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Predictors and Correlates of Follow-up Visit Adherence among Adolescents Receiving Laparoscopic Adjustable Gastric Banding

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Abstract

Background—Adherence behaviors have not been examined among adolescents undergoing laparoscopic adjustable gastric banding (LAGB). In addition, studies of youth receiving bariatric surgery have not considered the influence of psychopathology on postoperative adherence.

Objective—The purpose of this study was to evaluate predictors and correlates of adherence to post-surgery visits among a sample of adolescents undergoing LAGB.

Setting—Psychiatry Department, University Medical Center, United States.

Methods—Postoperative visits with surgical staff were analyzed over the two years following surgery (n= 101 adolescents). Growth mixture modeling examined trends in adherence.

Results—A three-class solution provided the best fit to the data. The classes from the final model were characterized by class 1 (61.6%) demonstrating high levels of adherence over the 24 months following LAGB, class 2 (28.5%) showing a more gradual decline in adherence, and class 3 (9.9%) with an accelerated decline in adherence. Higher levels of preoperative depressive symptoms and more preoperative episodes of loss of control over eating decreased the likelihood of adherence. Class 3 adolescents had significantly higher estimated 24-month body mass indices than Classes 1 or 2.

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Conclusions—Variable patterns of follow-up visit adherence were identified among adolescents receiving LAGB, which were predicted by depressive symptoms and loss of control over eating. The trajectory characterized by a rapid decline in adherence to follow-up visits was also associated with less weight loss.

Keywords

Bariatric Surgery; Adolescents; Adherence; Follow up; Laparoscopic Adjustable Gastric Banding

INTRODUCTION

Variability in weight loss is a significant clinical problem for both adults and adolescents undergoing bariatric procedures. Postoperative excess weight loss can fluctuate widely among adolescents (e.g., 4% 64%[1]), and for adults receiving laparoscopic adjustable gastric banding (LAGB), the majority evidence weight plateaus or regain starting approximately six months following surgery[2]. Adherence, or "the extent to which a person's behavior coincides with medical or health advice" (p. e475[3]) is a likely contributor to variable weight loss outcomes[4–8]. Adherence behaviors are important to the overall clinical management of individuals receiving bariatric surgery, as missing routine appointments results in suboptimal care, and failure to follow guidelines for diet or vitamin supplementation affects weight loss[6] and risk for malnutrition[9, 10]. However, extant research on bariatric surgery[4, 6, 8, 11–16] includes a range of different adherence behaviors (e.g., attendance at postoperative appointments or support groups, following recommendations for diet and physical activity or multivitamin therapy), which limits comparisons across studies. Additional research is needed to better understand modifiable factors affecting adherence.

Several studies have evaluated the influence of psychosocial variables on postoperative adherence behaviors among adults receiving bariatric surgery. Depressive symptoms, negative affect, and eating disorders, relate to postoperative adherence (e.g., self-reported adherence to postoperative diet, postoperative appointment attendance) in some studies[4, 6, 14, 17], but not others[12, 18]. Adolescence is a unique developmental stage characterized by notable rates of non adherence and the initiation of self-management of medical care for chronic illnesses[3, 19]. Among adolescents receiving bariatric surgery, adherence to postoperative diet is incomplete[9], and attendance at routine visits following gastric bypass declines over time[20]. To date, adherence behaviors have not been examined among adolescents undergoing LAGB. The relatively frequent visit schedule required for band adjustments post-LAGB may present a challenge to adherence generally, and for the adolescent population specifically. In addition, although psychological factors are well-documented influences on treatment adherence among adolescents with other chronic medical conditions[21–24], studies of youth have not considered the influence of psychopathology on post-bariatric surgery adherence.

Thus, the purpose of the study was to evaluate clinic appointment attendance in the two years following LAGB in a sample of adolescents, including rates and patterns of adherence to visits[3] within and across participants. The study also aimed to examine predictors and correlates of postoperative visit attendance. We predicted that subgroups demonstrating

different attendance patterns would be identified within the sample based on previous research demonstrating heterogeneity among adolescent surgical candidates (e.g., 25). In addition, we hypothesized that like adults receiving bariatric surgery[6, 14] or adolescents with chronic health problems[21–24], psychosocial problems such as elevated depressive symptoms, low levels of quality of life, and eating pathology would predict adherence post-LAGB. Further, as in adults receiving LAGB[7, 8], we hypothesized pre- and post-surgical adherence to clinic visits would be related to weight loss outcomes.

METHODS AND PROCEDURES

Participants

Participants were 101 adolescent candidates enrolled in a university hospital bariatric surgery program between August 2006 and December 2009. All adolescents received LAGB under an FDA approved Investigational Device Exemption. Primary eligibility criteria included: 1) age 14–17 years, 2) BMI > 40 kg/m^2 or > 35 kg/m^2 with serious comorbid conditions (e.g., Type II diabetes); 3) a 5-year or more history of obesity with failed attempts at diet and medical management for at least one year, and followed in the surgery program for at least six months; 4) for females, appropriate contraception and not planning to become pregnant in the year following surgery, 5) no medical contraindications for surgery, and 6) absence of current self-induced vomiting. Written informed assent and consent, respectively, were provided by adolescents and their parent(s) to receive LAGB and an Institutional Review Board reviewed and approved the protocol.

Procedures

Prior to surgery, adolescents and parent(s) met with the surgical staff for routine visits and completed at least one evaluation with a psychologist or psychiatrist, which included self-report assessments of psychiatric functioning and a clinical interview. Data from these visits with surgery and psychiatry were used as predictors of adherence in the current study. Detailed information about the pre-surgery assessments and clinical interview has been published elsewhere[26].

Predictors of Adherence to Clinic Appointments

Psychiatric Symptoms—Prior to surgery, adolescents completed the following assessments:

Beck Depression Inventory (BDI[27]): The psychometric properties of the BDI are well-established for measuring depressive symptoms in adolescents[28], and this assessment is commonly administered in studies of adolescents receiving bariatric surgery (e.g., 29, 30). The total score was used, with higher scores reflecting more depressive symptoms.

Pediatric Quality of Life Inventory (PedsQL[31]): The PedsQL is a 23 item measure of health-related quality of life, with the total score (used in the analyses described below) ranging from 0–100, with higher scores indicating better quality of life. The PedsQL total score is a reliable and valid measure of quality of life that discriminates between clinical and non-clinical populations[32].

Eating Disorders Examination-Questionnaire (EDE Q[33]) and/or Questionnaire on Eating and Weight Patterns-Revised (QEWP[34]): Adolescents completed the QEWP or EDE-Q, or both. The EDE-Q is a 38-item measure of eating disorder symptoms with adequate reliability and validity[35], which has been used for overweight youth[36] and adolescents with eating disorders[37]. The QEWP is a 28-item self report instrument with appropriate psychometrics (e.g., 38) designed to assess dieting and weight history, and symptoms of binge eating disorder. The QEWP measure of objective binge eating episodes has been used in other research on youth receiving bariatric surgery[29]. Only the EDE-Q assesses subjective bulimic episodes, or consuming an amount of food that is not objectively large, but is seen by the individual as large, with a sense of loss of control. This study utilized a composite variable based on objective or subjective bulimic episodes by EDE-Q or objective binge eating episodes from the QEWP to code the presence or absence of 'loss of control over eating' episodes, or any eating characterized by a loss of control regardless of the amount consumed[39].

Demographic variables—Age, gender, and race/ethnicity were obtained by clinical interview. Measures of height and weight were obtained during routine visits with the surgery staff, and were used to calculate body mass index (kg/m^2). Median household income was obtained from the 2000 US Census Bureau American Factfinder program (http://factfinder.census.gov) using the zip code for the participants' primary home address. Use of census-based data has been shown to be a valid method of overcoming the absence of information about socioeconomic status in medical records[40].

Distance from Clinic—Similar to other studies[11, 20], participants' home addresses were obtained from clinical charts, and Google maps determined the travel distance from the adolescent's home to the medical center campus.

Pre surgery visits with surgical staff—A chart review identified the total number of visits adolescents attended prior to surgery. The total amount of time between the adolescents' first visit with the surgical staff and LAGB was also calculated.

Outcome Measures

Measure of Clinic Appointment Attendance—By study protocol, routine appointments with surgical staff were scheduled to occur on 17 occasions, including: one week, two weeks, four weeks, six weeks, and twelve weeks post-LAGB and monthly thereafter for the initial 12 months, and then at 15, 18, and 24 months post-surgery. The clinic visit schedule was developed by the team's pediatric surgeon and pediatric endocrinologist, in consultation with adult bariatric surgeons and the medical center's diabetes treatment center, to ensure close medical monitoring of potential postoperative risk and diabetes management. Data from these visits were collapsed into 10 time-points to better reflect current clinical practice in our program, including: week two (week 1 or 2), week six (week 4 or 6), month three (month 3 or 4), month six (month 5 or 6), month eight (month 7 or 8), month 10 (month 9, 10, or 11), month 12 (month 12, 13, or 14), month 15 (month 15, 16, 17), month 18 (month 18, 19, or 20), and month 24 (month 22, 23, or 24).

Adherence was coded into four outcomes at each time point: (1) attending the visit within the expected time-frame; (2) attending the visit outside of the expected time-frame; (3) not attending the visit; and (4) not attending the visit and never returning for additional visits. The expected time-frame for attending visits was ± 7 days for weekly visits (week 1, 2, 4, 6, 12) and ± 14 days for monthly visits in the first postoperative year and the 15, 18, and 24 month visits. Adherence to time-frame was first determined for the 17 original expected visits and appointments were coded in only one time-point. After the visits were collapsed, priority was given to any on-time attendance within the 10 time-points.

Other summary variables, including the total number of visits attended with surgical staff over the two postoperative years, the number of visits attended within an expected time-frame, and time to drop-out were also examined. Drop-out was coded as the point at which an adolescent failed to return for any additional visits.

Body Mass Index—Post-LAGB height and weight were measured during routine visits attended with surgical staff.

Statistical Analysis

A series of growth mixture models (GMMs) estimated the trajectory of change in clinic appointment attendance over 24 months following LAGB, and classified similar participants into groups. Growth mixture models assume data that are not available (e.g., 24.5% of BMIs across time points when adolescents did not attend a clinic visit) are missing at random. Tests of baseline differences between participants with and without missing BMIs, and correlations between patterns of missingness and unobserved variables, were not statistically significant, which suggests that the missing at random assumption was appropriate. Growth for attendance was modeled as a single class using linear, quadratic, cubic, and via nonlinear spline. Best fit for the model was evaluated by considering lowest Bayesian Information Criterion (BIC). A statistically significant variance for the random intercept and slope provided evidence of population heterogeneity in patterns of attendance, and a visual inspection of the plotted trajectories for adherence confirmed this variability. Subsequently, GMMs with additional classes were tested (2–5 classes), with the number of classes for the final model selected by Lo Mendel-Rubin chi square tests, which evaluates the relative improvement in model fit for each increased number of classes, and entropy. After final GMMs were estimated, pre-operative covariates hypothesized to relate to post-surgery adherence were entered to examine their predictive value on class membership. We tested covariate influence using the Modal ML method[41] in Mplus using the 3STEP approach described by Asparohov and Muthen (2013; see http://www.statmodel.com/examples/webnotes/webnote15.pdf). The same methods were used to examine differences between groups on BMI at the end of 24-months as a distal outcome.

RESULTS

Demographic Characteristics

The sample was 28 males (27.7%) and 73 females (72.3%), with a mean age of 15.8 ± 1.1 years and average BMI of 47.8 ± 7.2 kg/m^2, and 34.7% classified as white (n = 35), 39.6%

classified as Hispanic/Latino (n = 40), 20.8% classified as African American (n = 21), and 5.0% classified as of another race (n = 5). Baseline mean total scores on the BDI and PedsQL were 9.0 ± 8.3 and 72.9 ± 15.2, respectively.

Growth Mixture Models

Lo-Mendel-Rubin chi-squares tests indicated a 3-class solution provided a significant improvement over the 2-class model and the best BIC and entropy of the 2–5 class models [3-class parameters=13, loglikelihood= 985.35, BIC=1996.69, entropy=0.887]. The three classes from this model are characterized by class 1 (61.6%) with high levels of adherence over the 2-year follow-up, class 2 (28.5%) showing a more gradual decline in adherence, and class 3 (9.9%) with an accelerated decline in adherence. The rate of change in adherence for class 3 (μ_{slope} = 0.86, SE = 0.19, $p < 0.001$) was greater than class 1 (μ_{slope} = −0.07, SE = 0.01, $p < 0.001$) and class 2 (μ_{slope} = −0.285, SE = 0.035, $p < .001$). The variance estimate for slope was not significant (VAR = 0.001, SE = 0.001, $p = 0.21$), indicating that the individual variability in adherence over time was accounted for by class membership. Figure 1 summarizes these trajectory changes in probability of dropout over time; probabilities of other types of adherence are available upon request. On average, adolescents attended 9.09 appointments (range of 2–17). Sixty adolescents were seen for a month 24 visit (months 22, 23, or 24), and the median time of drop-out among the 41 other adolescents was the month 10 visit (months 9, 10, or 11).

Baseline predictors were examined, including: gender, age, race/ethnicity, distance from treatment center, clinically significant symptoms (loss of control over eating, total BDI score, total PedsQL); Table 1 summarizes the effects of the final model of baseline covariates on these trajectories. The covariate effects indicate that change in adherence was significantly predicted by baseline total BDI score. For every 5 unit increase in BDI, the adherence rate decreased by a factor of 0.27. Loss of control over eating was also a significant predictor of class membership; reporting loss of control episodes increased the odds of being in the class characterized by early dropout (Class 3) by 3.51 relative to being classified as maintaining consistent adherence throughout follow up (Class-1). Other psychiatric and demographic variables were not significant predictors of either trajectory or rate of change in adherence over the 24 months of follow-up.

Twenty-four month post-surgery BMI significantly differed by group, with Class 3 having significantly higher estimated BMIs than Class 1 (Mdiff BMI = 4.23, SE = 1.13, $p < 0.001$) and Class 2 (Mdiff BMI = 2.57, SE = 1.15, $p < 0.05$). Class 1 did not significantly differ from class 2 (Mdiff BMI = 1.44, SE = 1.19, $p < 0.74$).

DISCUSSION

Adolescents attended an average of 53% of the expected clinic appointments with surgery staff over the two years following surgery. Modeled trajectories identified three distinct patterns among participants, including: (1) consistently high levels of attendance (Class 1); (2) a gradual decline in attendance (Class 2) and; (3) a more rapid decline in attendance (Class 3). Adolescents characterized by failing to attend visits soon after receiving LAGB had a significantly higher average BMI two years post-surgery in comparison to the other

subgroups. Change in adherence over time was significantly predicted by baseline total scores on the Beck Depression Inventory and loss of control eating episodes, with higher levels of depressive symptoms and the presence of loss of control eating associated with early dropout. In adults, postoperative adherence behaviors are affected by elevated depressive symptoms, negative affect, and the combination of mood and eating disorders[4, 6, 14, 17]. However, as described previously, no specific associations have been noted between binge eating and adherence outcomes[12]. In this study, other factors, including distance from the medical center, gender, and initial BMI were not significant predictors of adherence to clinic appointments. This finding contrasts studies of adults[42], but replicates the one other study of adolescents[20]. Unlike prior work with younger[20] and older[18] patients, age was not related to attendance.

The development of interventions for adolescents can be informed by our growth mixture models identifying three homogeneous subgroups of adolescents. In particular, the subsample of adolescents characterized by rapid failure to attend visits also reported increased baseline depressive symptoms and loss of control eating episodes. A focus on reducing pre operative loss of control eating episodes may also be useful to enhance clinical outcomes, as this symptom is an important clinical characteristic among severely obese youth in behavioral or surgical interventions. Loss of control eating appears to decrease the short-term effectiveness of family based treatment[43], and in addition to the effects on clinic appointment attendance noted above, also predicts short term post-LAGB weight loss among adolescents[44].

Similar to programs developed for other chronic illnesses in pediatric populations[45], obese adolescents[46–48], and adults receiving bariatric surgery[49], it might also be possible to capitalize on adolescents' affinity for novel technology to improve adherence. The development of smartphone or other Internet-based applications for post bariatric surgery monitoring has numerous advantages[49], including facilitating reminders about adherence and collection of self reported information when adolescents are not attending routine visits. Technology also facilitates connecting adolescents and their families across significant distances[3], which could increase support and investment in adherence behaviors. Although some support has been found for the impact of postoperative dietary counseling on adherence in adults[50], it is not yet clear whether intervening pre- or post-surgery would be more effective for increasing attendance at visits for adolescents; however, additional research could determine the optimal window to improve outcomes.

The current study was limited by the reliance on self-report measures, which can be affected by concerns about approval for surgery. Like previous research[20], only information about visit attendance was available for all participants, which is only one component of adherence[3], and it is possible that data on other aspects of postoperative behavior (e.g., adherence to nutritional recommendations) are more relevant in this population. In addition, the original protocol for clinic visits was potentially burdensome, as evidenced by only one adolescent (1.0%) attending all 17 expected appointments, and three of these appointments occurred outside the expected time-frame. The frequency of protocol visits may have resulted in lower rates of overall attendance. As aforementioned, different definitions of adherences are employed across studies (e.g., failure to attend appointment within three

weeks of when scheduled[11]; inability to follow diet/exercise recommendations, percent attendance at scheduled visits[8]; failing to modify eating behavior[12]; attendance at > or < 6 visits, number of visits[13], which complicates comparisons between this analysis and extant research on LAGB. The available predictors of adherence did not include variables that may be particularly important for adolescents, such as access to parental health insurance[20], parental barriers to escorting adolescents to visits, or other parental factors (e.g., BMI[51]). Further, by incorporating an assessment of a broader form of loss of control over eating (the EDE-Q), our measure of this construct was not consistent for all participants. This study also has several important strengths, including sample size, the inclusion of consecutively referred participants, and the duration of follow-up.

As all bariatric interventions carry risk for peri- and postoperative complications[10], surgical teams must weight potential costs and benefits, including risk for non-adherence, before approving an adolescent for surgery. Some distinctive clinical issues must also be considered for adolescents pursuing LAGB. Although LAGB is not approved by the FDA for use among individuals younger than 18, the reversibility, relative safety profile, lower risk of nutritional deficiencies[52], and improved weight loss outcomes in comparison to behavioral therapies[53], are advantages for this age group. However, LAGB also requires adherence to nutritional recommendations to avoid revisional procedures[53] and ongoing follow-up, which was not optimal in our sample. Adolescence presents unique and complex challenges for assessing and improving treatment adherence in bariatric surgery, and it is not yet possible to assess the potential for non-adherence on the basis of existing data. Additional research is needed to determine whether our results generalize to other surgical procedures, and to better understand predictors of the failure to adhere to postoperative treatment that may affect long term weight outcomes.

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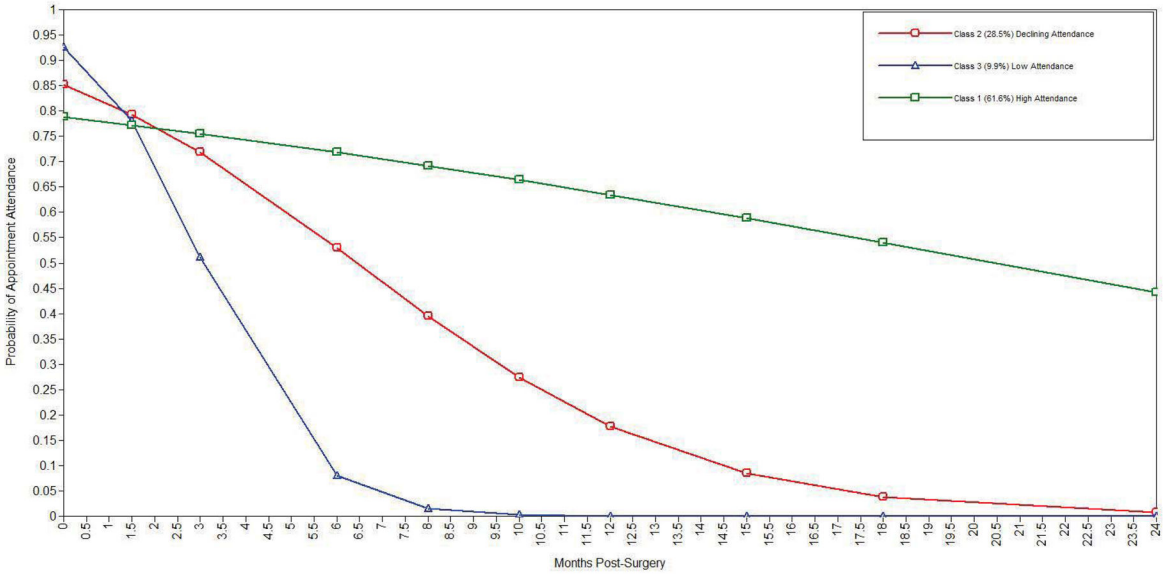

Figure 1.

Trajectory Change in the Probability of Dropout over the 24 Months following Laparoscopic Adjustable Gastric Banding among 101 Adolescents

Table 1

Summary of Baseline Predictors of Adherence Trajectory

	Slope	Class 1 versus Class 3	Class 2 versus Class 3
	β(SE)	β(SE)	β(SE)
Body Mass Index	−0.006 (0.004)	0.122 (0.363)	0.294 (0.198)
Presence of Loss of Control over Eating Episodes	−0.017 (0.018)	**1.27 (0.508)***	−0.609 (0.614)
Baseline Pediatric Quality of Life Scale Total Score	0.003 (0.010)	1.13 (1.33)	−0.545 (0.467)
Gender	−0.049 (0.027)	−6.47 (7.58)	0.061 (1.14)
Median household income by zip code	−0.005 (0.004)	−0.168 (0.510)	0.412 (0.226)
Baseline Beck Depression Inventory Total Score	**−0.027 (0.007)****	−1.61 (1.55)	−0.002 (0.262)

* $p < 0.05$,

** $p < 0.01$