	[2.3, 8.5]	[1.3, 6.3]	[1.5, 6.1]	[5.7, 10.7]	[4.7, 7.5]
6 days	[0.0, 2.6]	[0.0, 3.7]	[0.6, 4.1]	[0.9, 4.4]	[0.0, 7.7]	[1.3, 7.3]	[2.7, 8.6]	[2.4, 4.9]
7 days	[0.0, 0.0]	[0.0, 0.3]	[0.0, 3.7]	[0.1, 1.5]	[0.0, 0.4]	[0.2, 1.9]	[0.8, 3.0]	[0.6, 1.5]
More than 7 days	[0.0, 1.0]	[0.0, 0.1]	[0.0, 0.7]	[0.0, 4.3]	[0.1, 2.3]	[0.3, 7.8]	[5.6, 10.7]	[2.5, 4.4]

4.4.4 Surgery Type

Table 35 shows that patients who had high gastric bypass had the longest hospital stays, followed by gastroenterostomy, then gastroplasty. More than 50% of patients who had gastroplasty had a hospital stay of 1 day or less, compared to 2.1% of high gastric bypass patients and 3.2% of gastroenterostomy patients. Lengths of stay were similar for high gastric bypass and other gastroenterostomy (Table 36), with the median for both being 3 days. Although 65.5% of other gastroplasty patients had a length of stay of 2 days or less, 5.3% had a length of stay of more than 7 days, a higher percentage than the other two surgical procedures. This association was expected since gastroplasty includes laparoscopic adjustable banding.

Table 35. Weighted Frequencies of Length of Stay, by Surgical Procedure

	High Gastric Bypass (n=202,315)		Other Gastroenterostomy (n=130,774)		Other Gastroplasty (n=31,784)		Total (N=364,873)		p value*
	n	**Cum. %**	**n**	**Cum. %**	**n**	**Cum. %**	**n**	**Cum. %**	
Days of care									**<.0001**
Less than 1 day	23	0.0	211	0.2	130	0.4	364	0.1	
1 day	4,183	2.1	3,975	3.2	15,981	50.7	24,139	6.7	
2 days	60,990	32.2	44,401	37.2	4,715	65.5	110,106	36.9	
3 days	77,557	70.6	44,843	71.4	3,891	77.7	126,291	71.5	
4 days	29,741	85.3	20,396	87.0	1,754	83.3	51,891	85.7	
5 days	12,416	91.4	7,951	93.1	1,961	89.5	22,328	91.9	
6 days	8,186	95.4	3,657	95.9	1,494	94.2	13,337	95.5	
7 days	2,709	96.8	965	96.7	178	94.7	3,852	96.6	
More than 7 days	6,510	100.0	4,375	100.0	1,680	100.0	12,565	100.0	

* Poisson regression

Table 36. 95% Confidence Intervals (CI) for Weighted Percentages of Length of Stay, by Surgical Procedure

	High Gastric Bypass (n=202,315)	Other Gastroenterostomy (n=130,774)	Other Gastroplasty (n=31,784)	Total (N=364,873)
	95% CI	**95% CI**	**95% CI**	**95% CI**
Days of care				
Less than 1 day	[0.0, 0.0]	[0.0, 0.5]	[0.0, 0.9]	[0.0, 0.2]
1 day	[1.3, 2.8]	[1.9, 4.2]	[42.2, 58.3]	[5.4, 7.8]
2 days	[26.2, 34.1]	[29.5, 38.4]	[9.0, 20.7]	[27.4, 33.0]
3 days	[34.3, 42.4]	[29.9, 38.7]	[8.7, 15.8]	[31.8, 37.4]
4 days	[11.9, 17.5]	[12.3, 18.9]	[2.6, 8.5]	[12.2, 16.2]
5 days	[4.0, 8.3]	[4.3, 7.9]	[1.5, 10.8]	[4.7, 7.5]
6 days	[2.1, 6.0]	[1.4, 4.2]	[1.4, 8.0]	[2.4, 4.9]
7 days	[0.6, 2.1]	[0.3, 1.1]	[0.0, 1.1]	[0.6, 1.5]
More than 7 days	[1.9, 4.5]	[1.8, 4.9]	[0.9, 9.7]	[2.5, 4.4]

4.4.5 Expected Source of Payment

Tables 37 and 38 shows that patients who were “self-pay only” had the shortest hospital stay, followed by “private only” and “public and private”. Patients with “public only” had the longest hospital stay. Nearly three-quarters of patients who paid with private insurance only had a hospital stay of 3 days or less, whereas only 2.5% stayed in the hospital longer than a week. Only 18.2% of patients who were expected to pay with only public insurance had a hospital stay of 2 days or less. Those who were expected to pay with only public insurance had a median hospital stay of 4 days, and almost 10% had a hospital stay of more than 7 days. Nearly 50% of patients who paid out of pocket had a hospital stay of 2 days or less, and no one who paid out of pocket had a hospital stay of more than 7 days. Self-pay patients were more likely to undergo gastroplasty (26.1%), compared to patients expected to pay with some type of health insurance (7.9%), which may help explain the difference in length of hospital stay.

Table 37. Weighted Frequencies of Length of Stay, by Expected Source of Payment

	Private only (n=272,609)		**Public only** (n=48,826)		**Public and Private** (6,278)		**Self-pay only** (n=13,819)		**Total** (N=341,532)		**p value***
	n	**Cum. %**	**n**	**Cum. %**	**n**	**Cum. %**	**n**	**Cum. %**	**n**	**Cum. %**	
Days of care											**<.0001**
Less than 1 day	272	0.1	80	0.2	0	0.0	12	0.1	364	0.1	
1 day	17,671	6.6	1,415	3.1	984	15.7	2,516	18.2	22,574	6.7	
2 days	91,615	40.2	7,410	18.2	912	30.2	6,763	48.9	104,184	37.2	
3 days	93,562	74.5	14,288	47.5	2,715	73.5	11,719	84.8	115,521	71.1	
4 days	36,884	88.0	11,931	71.9	133	75.6	12,602	91.2	49,831	85.6	
5 days	15,813	93.8	3,664	79.4	971	91.0	13,356	96.7	21,202	91.8	
6 days	7,673	96.7	4,351	88.4	214	94.4	13,663	98.9	12,545	95.5	
7 days	2,361	97.5	938	90.3	0	94.4	13,819	100.0	3,455	96.5	
More than 7 days	6,758	100.0	4,749	100.0	349	100.0	0	100.0	11,856	100.0	

* Poisson regression

Table 38. 95% Confidence Intervals (CI) for Weighted Percentages of Length of Stay, by Expected Source of Payment

	Private only (n=272,609)	**Public only** (n=48,826)	**Public and Private** (6,278)	**Self-pay only** (n=13,819)	**Total** (N=341,532)
	95% CI	**95% CI**	**95% CI**	**95% CI**	**95% CI**
Days of care					
Less than 1 day	[0.0, 0.3]	[0.0, 0.5]	[0.0, 0.0]	[0.0, 0.3]	[0.0, 0.2]
1 day	[5.4, 7.6]	[1.1, 4.7]	[5.1, 26.2]	[0.3, 35.9]	[5.4, 7.8]
2 days	[30.3, 36.9]	[8.9, 21.4]	[4.1, 25.0]	[14.0, 47.5]	[27.6, 33.4]
3 days	[31.1, 37.5]	[21.7, 36.9]	[23.1, 63.4]	[18.7, 53.0]	[30.9, 36.7]
4 days	[11.4, 15.7]	[16.8, 32.1]	[0.0, 4.7]	[0.0, 14.0]	[12.5, 16.7]
5 days	[4.2, 7.4]	[3.5, 11.5]	[1.2, 29.7]	[0.0, 13.2]	[4.7, 7.7]
6 days	[1.6, 4.0]	[3.3, 14.5]	[0.3, 6.5]	[0.0, 6.0]	[2.4, 5.0]
7 days	[0.4, 1.3]	[0.0, 3.8]	[0.0, 0.0]	[0.0, 2.9]	[0.5, 1.5]
More than 7 days	[1.6, 3.3]	[4.4, 15.0]	[0.0, 13.8]	[0.0, 0.0]	[2.4, 4.5]

4.4.6 Poisson Regression Models

A Poisson regression model, using sampling weights, was fitted to determine what variables are independently related to length of hospital stay after bariatric surgery. In Table 39, unadjusted and adjusted relative risks are shown with 95% confidence intervals for variables hypothesized to influence length of hospital stay. Hospital region, age, the number of diagnoses (other than obesity), surgical procedure, expected payment source, and year were all significantly related to length of stay.

The multivariable model included age, the number of diagnoses (other than obesity), surgery type, the expected source of payment, and year. Hospital region was no longer statistically significant nor did it significantly help the overall fit of the model, and thus region was dropped from the final model. In the adjusted model, the relative risk of a longer hospital stay was higher for age groups (40-49 years and 50-59 years) compared with the youngest age group, but lower for 30-39 year olds and those 60 years or more. Patients with more than 1 diagnosis have a higher risk of a longer hospital stay compared to patients with no diagnoses (having 1 diagnosis does not have a statistically significant higher risk than having no diagnoses). Patients with 6 diagnoses had the highest risk of a longer hospital stay (1.32 times) compared to patients with no diagnoses. Patients who had gastroplasty had a significantly lower risk of a longer hospital stay (RR=.80) compared to patients who had high gastric bypass. Patients who were expected to use only public insurance to pay for their surgery had a significantly higher risk (RR=1.25) of a longer hospital stay compared with those using only private insurance. Patients who were expected to pay out of pocket had a significantly lower risk of having a longer hospital stay compared to those who had only private insurance cover their surgery (RR=.88). The risk of having a long hospital stay decreased every year; the relative risk for year 2004 was 0.69, compared to 1999.

Table 39. Relative Risks (RRs) and 95% Confidence Intervals for Length of Hospital Stay

		Unadjusted		Adjusted	
	Group	**RR [95% CI]***	**p value**	**RR [95% CI]***	**p value**
Hospital region			**<.0001**		
	South	Ref	-	---	
	Northeast	1.05 [1.05, 1.06]	**<.0001**	---	
	Midwest	1.07 [1.06, 1.07]	**<.0001**	---	
	West	1.05 [1.05, 1.06]	**<.0001**	---	
Age (years)			**<.0001**		**<.0001**
	18-29	Ref	-	Ref	-
	30-39	1.00 [0.99, 1.00]	0.31	0.98 [0.97, 0.99]	**<.0001**
	40-49	1.07 [1.06, 1.08]	**<.0001**	1.03 [1.03, 1.04]	**<.0001**
	50-59	1.08 [1.08, 1.09]	**<.0001**	1.03 [1.02, 1.03]	**<.0001**
	60 +	1.09 [1.07, 1.10]	**<.0001**	0.93 [0.92, 0.95]	**<.0001**
Number of diagnoses			**<.0001**		**<.0001**
	0	Ref	-	Ref	-
	1	1.05 [1.04, 1.06]	**<.0001**	1.00 [0.99, 1.01]	0.68
	2	1.12 [1.11, 1.13]	**<.0001**	1.07 [1.06, 1.08]	**<.0001**
	3	1.10 [1.09, 1.11]	**<.0001**	1.06 [1.05, 1.07]	**<.0001**
	4	1.11 [1.10, 1.12]	**<.0001**	1.06 [1.05, 1.07]	**<.0001**
	5	1.22 [1.21, 1.23]	**<.0001**	1.11 [1.10, 1.12]	**<.0001**
	6	1.41 [1.40, 1.42]	**<.0001**	1.32 [1.31, 1.33]	**<.0001**
Surgical procedure			**<.0001**		**<.0001**
	High Gastric Bypass	Ref	-	Ref	-
	Other Gastroenterostomy	0.97 [0.96, 0.97]	**<.0001**	1.03 [1.03, 1.04]	**<.0001**
	Other Gastroplasty	0.75 [0.74, 0.75]	**<.0001**	0.80 [0.79, 0.80]	**<.0001**
Expected payment source			**<.0001**		**<.0001**
	Private only	Ref	-	Ref	-
	Public only	1.33 [1.32, 1.33]	**<.0001**	1.25 [1.25, 1.26]	**<.0001**
	Public and Private	1.07 [1.06, 1.09]	**<.0001**	1.06 [1.05, 1.08]	**<.0001**
	Self-pay only	0.86 [0.85, 0.87]	**<.0001**	0.88 [0.88, 0.89]	**<.0001**
Year			**<.0001**		**<.0001**
	1999	Ref	**-**	Ref	**-**
	2000	0.88 [0.87, 0.90]	**<.0001**	0.91 [0.90, 0.93]	**<.0001**
	2001	0.87 [0.86, 0.88]	**<.0001**	0.90 [0.89, 0.91]	**<.0001**
	2002	0.75 [0.74, 0.76]	**<.0001**	0.77 [0.76, 0.78]	**<.0001**
	2003	0.71 [0.70, 0.71]	**<.0001**	0.72 [0.71, 0.73]	**<.0001**
	2004	0.69 [0.68, 0.69]	**<.0001**	0.69 [0.68, 0.70]	**<.0001**

* Estimated using Poisson regression

To assess the overall fit of the final multivariable model, observed versus predicted values for length of hospital stay were plotted (Figure 5). The deviance per degree of freedom was 53.6278, which shows a large discrepancy between the observed and fitted values. Thus, while this model was the best fitting model, there is still a substantial lack of fit.

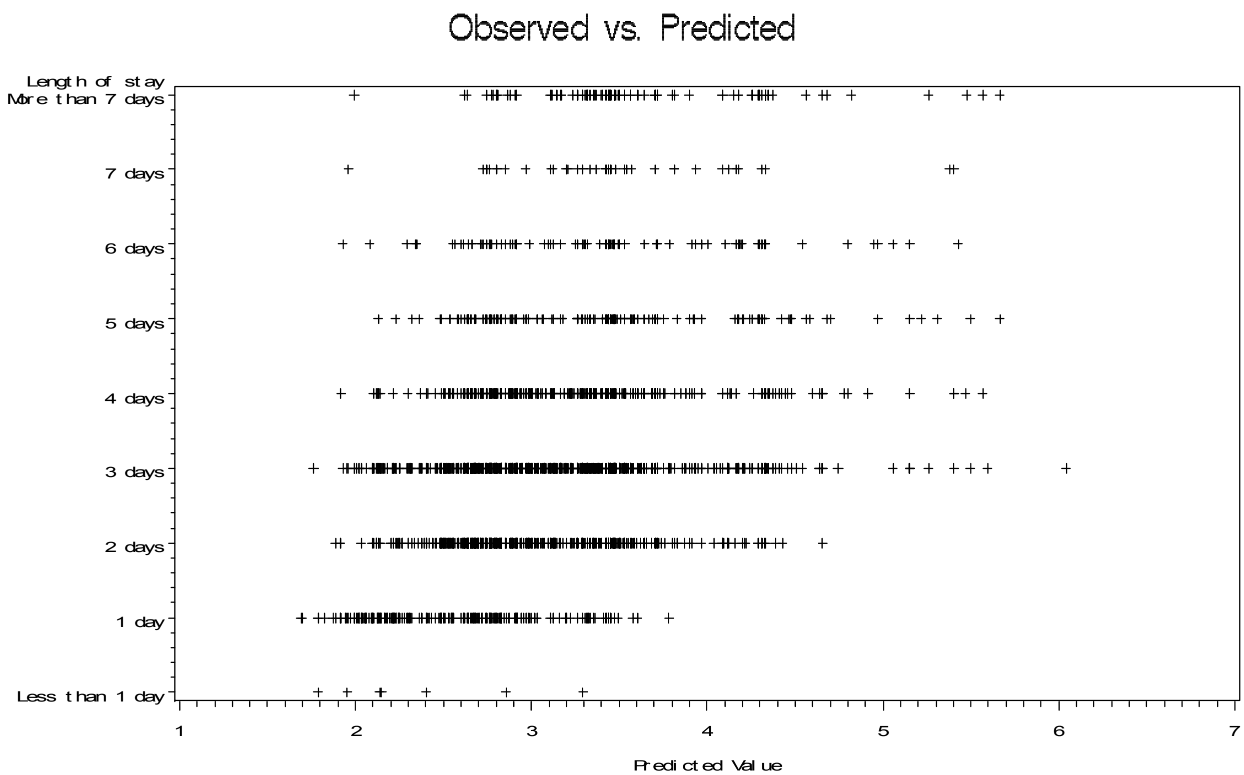

Figure 5. Plot of Observed vs. Predicted Values for Length of Stay

4.5 COMPARISON OF SEVERELY OBESE INDIVIDUALS IN THE U.S. POPULATION (NHANES) AND THOSE HAVING BARIATRIC SURGERY (NHDS) (2003-2004)

There were an estimated 9.7 million severely obese adults in the United States in 2003-2004, and only about 222,000 bariatric surgeries in the same time period (i.e., only 2.3% of the severely obese population in the United States had bariatric surgery in 2003 and 2004). Severely obese adults under the age of 30 and at least 60 years old were under-represented in the bariatric surgery population whereas those 30-49 years old were over-represented (Tables 40 and 41). The median age was only slightly lower for surgical patients compared to severely obese adults (41 vs. 43 years).

Compared to females, males were less likely to get surgery as 27.5% of the severely obese adults were male but only 15.7% of the bariatric surgical patients were male.

Table 40. Weighted Frequencies and Percentages for Age and Sex in NHDS and NHANES for 2003-2004

	Bariatric Surgery (N=219,031)		Severely Obese (N=9,668,475)		p value*
	n	Cum. %	n	Cum. %	
Age group (years)					**<.0001**
18-29	26,487	12.1	2,197,480	22.7	
30-39	70,477	44.3	2,128,673	44.7	
40-49	68,547	75.6	1,956,915	65.0	
50-59	46,694	96.9	2,112,765	86.8	
60+	6,826	100.0	1,272,642	100.0	
Age, mean, median		41.4, 41		43.0, 43	
	n	%	n	%	
Sex					**<.0001**
Male	34,303	15.7	2,657,910	27.5	
Female	184,728	84.3	7,010,565	72.5	

* Chi-square test

Table 41. 95% Confidence Intervals (CI) for Weighted Percentages for Age and Sex in NHDS and NHANES for 2003-2004

	Bariatric Surgery (N=219,031)	**Severely Obese (N=9,668,475)**
	95% CI	**95% CI**
Age group (years)		
18-29	[9.7, 14.4]	[16.5, 28.9]
30-39	[28.6, 35.7]	[15.8, 28.2]
40-49	[27.6, 35.0]	[13.7, 26.8]
50-59	[18.4, 24.2]	[15.3, 28.4]
60+	[2.1, 4.1]	[9.0, 17.3]
Sex		
Male	[12.8, 18.5]	[20.7, 34.3]
Female	[81.5, 87.2]	[65.7, 79.3]

About 95.5% of bariatric surgical patients were expected to use some type of health insurance to cover their surgery, whereas, almost 17% of severely obese individuals in the United States had no health insurance (Table 42). Over 80% of bariatric surgical patients had only private insurance and 13.7% had only public insurance cover their surgery. In the severely obese population, 54.6% had private insurance only, while 21.9% had only public insurance. Table 43 shows a significantly higher percentage of surgical patients with only private insurance, and significantly lower percentages of surgical patients with both private and public insurance compared to severely obese adults in the United States.

Table 42. Weighted Frequencies for Health Insurance in NHDS and NHANES for 2003-2004

	Bariatric Surgery (N=219,031)		**Severely Obese (N=9,668,475)**		**p value***
	n	**%**	**n**	**%**	
Insurance					**<.0001**
Private only	164,625	80.1	5,257,377	54.6	
Public only	28,229	13.7	2,109,391	21.9	
Private and Public	3,376	1.6	637,282	6.6	
*Self-pay/none***	9,275	4.5	1,621,707	16.9	
Missing	13,526	6.2	42,718	0.4	

* Chi-square test
** Self-pay only for NHDS and no health insurance for NHANES

Table 43. 95% Confidence Intervals (CI) for Weighted Percentages for Health Insurance in NHDS and NHANES for 2003-2004

	Bariatric Surgery (N=219,031)	**Severely Obese (N=9,668,475)**
	95% CI	**95% CI**
Insurance		
Private only	[76.8, 83.4]	[47.2, 62.0]
Public only	[11.0, 16.5]	[15.9, 27.9]
Private and Public	[1.1, 2.2]	[3.3, 9.9]
*Self-pay/none**	[2.4, 6.6]	[11.8, 21.9]

* Self-pay for NHDS and no health insurance for NHANES

5.0 DISCUSSION

The number of bariatric surgeries performed in the United States in short-stay non-Federal hospitals increased more than 15-fold from 7,265 in 1999 to 111,758 in 2004, reflecting the obesity epidemic and the recognition of the efficacy of bariatric surgery for sustained weight loss. Inasmuch as only a small percentage (2.3%) of severely obese adults actually received the surgery in 2003-2004, it is of interest to see what changes occurred with this rapid increase in procedures, specifically, the types of patients undergoing surgery and how they compare to the general population of people meeting the guidelines.

5.1 HOSPITAL CHARACTERISTICS WHERE BARIATRIC SURGERIES WERE PEFORMED

The South has a higher prevalence of obesity compared to other geographical regions in the United States (AOA, 2005). Using 2002 data from the Behavior Risk Factor Surveillance System databases, of the 5,024,058 severely obese adults aged 18-60 years, 40.6% were in the South, 24.4% were in the Midwest, and 19.4% were in the West, and 15.6% were in the Northeast (Poulose et al., 2005). Poulose et al. reported that the rate of bariatric procedures per 100,000 severely obese adults was highest in the Northeast and West, and lowest in the South and Midwest in 2002, for adults 60 years old or younger. This analysis found that 38.5% of bariatric surgeries were performed in the South, which may be associated with a larger percentage of severely obese adults living in the South in 2003-2004.

Birkmeyer et al. 2006, studied the Nationwide Inpatient Sample (NIS) in 2003, and found 77.3% of hospitals were non-profit and the median hospital bed size was 132 beds. In 2003, this analysis found a similar percentage of non-profit hospitals (75.2%) and the median hospital bed size grouping was 200-299 beds. One reason for the difference is because the hospital sampling frame was different for each survey. The NIS sampling frame was "community, non-rehabilitation" hospitals, and included hospitals from 37 states (HCUP, 2005). The NIS sampling design consisted of first stratifying hospitals based on region, ownership, bed size, location (urban or rural), and teaching status. They then took a random sample from each stratum. They did not have a minimum bed size requirement. Because the NHDS selected the largest PSU's with certainty and had a higher probability of selecting larger hospitals, this could account for why this thesis found a higher median bed size.

Note that hospital characteristics where bariatric surgeries were performed are not representative of all hospitals in the United States where bariatric surgeries were performed, because the sampling frame of NHDS includes only short-stay non-Federal hospitals. Also, some bariatric surgical procedures may not always require a hospital stay and thus are under-represented in the NHDS (e.g., laparoscopic adjustable banding). In a study of 400 consecutive patients who underwent laparoscopic adjustable banding in the U.S. from 2002 to 2004, about half (48%) had hospital stays (Watkins et al., 2005).

5.2 PATIENT CHARACTERISTICS

From 1999 to 2004, most of the bariatric surgical patients were 30-49 years old, with only small percentages in the youngest and oldest age groups. More than 77% had private health insurance. Overall, the majority of the bariatric surgeries performed were high gastric bypasses. People who undergo bariatric surgery commonly have obesity-related comorbities. For those with a BMI between 35 and 40 kg/m^2, the recommendation of the NIH Consensus Development Conference in 1991 was that there be the presence of "high risk" comorbidities to be eligible for bariatric surgery. Nearly three-quarters of surgical patients had at least 1 comorbidity. The most common comorbidities were hypertension (45.5%), sleep apnea (25.8%), and diabetes (21.8%). These percentages are similar to what other studies have reported.

5.3 COMPARISON OF SURGICAL PATIENTS AND ADULTS ELIGIBLE FOR SURGERY

Only 2.3% of severely obese individuals received bariatric surgery in 2003-2004. Most of the bariatric surgical patients were 30-49 years old, while there were a fairly even number of severely obese individuals in each of the age categories. About 27.5% of males were severely obese, while only 15.7% of bariatric surgical patients were male. Thus, severely obese individuals less than 30 years, at least 60 years, and males were under-represented in the bariatric surgery population (2003-2004). It could be that young adults do not have serious comorbidities yet or are still trying diet and exercise programs, and the adults in the oldest age group have contraindications for surgery.

Compared to the severely obese population, bariatric surgical patients were less likely to have only public insurance. Also, 16.9% of severely obese individuals did not have health insurance, but only 4.5% of bariatric surgical patients paid out of pocket. Many eligible adults can not afford to pay for the surgery or may think the cost of the elective surgery is prohibitive, although bariatric surgery may save long-term health care costs. Uninsured adults may be unaware of the benefits of bariatric surgery or may not even know they are eligible if they do not see a primary care physician for regular check-ups.

Encinosa et al., 2005, estimated that 0.6% of the 11.5 million eligible adults for bariatric surgery had obesity surgery in 2002. The "clinically eligible" population included all adults with a BMI > 40 kg/m^2 and diabetic adults with a BMI > 35 kg/m^2. In this analysis, the estimate was higher (2.3%) which could be because the number of bariatric surgeries increased in 2003 and 2004 more dramatically than the number of eligible adults, and/or because only severely obese adults (BMI > 40 kg/m^2) were included in the current analysis and not all who were considered eligible (BMI > 35 kg/m^2 with serious comorbid conditions or BMI > 40 kg/m^2). Encinosa et al., found that of the "clinically eligible" population, 31% were male, which was similar to the percentage of severely obese adults in NHANES for years 2003 and 2004 (27.5%). Comparing results from Livingston and Ko to this analysis, from 2000 to 2004, males and publicly-insured individuals were still under-represented in the bariatric surgery population. This justifies a greater need to critically evaluate why these individuals are still not getting surgery. There are variations in access to health care, and in how patients view health and appearance (Santry et al., 2007). In particular, men may be more resistant to weight loss interventions than women (Flum et al., 2007).

Santry et al., 2007, surveyed bariatric surgeons in the United States. They asked surgeons if they would operate given a hypothetical patient's age, race/ethnicity, sex, payment source, BMI, comorbidities, functional status, and social support. Social support was classified as either poor, adequate, or strong. From 820 surgeons surveyed, age, BMI, and social support were the most influential factors for patient selection. A 60-year old had a lower probability of being selected for surgery than a 37-year old. A patient with a higher BMI (55 kg/m^2) had a higher chance of being selected compared to a patient with a lower BMI (either 42 or 35 kg/m^2). Surgeons favored those with private insurance over public insurance. This could be because some studies link public insurance and low socio-economic status with poor outcomes (Santry et al., 2007). It is also possible that they had doubt that public insurances would sufficiently cover the cost of bariatric surgery. Flum et al., 2007, reported publicly insured patients in California had a wait time for bariatric surgery of more than 10 years. Santry et al. found that surgeons were less likely to select uninsured patients for surgery, perhaps this is because they are less likely to receive payments from individuals rather than from health insurances.

5.4 TEMPORAL TRENDS

The fifteen fold increase in the number of bariatric surgeries in only 3 years (2000-2003) is astounding. Reasons for the increase are largely due to an increase in the number of surgeons performing bariatric surgery, and media attention from celebrities publicly discussing their surgeries (Flum et al, 2007). This analysis found some of the same trends found in previous studies, i.e., an increase in the number of surgeries, the percentage of older patients, in comorbidities; and a decrease in length of hospital stay from 1999 to 2004. Like Smoot et al.

2006, using the NHDS, this analysis found a small increase in the percentage of females getting surgery.

There was an increase in the prevalence of nearly every comorbidity over the 6 years studied as well as an increase in the number of comorbidities patients had. It is unclear whether patients of the same size are sicker or whether the proportion of patients with a higher BMI (e.g., over 50 kg/m^2) increased in later years. A higher BMI is associated with having more comorbidities (LABS, 2008); however, BMI was not included in the NHDS.

There was a decrease in the percentage of high gastric bypass procedures and an increase in gastroenterostomy procedures. The percentage of gastroplasty surgeries doubled from 2003 to 2004. Laparoscopic adjustable bandings are increasing in popularity since the "LAP-BAND" was FDA approved in June, 2001 (FDA, 2001). The delay in the increase of gastroplasty surgeries from the approval of the "LAP-BAND" in 2001 to the explosion of gastroplasty surgeries in 2004, may be because surgeons had to first learn the procedure and become certified, and also patients may have become aware of it later or they may have at first been wary of the safety and efficacy of the newly approved procedure.

5.5 ERROR IN NHDS

In 2004, there was a suspicious difference in surgery type. The percentage of high gastric bypass surgeries and gastroenterostomy procedures were nearly reversed from percentages in 2003. NCHS was contacted and it was confirmed the numbers are correct as reported in the tables. However, it appears there was a coding problem in 2004, since it is not likely that the change in percentage of surgical procedures was real. High gastric bypass is reportedly still the most popular procedure in the United States, and thus, it is possible that some high gastric bypass surgeries were coded as gastroenterostomy. Hospital ID numbers were not included in the public-use dataset and thus changes in individual hospital coding could not be investigated. Gastroenterostomy and high gastric bypass are similar procedures as stated in the literature review, as gastroenterostomy includes other gastric bypass procedures. It is possible surgeries were miscoded, or coded differently for insurance reasons.

5.6 LENGTH OF HOSPITAL STAY

Length of stay increased with each additional diagnosis, with the highest risk of a long hospital stay for those with 6 diagnoses. Not counting the ICD-9 code for “obesity or “morbid obesity”, 6 diagnoses were the maximum allowed in the NHDS. Thus data were truncated at 6 diagnoses, and a further difference in length of stay for patients with more than 6 codes could not be detected for the 30.2% of patients who had 6 diagnoses codes other than “obesity”.

The probability of a longer hospital stay was greater for 40-59 year olds than 18-29 year olds, after controlling for the number of diagnoses, payment source, surgery type, and year. The oldest age group (60+ years) had a lower risk of a longer hospital stay compared to the youngest age group (less than 30 years). This is not surprising because older surgical patients often have a lower BMI compared to other age groups (LABS, 2008). A higher percentage of patients in the oldest age group received gastroplasty compared to younger age groups. Since laparoscopic adjustable banding does not reroute the digestive system and is only a restrictive procedure, it may be a safer procedure for older patients, short-term and long-term. Patients aged 30-39 years also had a slightly lower risk of a longer hospital stay compared to those less than 30 years. It could be that patients less than 30 years had more severe comorbidities and a higher BMI compared to 30-39 years olds, thus causing a longer hospital stay; however, severity of comorbidities was not assessed.

5.7 LIMITATIONS

A limitation of this analysis is that there were variables not captured that could be confounders (e.g., BMI, method of surgical procedure [lap. vs. open], severity of comorbidity, and race). A major limitation of this analysis is that BMI was not captured in the NHDS survey. Considering the presumably strong relationship between BMI and variables examined in this thesis regarding bariatric surgery. In a multi-center study of bariatric surgical candidates, higher BMI was associated with having more comorbidities (LABS, 2008). The LABS writing group also found males on average had higher BMIs than females, and an inverse relationship was found between age and BMI.

The analysis was done with the procedure and diagnosis codes that were available. Thus, it is possible to have missed some bariatric surgeries that were coded as other surgical procedures, or if there was not a diagnosis code for "morbid obesity", or "obesity" plus at least 1 comorbidity. If all diagnoses were not recorded, there would be an underestimation of the number of comorbidities and diagnoses the patient had.

There are more bariatric surgical procedures than the three found in the NHDS (e.g., biliopancreatic diversion [with and without duodenal switch]). Thus, in the years studied, there may have been inconsistent coding among newer surgeries as several procedures had to be coded to one of three surgery types. It was a limitation to not have data on specific procedures. The surgical method (open vs. laparoscopic) was also not captured, which can influence variables such as length of stay.

The variables in NHDS and NHANES were not perfectly comparable. For example, comorbidities could not be compared, and health insurance was assessed differently in each survey (i.e., in NHDS, expected source of payment instead of health insurance). Finally, race and ethnicity could not be included in the analysis, because of the large percentage of missing data. Therefore, patient characteristics could not be fully studied.

5.8 STRENGTHS

A major strength of this analysis is that data from national surveys were used. Sampling weights allowed national estimates to be calculated. This analysis is one of the only studies that compare severely obese individuals with bariatric surgical patients. Also, few studies have studied patient characteristics beyond just trends. NHANES measures height and weight, which provides a more accurate estimate of BMI, and thus the number of severely obese individuals, than studies that rely on self-reported weight or BMI. Studies can compare bariatric surgery characteristics of their study populations with results from this thesis.

5.9 CLINICAL SIGNIFICANCE

Variables were only tested for differences and trends that were hypothesized or based on prior research. Still, almost all differences tested were statistically significant. One potential reason for finding many statistically significant differences is due to relative unreliability of the estimates. The clustered data and stratified design increase the sampling variability of the estimates and reduce the precision of the estimates. The NCHS suggests estimates may not be reliable if they are based on fewer than 30 records or the relative standard error is greater than 30 percent (Dennison et al., 2000). The relative standard error is the standard error divided by the central estimate, multiplied by 100 (expressed as a percentage). The SUDAAN software can calculate specific standard errors; however, the "files needed to use SUDAAN have not been publicly released because they contain information that is confidential" (Dennison et al., 2000). Data needed to calculate standard errors include data on PSU's and hospitals, which may allow hospitals and patients to be identified. Thus, unweighted frequencies are shown for all variables by year, and certain variables may be less reliable that have categories with few records such as discharge status. Also, estimates for years 1999 and 2000 are based on few records, so estimates for these 2 years may be less reliable than later years.

Another reason why most associations tested were found to be statistically significant was because of the large sample. When the weights were applied to the sample to be representative of surgeries in the U.S., the sample size became very large, making the confidence intervals very narrow. While many statistically significant differences were found, it is important to differentiate between clinically significant and statistically significant differences. A test "may produce a statistically significant difference, yet be clinically meaningless" (Turk, 2000). "It is possible to identify a clinically unimportant effect as statistically significant by having sufficiently large samples" (Schulz et al., 2002). Evaluating statistically significant differences in order to determine clinical significance is crucial. The amount of change is the "most striking characteristic of the meaning of clinical significance" (Kazdin et al., 1999). Carefully examining frequencies, percentages, and confidence intervals for percentages helped determine what differences were socially significant (a component of clinical significance defined by Schulz et al. 2002, as "the extent to which outcomes are important to society"). There were some statistically significant differences that appeared to be due to only a small amount of change (e.g., age trends, trends in certain comorbidities [other chronic pulmonary disease, liver disease, and congestive heart failure]).

5.10 PUBLIC HEALTH SIGNIFICANCE

This analysis has great public health significance because it sheds light on where bariatric surgeries have been performed, who bariatric surgical patients are, and trends in these characteristics over recent years, as obesity surgery has become increasingly popular. Even though obesity and bariatric surgery rates are increasing substantially, still only a small percentage of severely obese adults get bariatric surgery. Many do not have health insurance, and they may not be able to afford to pay out of pocket. Others may not know of bariatric surgery or may be scared of risks, especially since the media can bring attention to adverse outcomes (Flum et al., 2007).

Flum et al. described the "lack of an equitable and rational system for delivering care an ethical and public health dilemma" (2007). Because bariatric surgery is the best treatment for sustainable weight loss in those with severe obesity and many comorbidities can improve and even be reversed, bariatric surgery should be available for everyone to improve health and increase quality of life.

Results from this thesis can help clinicians and policymakers see differences between surgical patients and the severely obese population and they can determine how to make changes to clinical practices or policies regarding eligibility and coverage of bariatric surgery. Clinicians and public health workers should make everyone eligible for surgery fully aware of the risks and benefits of bariatric surgery. Males and older adults with severe obesity were under-represented as bariatric surgical patients, and this did not change over time. Males and adults at least 60 years old may have more comorbidities, which may make them at an increased risk for surgical complications and thus they or their physicians decided they are not good candidates for surgery. However, it is also possible they are less often being considered for this life-saving procedure. The ratio of males to females receiving bariatric surgery did not seem to change very much over the years, which is a problem because males are under-represented in obesity surgery. The youngest and oldest age groups of the severely obese population were under-represented in those getting bariatric surgery, and there does not seem to be much change in later years.

Most of the surgical patients were covered by private insurance, leaving the percentage of patients who use only public insurance less than the percentage of severely obese adults with only public insurance and no sign of change through 2004. It is important to note, many public insurances did not have national coverage for bariatric surgery. For example, Medicare did not start national coverage for bariatric surgery until 2006 (ASBS, 2006). Before Medicare's new policy in 2006, the previous policy only covered gastric bypass surgery and vertical banded gastroplasty, and coverage was decided by region. The new policy covers laparoscopic and open gastric bypass, laparoscopic adjustable banding, and laparoscopic and open biliopancreatic diversion (with and without duodenal switch). There are no specific guidelines for proving failure in established weight loss programs (e.g., Weight Watchers). However, with the new policy, coverage is only provided if the bariatric surgery is performed at an American Society for Metabolic and Bariatric Surgery (ASMBS) Center of Excellence or American College of

Surgeons (ACS) Level One Center of Excellence. This change in the policy was to "optimize quality care" (ASBS, 2006). Many of the other health insurances may also have changed their policies regarding coverage of bariatric surgery in recent years.

5.11 FUTURE STUDIES

Several questions arise from this thesis. Since bariatric surgical patients are different from severely obese adults in the U.S. population and because the proportion of severely obese adults who get bariatric surgery is very small, to fully understand who is eligible and who undergoes bariatric surgery, further analysis may be needed. This thesis found that a higher percentage of older patients (60+ years) received gastroplasty compared to younger age groups. However, this may not be true among all bariatric surgical patients in the United States and needs to be investigated. Laparoscopic bands, which are a type of "gastroplasty", do not always require a hospital stay, and thus younger, healthier patients may have received laparoscopic bands but did not require a hospital stay and therefore were not included in the NHDS. Since there is high percentage of missing data for race, it may be of interest especially in light of access issues, to see how race/ethnicity in bariatric surgical candidates is associated with age, comorbidities, payment source, length of stay, and BMI. It would be interesting to know what patients' motivations are for getting surgery and analyze their motivation by patient characteristics (e.g., age, sex). It would also be intriguing to find out why most severely obese adults do not undergo bariatric surgery. Surveying adults who are eligible, or at least potentially eligible (without being screened by a multidisciplinary team), may shed light on why most severely obese adults are not getting bariatric surgery.

Given the limitations in using the NHDS (e.g., large percentage of missing race, lack of data on the specific type and method of surgical procedure, no data on outpatient procedures), there is a need for large, longitudinal studies to further study characteristics of bariatric surgical patients and their outcomes. This thesis only studied years through 2004, recent trends in bariatric surgery need to be analyzed (i.e., 2005 to the present).

5.12 CONCLUSIONS

The number of bariatric surgery has increased substantially from 1999 to 2004 (more than 15-fold). As the number of surgeries have increased, the percentage of patients who are less than 30 years old or 60 years old and older has increased; there was an increase in comorbidities; and the length of hospital stay decreased. A higher percentage of surgeries were being performed in the South. However, still only 2.3% of severely obese adults received the surgery in 2003-2004. Clinical practices and healthcare policies need to be reviewed in order to allow bariatric surgical candidates equitable care for severe obesity.

APPENDIX A

LIST OF ICD-9-CM CODES

Procedure codes:

ICD-9 codes used to determine bariatric surgeries:

44.31 High gastric bypass

44.38 Laparoscopic gastroenterostomy

44.39 Other gastroenterostomy

44.68 Laparoscopic gastroplasty

44.69 Other gastroplasty

44.95 Laparoscopic gastric restrictive procedure

44.96 Laparoscopic revision of gastric restrictive procedure

44.97 Laparoscopic removal of gastric restrictive device(s) (44.99)

*Of the procedure codes listed above, only 44.31 (High gastric bypass), 44.39 (Other gastroenterostomy), and 44.69 (Other gastroplasty) were found in the database.

Diagnoses codes:

Excluded from analysis was anyone with an abdominal neoplasm:

150.0-159.9 Malignant Neoplasm of Digestive Organs and Peritoneum

ICD-9 codes for obesity:

ICD-9 codes used to determine severe obesity:

278.01 Morbid obesity

ICD-9 codes used to determine obesity:

278.0 Overweight and obesity

278.00 Obesity, unspecified

278.01 Morbid obesity

ICD-9 codes for comorbidities:

ICD-9 codes used for hypertension:

401 Essential hypertension

401.0 Malignant

401.1 Benign

401.9 Unspecified

ICD-9 codes used for sleep apnea:

327.23 Obstructive sleep apnea

780.51 Insomnia with sleep apnea, unspecified

780.53 Hypersomnia with sleep apnea, unspecified

780.57 Unspecified sleep apnea

ICD-9 codes used for diabetes mellitus:

250 Diabetes mellitus

250.0 Diabetes mellitus without mention of complication

250.1 Diabetes with ketoacidosis

250.2 Diabetes with hyperosmolarity

250.3 Diabetes with other coma

250.4 Diabetes with renal manifestations

250.5 Diabetes with ophthalmic manifestations

250.6 Diabetes with neurological manifestations

250.7 Diabetes with peripheral circulatory disorders

250.8 Diabetes with other specified manifestations

250.9 Diabetes with unspecified complication

ICD-9 codes used for lipid disease:

272 Disorders of lipoid metabolism (272.0-272.9)

ICD-9 codes used for asthma:

493 Asthma (493.0-493.9)

ICD-9 codes used for liver disease:

571 Chronic liver disease and cirrhosis

571.4 Chronic hepatitis

571.5 Cirrhosis of liver without mention of alcohol

571.6 Biliary cirrhosis

571.8 Other chronic nonalcoholic liver disease

571.9 Unspecified chronic liver disease without mention of alcohol

572 Liver abscess and sequelae of chronic liver disease

572.0 Abscess of liver

572.8 Other sequelae of chronic liver disease

ICD-9 codes used for congestive heart failure:

428 Heart failure

428.0 Congestive heart failure, unspecified

428.1 Left heart failure

428.2 Systolic heart failure (428.20-428.23)

428.3 Diastolic heart failure (428.30-428.33)

428.4 Combined systolic and diastolic heart failure (428.40-429.43)

428.9 Heart failure, unspecified

ICD-9 codes used for ischemic heart disease (includes prior MI):

410 Acute myocardial infarction (410.0-410.9)

411 Other acute and subacute forms of ischemic heart disease (411.0-411.9)

412 Old myocardial infarction (412.0-412.9)

413 Angina pectoris (413.0-413.9)

414 Other forms of chronic ischemic heart disease (414.0-414.9)

ICD-9 codes used for kidney disease:

585 Chronic kidney disease (585.0-585.9)

586 Renal failure, unspecified

APPENDIX B

NHDS SURVEY

Medical Abstract—National Hospital Discharge Survey

OMB No. 0920-0212: Approval Expires 01/31/2000

Notice – All information which would permit identification of an individual or an establishment will be held confidential, will be used only by persons engaged in and for the purposes of the survey, and will not be disclosed or released to other persons or used for any other purpose. Public reporting burden of this collection of information is estimated to average 4 minutes per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. An agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it displays a currently valid OMB control number. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden to DHHS Reports Clearance Officer; Paperwork Reduction Project (0920-0212); Room 531-H, Hubert H. Humphrey Building, 200 Independence Avenue, SW; Washington, DC 20201.

FORM **HDS-1**
(5-12-99)

U.S. DEPARTMENT OF COMMERCE
BUREAU OF THE CENSUS
ACTING AS COLLECTING AGENT FOR
DEPARTMENT OF HEALTH AND HUMAN SERVICES
CENTERS FOR DISEASE CONTROL AND PREVENTION
NATIONAL CENTER FOR HEALTH STATISTICS

MEDICAL ABSTRACT – NATIONAL HOSPITAL DISCHARGE SURVEY

A. PATIENT IDENTIFICATION

1. Hospital number . . . . ☐☐☐☐

2. HDS number . . . . ☐☐☐☐

3. Medical record number ______________

4. Date of admission . . . . . Month ☐☐ - Day ☐☐ - Year ☐☐☐☐

5. Date of discharge . . . . . . Month ☐☐ - Day ☐☐ - Year ☐☐☐☐

6. Residence ZIP Code . . . . ☐☐☐☐☐

B. PATIENT CHARACTERISTICS

7. Date of birth — Month ☐☐ - Day ☐☐ - Year ☐☐☐☐

8. Age *(Complete only if date of birth not given)* . . . . Units ☐☐☐ — 1 ☐ Years; 2 ☐ Months; 3 ☐ Days

9. Sex *(Mark (X) one)* — 1 ☐ Male; 2 ☐ Female; 3 ☐ Not stated

10. Race — 1 ☐ White; 2 ☐ Black; 3 ☐ American Indian/Eskimo/Aleut; 4 ☐ Asian/Pacific Islander; 5 ☐ Other *(Specify)* ______________; 6 ☐ Not stated

11. Ethnicity *(Mark (X) one)* — 1 ☐ Hispanic origin; 2 ☐ Non-Hispanic; 3 ☐ Not stated

12. Marital status *(Mark (X) one)* — 1 ☐ Married; 2 ☐ Single; 3 ☐ Widowed; 4 ☐ Divorced; 5 ☐ Separated; 6 ☐ Not stated

13. Expected source(s) of payment

	Principal *(Mark one only)*	Other additional sources *(Mark all that apply)*
1. Worker's compensation	☐	☐
2. Medicare	☐	☐
3. Medicaid	☐	☐
4. Other government payments	☐	☐
5. Blue Cross/Blue Shield	☐	☐
6. HMO/PPO	☐	☐
7. Other private or commercial insurance	☐	☐
8. Self pay	☐	☐
9. No charge	☐	☐
10. Other *(Specify)* ______________	☐	☐

☐ **No source of payment indicated**

14. Status/Disposition of patient *(Mark (X) appropriate box(es))*

Status / Disposition

1 ☐ Alive → **a.** ☐ Routine discharge/discharged home
b. ☐ Left against medical advice
c. ☐ Discharged, transferred to another short-term hospital
d. ☐ Discharged, transferred to long-term care institution
e. ☐ Other disposition/not stated

2 ☐ Died

3 ☐ Status not stated

(Over)

C. FINAL DIAGNOSES (including E-code diagnoses) (ICD-9-CM codes may be entered if no narrative is available)

Principal: ______________________

Other/additional: ______________________

____

____

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____

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D. SURGICAL AND DIAGNOSTIC PROCEDURES (ICD-9-CM codes may be entered if no narrative is available)

Procedure	Date of procedure(s)		
	Month	Day	Year
Principal:			
Other/additional:			

☐ NONE

Completed by	Date

*U.S.GPO:1999-750-126/00039

FORM HDS-1 (5-12-99)

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