A Latent Class Analysis of Psychiatric Symptoms among 125 Adolescents in a Bariatric Surgery Program

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Abstract

Objective—The purpose of this study was to examine whether subgroups could be identified among a sample of adolescents presenting for bariatric surgery.

Methods—Participants were 125 severely obese adolescents enrolled in a bariatric surgery program referred for a psychiatric evaluation. A latent class analysis was conducted with self-report and clinician-rated measures of depressive symptoms, total problems by the Youth Self-Report Scale, anxiety severity, eating pathology, psychiatric diagnoses, quality of life, and family functioning.

Results—A 3-class model yielded the best overall fit to the data. Adolescents in the "eating pathology" class demonstrated high levels of both eating disordered and other psychopathology. The second class, or "low psychopathology" class exhibited the fewest psychosocial problems, whereas adolescents in the third class were intermediate on measures of psychopathology, which is consistent with "non-specific psychopathology."

Conclusions—The latent class analysis identified homogeneous subgroups with different levels of psychopathology among a heterogeneous sample of severely obese adolescents. The identification of clinically relevant subgroups in this study offers an important initial means for examining psychopathology among adolescent bariatric surgery candidates and suggests a number of avenues for future research.

Keywords

obesity; adolescents; bariatric surgery; psychopathology; latent class analysis

INTRODUCTION

With overweight and obesity among children and adolescents reaching epidemic proportions, it is crucial to understand the effects of excess weight on physical and mental health. In general, there is limited evidence that overweight or obese children and adolescents are at elevated risk for psychopathology. However, in comparison to their

normal-weight peers in the community, obese adolescents seeking treatment appear to be at risk for psychosocial problems (1–3). Certain pathological eating behaviors, like binge eating episodes, may also affect the onset of obesity (4), and the perception of loss of control during eating episodes among obese youth has been associated with excessive body weight gain (5). Consistent with these data, and similar to adults (6), severely obese adolescents presenting for weight loss surgery exhibit depressive symptoms, increased frequency of abnormal eating behaviors including binge eating, and impaired health-related quality of life (7, 8).

Behavioral and cognitive-behavioral treatments for obesity, including family-based approaches, are effective in reducing overweight among children and adolescents (9). However, weight reductions are modest (9, 10), largely not maintained over the long term, and less effective for severe obesity (11). The effect of psychological factors on outcome in obesity treatment programs is not clear. Some research suggests a negative association with weight loss (e.g., 12) while other studies fail to identify a relationship between psychiatric symptoms and weight loss (13–15). A recent study examined whether baseline characteristics, including psychopathology, predicted response to an inpatient CBT intervention following the identification of homogeneous groups among a heterogeneous sample of treatment-seeking overweight youth (16). Weight loss following the intervention did not differ between groups. However, subtypes characterized by dietary restraint and internalizing symptoms or internalizing symptoms alone had greater increases in weight during the follow-up period in comparison to a non-symptomatic group, which suggests that identifying subgroups within a larger population of obese adolescents may help to elucidate the relationship between psychopathology and treatment outcomes.

Surgical intervention is the most common treatment for severe obesity in adult patients. With refinements in surgical procedures and the potential for substantial weight loss, bariatric surgery has become an option for seriously overweight adolescents (17–21). Adolescents currently constitute only a very small proportion of the total number of bariatric surgeries (0.73%), but these procedures have increased significantly among adolescents in recent years (22). With studies indicating positive health outcomes among younger populations (e.g., 21, 23), it is likely that the number of adolescents receiving weight loss surgery will continue to grow. The prevalence of psychological symptoms among obese treatment-seeking youth, and the increasing popularity of bariatric surgeries for adolescents suggest that psychologists and psychiatrists will be required to assess adolescent candidates for surgery and help identify factors predictive of optimal surgical outcomes. Best practice guidelines for pediatric and adolescent bariatric surgery suggest the involvement of a mental health professional on multidisciplinary teams evaluating adolescents pre-surgery, and conducting specific assessments of quality of life, depression, and eating disturbances (24). However, current standards for adolescent patient selection still reflect primarily clinical judgment.

The purpose of the current study was to use latent class analysis (LCA) to examine whether subgroups of adolescents could be found among a sample of adolescents presenting for bariatric surgery with cross-sectional data. If the LCA identified clinically interpretable subgroups, future research could be undertaken to replicate and extend these findings. On the basis of prior studies of severely obese adolescents considering bariatric surgery, we hypothesized that the LCA would identify three distinct subgroups of adolescents, including adolescents without psychopathology, and subgroups characterized by greater psychopathology and abnormal eating behaviors (7, 8). Previous research observed that adults classified as seriously overweight (e.g., Class III Obesity, body mass index [BMI] ≥ 40 kg/m^2) presenting for bariatric surgery were significantly more likely to report psychiatric symptoms than less obese treatment seeking individuals (BMI of 30.0 to 39.9 kg/

m^2; 25). We therefore hypothesized that subgroups characterized by more psychiatric symptoms would also have higher BMIs, and we also conducted exploratory analyses to evaluate if age, gender, ethnicity, or socioeconomic factors predicted latent class membership.

METHODS

Participants

Participants were severely obese adolescents enrolled in the Center for Adolescent Bariatric Surgery (CABS) program at the Morgan Stanley Children's Hospital of New York Presbyterian/Columbia University Medical Center (CUMC). The CABS program has an FDA approved Investigational Device Exemption to perform this procedure on individuals younger than 18. The main eligibility criteria for adolescents include: 1) age between 14 and 17 years when enrolled, 2) BMI > 40 kg/m^2 or BMI > 35 kg/m^2 with serious comorbid conditions (e.g., Type II diabetes, hypertension, sleep apnea); 3) a history of obesity for at least five years, including failed attempts at weight loss treatment (e.g., diet and medical management) for one year, and followed at CUMC for at least six months; 4) among females, appropriate contraception and not planning to become pregnant over the year following surgery, 5) absence of medical contraindications (e.g., anomalies of the gastrointestinal tract, etc.), and 6) absence of current self-induced vomiting.

Procedures

All candidates were first evaluated by the surgical team, who described the procedures, potential risks and benefits, and obtained written informed consent and assent from the parent(s) and adolescent, respectively. Eligible individuals were subsequently referred for a psychiatric evaluation. Data were derived from 125 consecutive evaluations conducted between February 2006 and June 2009.

Adolescents completed self-report questionnaires and a clinical interview with a psychologist or psychiatrist. All adolescents were able to speak, read, and write English. At least one parent also completed assessments, and Spanish-speaking parents were provided with Spanish versions of assessments when available. The CUMC Institutional Review Board reviewed and approved the research protocol.

Demographic Characteristics—Weight and height were measured during routine visits to the CABS program. Information about median household income and percentage of households below the poverty level was obtained from the 2000 US Census Bureau American Factfinder web program (http://factfinder.census.gov) using the zip code of the primary home address for each participant. Other variables (e.g., age, sex) were obtained by interview.

Self-Report Measures

Beck Depression Inventory (BDI; 26): The BDI is a reliable and valid (27) 21-question measure of depressive symptoms, and a total score can be generated by summing the items. The Beck Depression Inventory is a common assessment in studies of adolescents both pre- and post-bariatric surgery (7–8; 17; 28–29).

Eating Disorders Examination-Questionnaire (EDE-Q; 30) and Questionnaire on Eating and Weight Patterns-Revised (QEWP; 31): The EDE-Q is a 38-item measure of eating disorder symptoms over the 28-day period before the completion of the questionnaire. The measure was originally developed for adults, and has demonstrated good internal consistency in this population (32); however, normative data for this questionnaire are

available for adolescent girls (33), and this measure has been used for adolescents with eating disorders (34, 35). The QEWP is a 28-item self-report instrument with appropriate psychometric data (e.g., 31, 36, 37) designed to assess dieting and weight history, and symptoms of binge eating disorder. The adult version of the measure was used in this study, and the two questions analyzed as a measure of binge eating (questions 10 and 11) for this study are slightly modified for the adolescent version of the QEWP (38). These questions were also used to assess binge eating in one previous study of youth receiving bariatric surgery (7).

Adolescents completed the QEWP (n=80), EDE-Q (n=42), or both (n=13) as a measure of loss of control eating episodes. Both the EDE-Q and QEWP measure the frequency of binge eating episodes, or the consumption of an objectively large amount of food with a sense of loss of control. However, 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, which may be particularly important for obese populations (5).

Family Environment Scale (FES; 39): The FES is a well-validated (40) 90-item true/false questionnaire assessing family functioning as perceived from the teen or parent's perspective. For the analyses described below, the subscales of the Family Relationships Index of the FES (Cohesion, Expressiveness, and Conflict subscales) were used. Questions from the Cohesion subscale assess the level of commitment, help, and support family members provide one another; the Expressiveness subscale measures the degree to which family members are encouraged to directly express their feelings; and the Conflict subscale evaluates the open expression of anger among family members.

Multidimensional Anxiety Scale for Children (MASC; 41): The MASC is a 39-item measure that uses a four-point scale to rate the frequency of a range of anxiety symptoms in children and adolescents. A total raw anxiety score can be obtained, which has good internal consistency (41).

Pediatric Quality of Life Inventory (PedsQL; 42): The PedsQL is a 23-item measure of health-related quality of life, which includes both an adolescent self-report and a parent-proxy version for ages 13 to 18. Scaled scores, including the total score used in the analyses described below, are standardized and range 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 with the advantage of discriminability between clinical and non-clinical populations (43).

Youth Self-Report (YSR; 44) and Child Behavior Checklist (CBCL; 44): The CBCL provides parent descriptions of adolescent competencies and emotional and behavioral problems, and the YSR measures parallel items from the adolescent perspective. Both assessments produce standardized *t* scores (mean: 50; standard deviation: 10), and the total problems score of the YSR and CBCL has good internal consistency (44).

Clinical Interview—Clinical interviews were conducted by a psychologist or psychiatrist with the candidates and at least one parent. A semi-structured interview template was developed by two of the authors (RS, MJD), and assessed domains including: demographic characteristics, motivation for weight loss surgery (adolescent and parent), compliance with requirements of the surgical program (adolescent and parent), a weight history, eating disorder psychopathology, psychiatric symptoms including current *Diagnostic and Statistical Manual of Mental Disorders-IV* (DSM-IV; 45) Axis I diagnoses, a school and social history, and family history of medical and psychiatric problems (adolescent and parent).

Statistical Analyses

Summary data are presented as total number, mean ± standard deviation, or as a percentage for categorical data.

Latent Class Analysis—Subgroups among the 125 adolescents were evaluated using latent class analysis (LCA). Latent class analysis assumes that a latent or unobserved variable (e.g., psychopathology) can explain the relationship of observed variables within a population (46; e.g., depressive symptoms, quality of life). For dichotomous indicators, distinct item endorsement probabilities represent each latent class, whereas for continuous indicators, estimated means are represented by profiles of thresholds. These probabilities or estimated means form unique profiles for each subgroup, and comparisons are made between different LCA models to determine the most appropriate model using fit statistics.

*M*plus version 5.1 (47) was used to fit 2- to 4-class models, and covariates were subsequently entered into the mixture model to improve the fit and estimate the effects of these variables on class membership. Adolescents can also be classified using posterior class probabilities, which estimates likely subgroups within the sampled population. Goodness-of-fit were measured using Bayesian Information Criterion (BIC; 48) and Akaike's Information Criterion (AIC; 49, with lower numbers indicating better fit. The best fitting model was selected after considering AIC, BIC, classification quality (e.g., entropy value), and likelihood ratio chi-square. The adjusted Lo-Mendel-Rubin loglikelihood ratio test compared successive models, and the model with a significant loglikelihood ratio indicated a larger number of classes provided a better fit to the data. Correlations between residual covariances for observed indicators were examined to evaluate assumptions of local independence, or assumptions that observed variables are uncorrelated within each class.

The primary indicators used in the LCA were chosen on the basis of previous research or clinical relevance. Specifically, LCA indicators included total scores for the YSR, CBCL, PedsQL, BDI, and MASC. Dichotomous indicators for current night eating symptoms or any DSM-IV diagnosis by clinical interview were also included. In addition, the Family Relationships Index was used as an indicator and index of the quality of social relationships in the family environment. Binge eating episodes as measured by the QEWP or EDE-Q and subjective bulimic episodes from the EDE-Q were used as indicators of loss of control eating.

Covariates—Several covariates were evaluated in the LCA, including: age, sex, ethnicity, BMI, median household income, and percentage of households below the poverty level. Goodness-of-fit statistics (AIC, BIC, log-likelihood) evaluated the significance of the conditional LCA model.

Missing Data—Missing data were replaced for the LCA under the assumptions of missing-at-random using an expectation maximization algorithm and the maximum likelihood estimator (47). This method does not allow for covariates to have any missing data, but does permit missing data to vary as a function of covariates. There were no missing data for age, sex, ethnicity, or BMI. Only one participant was missing data for median household income and percentage of households below the poverty level, as her zip code was not classified by the aforementioned web program.

RESULTS

Demographic Characteristics

The sample included 34 males (27.2%) and 91 females (72.8%) with a mean age of 15.8 ±1.4 years. The adolescents were of diverse ethnic and racial backgrounds, with 36.8% classified as Caucasian (n=46), 37.6% classified as Hispanic/Latino (n=47), 19.2% classified as African American (n=24), and 6.4% classified as of another race (n=8). The mean BMI was 48.4 ± 8.3 kg/m^2 (range 35.4 to 83.3 kg/m^2). Average median household income by zip code was $48,813 \pm $24,303 (range $14,896 to $140,222) and the percentage of households below the poverty level was 14.5% ± 2.8% (range 0.0% to 42.1%). One adolescent presented with significant cognitive impairment and was unable to complete the clinical interview or self-report questionnaires.

Fit Statistics and Selection of a 3-Class Model for the Latent Class Analysis

Table 1 presents the fit statistics for the 2–4 class baseline LCA models. The best overall fit to the data was a 3-class model, as it demonstrated generally high entropy and significantly improved fit over models with fewer classes. Table 1 also illustrates that the fit statistics were better for the 4-class model without covariates than the 3-class model. However, the 4-class model estimated a class with only thee adolescents, which in combination with the 3-class model producing clinically relevant subgroups, led us to consider this the optimal model choice. A separate set of models with covariates were estimated to examine the significance of these variables on latent class membership after determining the superiority of the 3-class solution without covariates.

Interpretation of the Latent Classes

Data from the best fitting model are listed in Table 2 by latent class assignment with data for the indicator and predictor variables for the entire sample of adolescents. The covariate adjusted LCA model and the LCA model without covariates had similar latent class profiles, and only the covariate adjusted model results are presented. As illustrated by Table 2, in comparison to class three, age significantly increased the probability of being in class one by an odds ratio (OR) of 3.21 (β=1.17, SE=0.401, p=0.004). Caucasian ethnicity (OR=0.028; β =−3.57, SE=1.78, p=0.04), median household income (OR=0.360; β =−1.02, SE=0.474, p=0.03), and percent of families below the poverty line (OR=0.849; β =−0.163, SE=0.071, p=0.02) decreased the probability of being in class one in comparison to class three. Median household income (OR=0.632; β =−0.460, SE=0.214, p=0.03) significantly decreased the probability of being in class two in comparison to class three.

In comparison to the other two latent classes, individuals grouped in class one demonstrated high levels of both eating disordered and other psychopathology. Specifically, these adolescents had the most depressive symptoms, total problems by YSR, and anxiety severity by MASC, the greatest probability of reporting binge eating episodes by QEWP or EDE-Q, subjective bulimic episodes, or night eating, the largest proportion with a DSM-IV diagnoses, and the lowest quality of life scores. The first class showed less cohesion and more conflict in their families, but were also more likely to report being encouraged to express their feelings directly. These characteristics suggest that adolescents in class one can be categorized as the "eating pathology" class. Class 2 Individuals, in comparison to the other latent classes, exhibited the least psychopathology, including lower depressive symptom scores, total problems, anxiety severity, limited eating pathology, few DSM-IV diagnoses, and the highest quality of life scores. For family functioning, class two reported the highest levels of cohesion and the lowest levels of conflict and expressiveness. Thus, the presentation of this class indicates a "low psychopathology" class. Adolescents in class three, in comparison to the other two classes, were intermediate on measures of

psychopathology, including depressive symptoms, anxiety severity, total problems, and eating disorder symptoms, and intermediate on their scores of family functioning for cohesion, expressiveness, and conflict. Class three is therefore consistent with "non-specific psychopathology".

To illustrate the frequencies of class membership, participants were assigned to a latent class based on the highest model estimated probability for class membership. As highlighted in Table 2, the classes using posterior probability are: the eating pathology class (n=17, 13.6% of the total sample); low psychopathology class (n=62, 49.6% of the total sample); and non-specific psychopathology class (n=45, 36.0% of the total sample). Based on differences derived from posterior class assignments, individuals in the eating pathology class were older, lived in zip codes with a lower median household income and greater percentage of families below the poverty line, and Caucasian adolescents. In addition, adolescents in the eating pathology class were diagnosed with Eating Disorder Not Otherwise Specified (n=4), Major Depressive Disorder (n=2), Generalized Anxiety Disorder (n=2), Depressive Disorder not Otherwise Specified (n=2), Oppositional Defiant Disorder (n=1), and Dysthymia (n=1) by clinical interview.

Validation of Latent Classes

In a series of additional models, the effect of latent class on two parent-reported variables (total CBCL score, total PedsQL score) were tested using nested model chi-square difference tests. A main effect of latent class was observed for total CBCL score ($\chi^2(2) = 20.31$, $p < 0.001$). The model estimated means for the total CBCL scores were 58.61 for class one, 19.46 for class two, and 42.01 for class three, with a variance of 379.05 in all three classes. Follow-up equivalence tests tested the between-class differences in total CBCL scores. The eating pathology class had significantly greater scores than the low psychopathology or non-specific psychopathology classes [class one > class two: $\chi^2(1) = 16.89$, $p < 0.001$; class one > class three: $\chi^2(1) = 9.31$, $p < 0.001$]. In addition, the non-specific psychopathology class had significantly greater total CBCL scores than the low-psychopathology class ($\chi^2(1) = 7.37$, $p < 0.001$). No main effect of latent class was observed for total PedsQL scores, as the fit of a model with means fixed to be the same across latent classes (log likelihood difference= −23.51) was superior to a model that allowed the means to vary across latent classes.

DISCUSSION

Until recently, effective treatment options for severely obese youth were limited. Bariatric surgery offers a means for achieving significant weight loss and positive health outcomes for adolescents (21, 23). Mental health evaluations are recommended prior to bariatric surgery (24); however, the content of these assessments, how practitioners should address untreated psychiatric problems, and the effect of treatment on surgical outcome are not clear. Limited data are available to identify pre-operative psychosocial factors that predict post-surgery outcomes for younger patients. Among adults, the data are conflicting, especially for pre-operative binge eating (e.g., 50), and few reliable predictors of success with bariatric surgery have been identified (6). The first prospective longitudinal study of adolescents found significant improvements in BMI, depressive symptoms, and health-related quality of life post-surgery (28), but did not examine the interaction between pre-surgery psychosocial factors and subsequent weight change.

The current study used information from a pre-surgery psychiatric evaluation to determine whether homogeneous subgroups with varying patterns of psychopathology could be found among a heterogeneous sample of severely obese adolescents. Three distinct subgroups were identified, including: a group exhibiting high levels of both eating disordered and other

forms of psychopathology (eating pathology); another group with intermediate psychopathology (non-specific psychopathology); and the final group with fewer overall problems (low psychopathology). In our exploratory analyses, some additional variables, in particular age, ethnicity, and socioeconomic factors, influenced the likelihood of being classified in one of the pathological subgroups of adolescents. Parent reports of total problems on the CBCL validated the three groups identified by the LCA; however, a similar pattern was not observed for parent-reported quality of life. It is not clear this measure did not affect latent class membership; however, on average, parents reported a lower quality of life for their children (60.06 ± 16.70) in comparison to adolescents themselves (69.07 ± 16.39).

When considering the sample as a whole (n=124), rates of depressive symptoms were similar to those observed in other studies of adolescent bariatric surgery candidates. Specifically, 25% of adolescents in our study had BDI scores in the clinical range (total 17), in comparison to Zeller and colleagues (2006; 8) and Kim and colleagues (2008; 7) who reported rates of 30% and 16%, respectively, using the same cutoff on the BDI. The mean total PEDSQL score was higher in our sample (69.06) than the average observed Zeller and colleagues (54.90; 8), but was also substantially lower than the comparison group of healthy children reported previously (83.0; 8). Higher rates of binge eating were observed by Kim and colleagues (2008; 7) using questions from the QEWP (48%) than those observed in our sample (25%); however, we found a similar proportion of binge eating behaviors endorsed by EDE-Q (40.5%).

This study suggests some clinical recommendations for child and adolescent psychologists and psychiatrists conducting evaluations prior to weight loss surgery. First, a substantial proportion of bariatric surgery candidates (approximately 50%) do not report significant psychopathology. Second, many youth reported intermediate levels of psychopathology, with approximately 40% of these patients receiving a DSM-IV diagnosis. As less than half of this group reported receiving current psychiatric treatment, some of these adolescents may benefit from an intervention to address their psychopathology prior to receiving surgery. Finally, when combining data from the QEWP and EDE-Q, clinically significant eating disorder pathology, including loss of control eating, was observed among only a minority of adolescents (15.3% of the total sample), and this behavior only specifically characterized the 17 adolescents in class one. However, these youth appear to be at risk for other problems, including high levels of depressive and anxiety symptoms, total problems, family conflict, and low quality of life. An even smaller percentage of these adolescents (23.5%) reported any current psychiatric treatment, and therefore this group may have the greatest need for referral.

Although the practical implications of using statistical methods like LCA may not be immediately apparent, such analyses can suggest useful avenues for future research and help to reduce the assessment burden for adolescent candidates. This analysis identified clinically interpretable subtypes using cross-sectional data, which is the first step in recognizing psychosocial factors that may relate to surgical outcomes. As the results of LCA can be significantly influenced by the variables included in the model, other investigators can use similar predictor variables to evaluate whether our findings are replicable. Replication across investigators will help to develop classification schemes that carry the greatest clinical utility. Similar to subtyping studies of obese youth (16), studies using the longitudinal extension of LCA called latent transition analysis have found class membership to have an important moderator effect on treatment response (e.g., 51). Future studies of adolescent bariatric surgery candidates can use longitudinal data to evaluate the ability of the subgroups observed in this analysis to predict post-surgery outcomes, including weight loss, adherence to treatment, improved quality of life, or decreases in psychopathology. Further,

while a number of assessments were used in this study, the results of the LCA suggest that clinicians assessing severely obese youth might focus initially on the assessment of eating behavior. Binge eating or night eating may indicate the adolescent has a higher risk of individual or familial psychopathology. Adolescents who deny eating disturbances appear to be at lower risk for psychiatric symptoms.

In addition, data from adolescents receiving surgical interventions for other chronic medical conditions highlights the relevance of assessing psychopathology among younger bariatric surgery patients and examining post-surgery outcomes in future research. Similar to youth presenting for weight loss surgery (8), adolescent liver transplant patients have low health-related quality of life and high rates of emotional problems (e.g., 52). For children and adolescents receiving liver or renal transplants, post-transplant non-compliance is related to lower health-related quality of life, psychosocial problems, including post-traumatic stress disorder and other psychiatric diagnoses, abuse, body image, and low-self esteem (53–57). Non-compliance among for adolescents receiving bariatric surgery could result in potential complications such as nutritional deficiency or less than expected weight loss (58). Adolescence appears to present a developmental stage where non-compliance with medical treatment peaks (59, 60), occurs at rates much greater than in adults (56), and may be affected by psychological factors (59). Thus, additional research is needed to examine the specific relationship between psychological functioning, compliance, and outcome among adolescents receiving bariatric surgery.

There are several important limitations in the design of this study. First, a clinical interview was used to generate DSM-IV psychiatric diagnoses. While all clinical interviews were conducted by doctoral-level staff (MD or PhD), more reliable diagnostic information may have been elicited by the use of structured interviews. The primary measure of binge eating used in the study (the QEWP) was not adapted for a younger population, and different frequencies of loss of control eating were observed between the QEWP and EDE-Q (25.0% vs. 40.5%), an assessment that is more commonly used with adolescents. However, only two discrepancies were noted in the reporting of binge eating for adolescents who completed both the QEWP and EDE-Q, and the use of questions from the QEWP facilitated comparisons with one previous study of youth receiving bariatric surgery (7). In addition, many of the primary study indicators in the LCA were patient or parent-reported symptoms, which can be affected by withholding of information due to concerns about approval for surgery. It is possible that the rates of psychosocial impairment in this study may be higher than reported. Although there are certainly limitations to the current study, there were also strengths, including the application of LCA to a severely obese adolescent sample, ethnic diversity, and the consistency of findings across clinician and self-report measures.

In conclusion, this study provides an important first step in understanding the clinical presentation of adolescents seeking bariatric surgery. Future studies can replicate the results of the LCA from the current study, and utilize our findings to hypothesize ways in which the observed subgroups could differ in post-surgery outcomes for weight loss, treatment compliance, and psychological functioning. Understanding the relationship between pre-operative psychosocial status and postoperative outcome is critical for generating a consensus regarding patient selection criteria, improving patient care, and fostering healthy development.

Acknowledgments

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Table 1

Summary of Fit Statistics and Classification Quality for Models

Latent Class Analysis Model	Loglikelihood	AIC	Sample-Size Adjusted BIC	Entropy
2-Class	−2756.39	5576.77	5565.84	0.788
3-Class	−2725.71	5541.41	5526.03	0.841
3-Class with covariates	**−2698.48**	**5510.96**	**5491.03**	**0.859**
4-Class	−2705.36	5526.72	5506.90	0.871

Note. AIC = Akiake Information Criterion. BIC = Bayesian Information Criterion. Bold text designates the best fitting model.

Table 2

Summary of Latent Class Indicators and Predictors by Latent Class and for the Total Sample of Adolescents

Indicators	Class One, Eating Pathology, n=17	Class Two, Low Psychopathology, n=62	Class Three, Non-Specific Psychopathology, n=45	Total Sample, n=125
	MEM (SE)	MEM (SE)	MEM (SE)	M (SD, n)
BDI Total Score	20.16 (1.77)	3.65 (0.991)	13.20 (0.842)	10.79 (8.16, n=118)
YSR Total Score	76.20 (4.67)	22.98 (2.79)	43.67 (2.67)	41.07 (22.33, n=110)
MASC Total Score	42.63 (5.68)	19.95 (2.79)	34.62 (2.44)	30.14 (19.35, n=122)
PedsQL Total Score	50.53 (3.39)	83.64 (1.99)	63.87 (1.77)	69.06 (16.39, n=118)
FES-Cohesion Subscale	3.62 (0.653)	7.78 (0.385)	6.64 (0.333)	6.63 (2.60, n=101)
FES-Expressiveness Subscale	5.53 (0.577)	1.82 (0.355)	4.30 (0.305)	3.58 (2.43, n=101)
FES-Conflict Subscale	6.39 (0.424)	5.87 (0.267)	6.12 (0.224)	6.07 (1.54, n=101)
	Probability	Probability	Probability	Frequency
QEWP Binge Eating Episodes	73.2%	0.00%	27.1%	25% (n=20/80)
EDE-Q Binge Eating Episodes	100.0%	12.4%	34.1%	40.5% (n=17/42)
EDE-Q Subjective Bulimic Episodes	73.1%	11.3%	18.0%	26.2% (n=11/42)
Night Eating by Clinical Interview	52.1%	9.1%	25.4%	23.4% (n=29/124)
Any DSM-IV Diagnosis by Clinical Interview	82.8%	11.2%	42.0%	36.3% (n=45/124)
Covariates	M (SD)	M (SD)	M (SD)	
Age (in years)	16.24 (0.752)	15.81 (1.10)	15.53 (1.25)	15.78 (1.14, n=125)
Body Mass Index (kg/m^2)	47.55 (5.61)	46.93 (7.46)	50.92 (9.81)	48.40 (8.33, n=125)
Median Household Income	$43,822 ($22,805)	$51,527 ($26,092)	$46,318 ($22,016)	$48,813 ($24,303, n=124)
Percent Families Below the Poverty Line	16.66% (14.51%)	13.82% (13.10%)	14.92% (11.97%)	14.51% (12.83%, n=124)
	Percent	Percent	Percent	
Sex (% women)	70.6%	71.0%	75.6%	72.8%
Ethnicity (% Caucasian)	41.2%	35.5%	37.8%	36.8%
Ethnicity (% Hispanic)	41.2%	40.3%	31.1%	37.6%
Ethnicity (% African American)	17.6%	17.7%	22.2%	19.2%
Ethnicity (% Other)	0.00%	6.5%	8.9%	6.4%

Note. MEM=Model Estimated Mean, SE=Standard Error, M=Mean, SD=Standard Deviation, BDI= Beck Depression Inventory, YSR= Youth Self-Report, MASC= Multidimensional Anxiety Scale for Children, PedsQL=Pediatric Quality of Life Inventory, FES= Family Environment Scale, QEWP= Questionnaire on Eating and Weight Patterns, EDE-Q= Eating Disorder Examination Questionnaire