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Association between Health-Related Quality of Life and Body Mass After Adjustable Gastric Banding: A Nonlinear Approach

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ABSTRACT

Objective: To estimate the relationship between health utilities and body mass index (BMI) among a cohort of obese patients who underwent laparoscopic adjustable gastric banding (LAGB). **Methods:** We used a cross-sectional survey to ascertain demographic, clinical, and health utility data from patients who had undergone LAGB in Washington State from 2004 to 2010. The EuroQol five-dimensional (EQ-5D) questionnaire was used for health utility estimation. We calculated adjusted EQ-5D questionnaire indices across BMI categories by using a two-part model. We also used logistic regression to examine the relationship between BMI and the likelihood of reporting problems on each of the EQ-5D questionnaire dimension. **Results:** Data were obtained from 790 subjects. The mean adjusted EQ-5D questionnaire indices for all obese BMI categories were significantly lower than those in the normal weight category. The relationship between BMI and EQ-5D questionnaire indices was nonlinear. Respondents classified as morbidly obese II (BMI $>$ 50 kg/m^2) had the greatest decrement (−0.15, 95% confidence interval −0.28 to −0.01) in EQ-5D questionnaire indices. The association between EQ-5D questionnaire indices and BMI at the time of the survey was weaker after adjusting for weight loss after LAGB. Respondents with higher BMI were more likely to report having problems in the mobility, usual/activity, pain/discomfort, and anxiety/depression dimensions (trend test, $P < 0.05$), but not for the self-care dimension (trend test, $P = 0.08$). **Conclusions:** The EQ-5D questionnaire has a negative and nonlinear relationship with BMI for obese patients who had LAGB. The relationship is confounded by weight loss. Within the EQ-5D questionnaire dimensions, patients are more likely to report having problems in the mobility, usual/activity, pain/discomfort, and anxiety/depression dimensions in higher BMI categories, but not in the self-care dimension.

Keywords: EQ-5D, gastric banding, health-related quality of life, health utility, obesity.

Background

Laparoscopic adjustable gastric banding (LAGB) is a minimally invasive bariatric surgery for treating obesity. The procedure has increased in popularity from 1% of bariatric operations in 2004 to 29% in 2008 [1]. While weight loss is an important clinical outcome following bariatric surgery, patient-reported outcomes, such as health utility and health-related quality of life (HRQOL), are gaining traction, particularly for reimbursement decisions [2,3].

Despite the frequent use of health utility assessments in studies of obese patients, a number of gaps remain. First, although studies have measured health utilities by using the EuroQol five-dimensional (EQ-5D) questionnaire multiattribute utility index among obese patients [4–8], there is a paucity of data for people who are morbidly obese (body mass index [BMI] $>$ 40 kg/m^2). A common issue is that researchers have grouped obese and morbidly obese individuals into a single category, potentially introducing misclassification in their analyses [5–9]. A recent study has shown the statistical impact of grouping morbidly obese patients into a single category on mortality estimates [10]. To estimate health utility values for morbidly obese individuals, Campbell et al. [11] performed a linear regression to extrapolate health utilities for morbidly obese and super obese people. It is unclear, however, whether such linear extrapolation provides ideal health utility estimates.

Few studies have described the relationship between health utility, BMI, and the magnitude of BMI changes after bariatric surgery. Most importantly, none of the studies was conducted on obese patients who underwent LAGB. One published study used a hypothetical scenario to elicit how patients might value weight change in terms of patient preferences, but it did not assess actual health state preference or health utility following weight loss [12,13].

The goal of this study was to estimate the relationship between EQ-5D questionnaire indices and the BMI among a cohort of obese patients who underwent LAGB. Second, we

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sought to examine the relationship between the five dimensions of the EQ-5D questionnaire and each obesity category.

Methods

Data Collection

A cross-sectional survey [14] was created to collect data from patients who had LAGB surgery in Washington State from year 2004 to 2010. The survey contained the EQ-5D-3L questionnaire instrument [15] and questions on patients' demographics, height, weight, weight change since surgery, obesity-related comorbidities, insurance status, and type of band used. Comorbidities were ascertained by directly asking respondents whether they have obesity-related diseases (diabetes, hypertension, sleep apnea, urinary incontinence) or use any interventions to manage obesity-related conditions (i.e., home mobility device). Eligible participants were patients aged 18 years or older who had undergone LAGB at inpatient or outpatient surgical centers in Washington State. Surgical sites within Washington State performing LAGB were identified and recruited by contacting the surgeons who performed LAGB. Once a surgical site agreed to participate, patients eligible to receive mailing were identified. Patients were contacted by mail with the request to complete the survey. Each subject was assigned an ID for data entry. Round one of the survey mailing started in January 2010, which included a $2 monetary incentive and the survey. Additional rounds of the survey were sent out to patients who did not respond. In the end, a total of five rounds of the survey were completed. In addition, we separately obtained deidentified age information of the respondents at the time of surgery from the surgical sites. Approval from the University of Washington Institutional Review Board was obtained before the beginning of the data collection process.

Classifications of BMI Categories

We calculated the BMI by using respondents' self-reported height and weight measures. To compare EQ-5D questionnaire indices across BMI categories, we adopted the World Health Organization BMI classifications [16], with further stratification of the class III obesity into two additional morbid obesity categories. The categories included normal weight (BMI 19–24.99 kg/m^2), overweight (BMI 25–29.99 kg/m^2), class I obesity (BMI 30–34.99 kg/m^2), class II obesity (BMI 35–39.99 kg/m^2), class III obesity (BMI 40–44.99 kg/m^2), morbid obesity I (BMI 45–49.99 kg/m^2), and morbid obesity II (BMI $>$ 50 kg/m^2). BMI change was calculated by subtracting BMI before (baseline) LAGB surgery from BMI at the time of the survey (after LAGB surgery).

Valuation of EQ-5D Questionnaire Indices

The EQ-5D-3L questionnaire is a HRQOL instrument containing five dimensions (mobility, self-care, usual/activity, pain/discomfort, and anxiety depression) and a visual analogue scale. Each dimension has three severity levels: no problem, some problem, and severe problem. The responses to the five dimensions allow patients to be classified into 243 health states. To transform these health states into US population-based health preference weights, or health utilities, we used the valuation method of Shaw et al. [17], which asked the study respondents to value 13 of the 243 possible health states by using the time trade-off method. The EQ-5D questionnaire index measures health utility on a scale between 0 (death) and 1 (perfect health).

Descriptive Analysis

Descriptive statistics were used to describe respondents' age, gender, insurance status, presurgical BMI, BMI at the time of the survey, comorbidities, and the type of band used. Mean EQ-5D questionnaire indices were stratified by BMI categories and BMI changes.

Main Analysis

We first examined the relationship between BMI and EQ-5D questionnaire indices among patients who underwent LAGB. The dependent variable was the EQ-5D questionnaire index, and the primary independent variable was BMI at the time of the survey, coded as dummy variables according to World Health Organization BMI categories, with normal weight as the reference category. We adjusted for time since surgery, gender, insurance status, and the number of comorbidities. We were not able to adjust for age because age data were not linked to respondent surveys. Inspection of the distribution of EQ-5D questionnaire indices graphically showed that a high proportion of respondents had values of 1 and was left skewed (ceiling effects) [18,19]. When EQ-5D questionnaire data are nonnormal and exhibit ceiling effects, the standard linear model may yield inaccurate estimates regarding the relationship with BMI. We thus used a two-part model (TPM), which is a more flexible approach to address the ceiling effect and the left-skewed distribution. It had also been demonstrated that the TPM performed better than other models including censored least absolute deviation models or Tobit models in addressing ceiling effects of EQ-5D questionnaire data [19,20]. To estimate the TPM, we first used a logistic model to estimate the probability that EQ-5D questionnaire values were 1. We then used a generalized linear model with the log link function and Gaussian distribution to model EQ-5D questionnaire indices not equal to 1 to address the skewed distribution. The use of the generalized linear model also avoids potential difficulties of retransformation of the dependent variable [21]. The expected value of EQ-5D questionnaire indices for a given BMI category was then calculated by multiplying the probability of EQ-5D questionnaire indices not at 1 and the expected EQ-5D questionnaire indices given EQ-5D indices were not equal to 1. We also calculated marginal effects for each BMI category, which indicated the difference in EQ-5D questionnaire values for a given category relative to the normal and to the adjacent weight category. Ninety-five percent confidence intervals for marginal effects were estimated by bootstrapping (500 replications) [22].

Additional Analyses

To examine how weight change impacted the relationship between BMI and the EQ-5D questionnaire, we performed two additional analyses. First, we added BMI change as an additional covariate to determine whether it confounded the relationship between BMI and the EQ-5D questionnaire index. In addition, to examine the relationship between BMI and the likelihood of reporting problems on each of the EQ-5D questionnaire dimensions, we constructed five separate multiple logistic regression models for each of the five dimensions, adjusting for time since surgery, gender, insurance status, and the number of comorbidities. We dichotomized dependent variables by recoding EQ-5D questionnaire dimension measures as 0 for no problem and 1 for some problem or severe problem. We used the chi-squared test of trend to examine for association between the likelihood of reporting problems in each dimension as BMI. An alpha level of 0.05 was used to assess statistical significance. All statistical analyses were performed by using STATA 12.1 (StataCorp, College Station, TX).

Results

A total of 1556 surveys were distributed, and 790 surveys were returned (50.77% response rate). The mean time between surgery