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The longitudinal trajectory of post-surgical % total weight loss among middle-aged women who had undergone bariatric surgery

Dong-Chul Seo [a,*], Chung Gun Lee [b], Mohammad R. Torabi [a], David K. Lohrmann [a]

[a] Department of Applied Health Science, Indiana University School of Public Health, Bloomington, IN, USA
[b] Department of Physical Education, Seoul National University, Seoul, South Korea

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ABSTRACT

Middle-aged women are at a higher risk of being obese. We examined the trajectory of post-surgical % total weight loss (%TWL) among middle-aged female bariatric patients. We fitted sequential generalized estimating equations models to analyze a sample of women who received bariatric surgery in 1995–2012, aged 40–65 years at the time of surgery (N = 158,292) whose pre-operative body mass index (BMI) was ≥30 kg/m^2 in the Bariatric Outcomes Longitudinal Database. The %TWL computed by 100% × (pre-surgery BMI − post-surgery BMI) / pre-surgery BMI showed different trajectories depending on type of surgery. For gastric banding, %TWL increased rapidly right after bariatric surgery and started to decrease around 1 year after surgery. For Roux-en-Y gastric bypass (RYGB) and sleeve gastrectomy, %TWL overall did not show remarkable changes from around 1 year after surgery. The highest increase in %TWL was observed in patients whose pre-operative BMI was 40 or higher and those who had undergone RYGB ($ps < 0.001$). Whereas the trajectories of %TWL among patients with sleeve gastrectomy and gastric banding did not differ much between different pre-operative BMI groups, the trajectories for RYGB were notably different between different pre-operative BMI groups ($ps < 0.001$). Middle-aged female bariatric patients are likely to achieve the highest %TWL if they receive RYGB and if their pre-operative BMI is 40 or higher. Further research is warranted to corroborate the present study's finding on the long-term effect of different types of bariatric surgery on %TWL among middle-aged women.

1. Introduction

More than one-third of U.S. adults aged 20 years or older are obese, (Flegal et al., 2012) posing a grave public health concern and hefty disease burden to U.S. society (Wang et al., 2011). According to a recent review, middle-aged women are at a higher risk of being obese because of the change in hormonal milieu during the menopausal transition (Davis et al., 2012). A study found in Latin American women that the menopause increased the risk of metabolic syndrome and abdominal obesity as much as by 18% (Royer et al., 2007) A decline in ovarian hormone among middle-aged women can generate metabolic changes and other symptoms that help gain weight (Davis et al., 2012; Royer et al., 2007). It has been reported that women with a higher body mass index (BMI) are more likely to experience vasomotor symptoms, which is one of the important features of climacteric disturbance (Da Fonseca et al., 2013). This warrants an effective weight-reduction intervention for middle-aged women.

Most traditional weight-reduction interventions such as behavioral modification programs and pharmacological therapies often result in short-term, not long-term, weight-loss (Karmali et al., 2013). By contrast, bariatric surgery has been reported as one of the most dependable methods of treating obesity, producing not only sustained weight-loss but also improvements in many obesity-related comorbidities (Buchwald, 2005; Valezi et al., 2010; Chang et al., 2014). As the number of people who receive bariatric surgery is rapidly increasing, it is important to have a good understanding of types of surgery or specific preoperative factors that may affect weight loss outcomes.

Several meta-analyses showed that mean weight loss varied by the type of bariatric surgery. The greatest weight loss occurred among patients who had undergone Roux-en-Y gastric bypass (RYGB); intermediate weight loss occurred among patients who had undergone gastroplasty, and the lowest weight loss occurred among patients who had undergone adjustable gastric band (Buchwald et al., 2004; Buchwald et al., 2009; Maggard et al., 2005). All the review studies and meta-analyses that compared % excess weight loss (%EWL) in bariatric patients indicate that patients with RYGB achieved higher %EWL

* Corresponding author at: Department of Applied Health Science, Indiana University School of Public Health, 1025 E. Seventh Street, Suite 116, Bloomington, IN 47405-7109, USA.
E-mail address: seo@indiana.edu (D.-C. Seo).

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than patients with adjustable gastric band (Buchwald et al., 2004; Buchwald et al., 2009; Garb et al., 2009; Franco et al., 2011; O'Brien et al., 2006; Tice et al., 2008) or sleeve gastrectomy.(Franco et al., 2011; Li et al., 2012).

Preoperative BMI was also found to have an important effect on weight loss outcomes among patients who had bariatric surgery (Livhits et al., 2012). The majority of previous studies that examined the association between preoperative BMI and weight loss after bariatric surgery showed a negative association (i.e., the heavier the patients, the lower the weight loss), whereas other studies found a positive or no association between the preoperative BMI and weight loss after bariatric surgery (Livhits et al., 2012). Interestingly, the majority of studies that showed a negative or no association between the preoperative BMI and weight loss were based upon %EWL measure (Livhits et al., 2012). To the contrary, most studies that showed a positive association between the preoperative BMI and weight loss were based upon absolute values of weight loss rather than %EWL (Livhits et al., 2012). The finding of a recent study is noteworthy that %EWL, computed by 100% × (initial BMI − nadir BMI) / (initial BMI − ideal BMI) with the ideal BMI reference point between 0 and 25 kg/m^2, is inappropriate as a weight-loss outcome measure in bariatric patients (van de Laar, 2012). Rather, the study argued that % total weight loss (%TWL), computed by 100% × (initial BMI − nadir BMI) / (initial BMI), should be used.(van de Laar, 2012) Thus, given that the present study investigated the dynamics of post-surgical longitudinal weight loss in bariatric patients that typically vary over time, the present study computed %TWL by 100% × (pre-surgery BMI − post-surgery BMI) / pre-surgery BMI and used such %TWL in examining weight loss in bariatric patients.

Few studies investigated trajectories of post-surgical %TWL in bariatric patients. More importantly, to date, no study has examined weight loss (%TWL) after bariatric surgery among middle-aged female patients who are more likely to gain weight than other ages due to hormonal changes (Davis et al., 2012; Royer et al., 2007). The purpose of the present study was to examine long-term (i.e., up to 5 years) trajectories of post-surgical weight loss in terms of %TWL among middle-aged women aged 40 to 65 years who had undergone bariatric surgery. Based on previous literature, it was hypothesized that trajectories of %TWL in middle-aged female bariatric patients would differ based on type of bariatric surgery and pre-surgical BMI level.

2. Methods

2.1. Data

The data of the present study was drawn from the Bariatric Outcomes Longitudinal Database (BOLD). The BOLD is the world's largest and most comprehensive database of clinical bariatric surgery patient information collected from diverse geographical and provider settings (Bariatric Outcomes Longitudinal Database (BOLD)). Surgical Review Corporation manages the BOLD and collects prospective data on all bariatric surgery patients treated by participants in the Center of Excellence in Metabolic and Bariatric Surgery (COEMBS) program (Bariatric Outcomes Longitudinal Database (BOLD)). Such bariatric patient information is delivered via a secure website and stored in the BOLD database system (Bariatric Outcomes Longitudinal Database (BOLD)). Data entry users appointed by provisional participants and surgeon designees in the COEMBS program are required within 30 days of each pre-, intra- and post-operative encounter to enter prospective data into BOLD (Bariatric Outcomes Longitudinal Database (BOLD)). The main aim of the BOLD is to examine short- and long-term outcomes of various kinds of bariatric surgery and to assess the relationship between these outcomes and patients' comorbidities, demographics, surgical and clinical characteristics, and pre- and post-operative treatment (Bariatric Outcomes Longitudinal Database (BOLD)).

A separate study sample (N = 158,292) was drawn from the BOLD for patients who met the following inclusion criteria: (Flegal et al., 2012) women aged 40 to 65 years on the day of bariatric surgery, (Wang et al., 2011) patients who received RYGB, sleeve gastrectomy, or gastric banding procedure for the first time (to avoid confounding due to multiple bariatric procedures given to a single patient), (Davis et al., 2012) pre-operative BMI ≥ 30 kg/m^2, (Royer et al., 2007) 100 cm ≤ pre- and post-operative height ≤ 210 cm (to minimize confounding due to extreme height), (Da Fonseca et al., 2013) 50 kg ≤ pre- and post-operative mass ≤ 400 kg (to minimize confounding due to extreme mass), (Karmali et al., 2013) z-score of % TWL < 3.3 (to minimize undue influence of outliers), and (Buchwald, 2005) 1 week ≤ follow-up period ≤5 years.

2.2. Measures

The dependent variable of the present study is %TWL which was computed by 100% × (pre-surgery BMI − post-surgery BMI) / pre-surgery BMI (van de Laar, 2012). The independent variables are time, type of bariatric surgery, and pre-surgical BMI group. Time was measured as the number of weeks that passed since a patient received her first bariatric surgery. The effect of quadratic and cubic time as well as linear time was examined. The examined type of bariatric surgery included the three most common bariatric procedures such as RYGB, sleeve gastrectomy, and gastric banding. Pre-surgery BMI was categorized into Class I obesity (30–34.9), Class II obesity (35–39.9), and Class III obesity (40 or above). Age at surgery and race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, and others) were included as demographic control variables. Age was calculated by subtracting birth date from surgery date.

2.3. Statistical analysis

All the variables were initially examined on their descriptive statistics and effect sizes (Cohen's *d*). Generalized estimating equations models with the autoregressive correlation structure were fit using SAS GENMOD procedure to examine the trajectory of post-surgical %TWL. By using REPEATED statement, the correlations within repeated measures were taken into account. To test the hypothesis that trajectories of %TWL in middle-aged female bariatric patients would differ based on type of bariatric surgery and pre-surgical BMI level, interaction effects as well as main effects were examined. Both two-way interactions ("time × type of surgery" and "time × pre-surgery BMI group") and three-way interactions (time × type of surgery × pre-surgery BMI group) were probed. Linear time variable was centered at the first week since surgery to help interpret analysis results. All the analyses were performed using SAS version 9.3 (SAS Institute Inc., Cary, NC).

3. Results

3.1. Descriptive statistics

Table 1 describes the characteristics of female patients aged 40–65 years who received bariatric surgery from 1995 to 2012. The mean %TWL was the highest among patients whose pre-operative BMI was 40 or higher and patients who had undergone RYGB. Patients whose pre-operative BMI was <35 and patients who had undergone gastric banding achieved the lowest mean %TWL. In terms of weight loss relative to standard deviation units (i.e., Cohen's d), however, patients whose pre-operative BMI was between 35 and 40 showed better results than the other two BMI groups. As for the type of surgery, patients who had undergone RYGB still showed better results than the other two types of surgery even in terms of Cohen's d of weight loss. The mean age of patients at surgery was 50.9 years. The mean and median follow-up periods, respectively, were 386 days (55 weeks) and 324 days (46 weeks). A total of 68,541 (43% of the sample) patients were followed up >1 year.