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# Prevalence of alcohol use disorders before and after bariatric surgery

**Wendy C. King, PhD**,
Epidemiology, GSPH, University of Pittsburgh

**Jia-Yuh Chen, MS**,
Biostatistics, GSPH, University of Pittsburgh

**James E. Mitchell, MD**,
Neuropsychiatric Research Institute

**Melissa A. Kalarchian, PhD**,
Psychiatry, University of Pittsburgh School of Medicine

**Kristine J. Steffen, PharmD, PhD**,
Neuropsychiatric Research Institute

**Scott G. Engel, PhD**,
Neuropsychiatric Research Institute

**Anita P. Courcoulas, MD, MPH**,
Surgery, University of Pittsburgh Medical Center

**Walter J. Pories, MD**, and
Surgery, Brody School of Medicine, East Carolina University

**Susan Z. Yanovski, MD**
Division of Digestive Diseases and Nutrition, National Institute of Diabetes and Digestive and Kidney Diseases

## Abstract

Corresponding Author: Wendy C. King, PhD, Research Assistant Professor, Department of Epidemiology, University of Pittsburgh, Graduate School of Public Health, 130 DeSoto Street, Office 517, Pittsburgh, PA 15261, 412-624-1612 (phone), 412-624-7397 (fax), kingw@edc.pitt.edu.

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Online-Only Material: eFigure 1, eTable 1 and eTable 2 are available at http://www.jama.com

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Dr. King and Ms. Chen had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.
*Study concept and design:* King, Mitchell
*Analysis and interpretation of data:* Chen, Courcoulas, Engel, Kalarchian, King, Mitchell, Pories, Steffen, Yanovski
*Drafting of the manuscript:* King
*Critical revision of the manuscript for important intellectual content:* Chen, Courcoulas, Engel, Kalarchian, King, Mitchell, Pories, Steffen, Yanovski
*Statistical analysis:* Chen, King
*Obtained funding:* Courcoulas, Mitchell, Pories
*Study supervision:* Courcoulas, Mitchell, Pories, Yanovski


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**Context—**Anecdotal reports suggest bariatric surgery may increase the risk of alcohol use disorders (AUD), but prospective data are lacking.

**Objectives—**Determine the prevalence of pre- and postoperative AUD, and independent predictors of postoperative AUD.

**Design, Setting, Participants—**Longitudinal Assessment of Bariatric Surgery-2 is a prospective cohort study of adults who underwent bariatric surgery at 10 U.S. hospitals. Of 2458 participants, 1945 (78.8% female, 87.0% white, median age=47 years, median body mass index=45.8 kg/m$^2$) completed pre- and postoperative (1 and/or 2 years) assessments between 2006–2011.

**Main Outcome measure—**Past year AUD symptoms determined with the Alcohol Use Disorders Identification Test (indication of ‘alcohol-related harm,’ ‘alcohol dependence symptoms,’ or score ≥8).

**Results—**The prevalence of AUD did not significantly differ from pre- to 1 year postoperative (7.6% vs. 7.3%; p=.98), but was significantly higher at 2 years (9.6%; p<.01). Male sex (adjusted odds ratio [OR], 2.1; 95% confidence interval [CI], 1.5–3.0; p<.0001), younger age (OR, 1.3; CI, 1.03–1.7 per 10 years younger with pre-op AUD; p=.03; OR, 2.0; CI, 1.7–2.3 per 10 years younger without pre-op AUD; p<.0001), smoking (OR, 2.6; CI, 1.2–5.6; p=.02), regular alcohol consumption (OR, 6.4; CI, 4.2–9.7; p<.0001), AUD (e.g., OR, 11.1; CI, 7.7–16.1 at age 45; p<.0001), recreational drug use (OR, 2.4; CI, 1.4–4.1; p<.01) and lower ‘belonging’ interpersonal support (OR, 1.1; CI, 1.04–1.2; p<.01) preoperatively, and undergoing a Roux-en-Y gastric bypass (OR, 2.1; CI, 1.4–3.1; p<.001; reference=adjustable gastric band) were independently related to an increased odds of AUD postoperatively.

**Conclusion—**In this cohort, the prevalence of AUD was greater in the second postoperative year than preoperatively or in the first postoperative year, and was associated with preoperative AUD and regular alcohol consumption, and undergoing Roux-en-Y gastric bypass.

## Introduction

As the prevalence of severe obesity (defined as body mass index [BMI] ≥ 35 kg/m$^2$) rises in the United States,[1] it is becoming increasingly common for health care providers and their patients to consider bariatric surgery, the most effective and durable treatment for severe obesity.[2] Although bariatric surgery may reduce long-term mortality,[3–4] and carries a low risk of short-term serious adverse outcomes,[5] safety concerns remain. Anecdotal reports suggest that bariatric surgery may increase the risk for alcohol use disorder ([AUD]; alcohol abuse and alcohol dependence).[6] However, only three studies have examined AUD pre- and post- bariatric surgery. Mitchell et al.[7] attempted to contact 100 Roux-en-Y gastric bypass (RYGB) patients 13–15 years postoperatively. Of 8 deaths, one was attributed to alcoholism complications. Of 78 patients who agreed to a diagnostic interview, 10 (12.8%) vs. 6 (7.7%) reported AUD, pre- vs. postoperatively, respectively. Ertelt et al.[8] mailed a survey to 250 patients 6–10 years following RYGB. Of respondents (n=70), the number of participants who had AUD symptoms pre- (n=6; 8.6%) versus post- (n=7; 10.0%) RYGB was similar. Importantly, the majority (71.4%) with AUD symptoms postoperatively had AUD symptoms preoperatively. Suzuki et al.[9] recruited 51 of 530 targeted patients two or more years following RYGB or laparoscopic adjustable gastric banding (LAGB). Preoperative AUD was determined by retrospectively examining clinical psychiatric evaluations. Postoperative AUD was determined by diagnostic interview. No participants met criteria for current AUD preoperatively, and no LAGB patients (n=23) reported current AUD postoperatively. However, 6 of the 28 (21.4%) RYGB patients did, 83.3% of whom had a history of preoperative AUD with remission at surgery.[9] Given the limitations of these studies (low participation rate,[8;9] small sample size,[7–9] retrospective assessments of

AUD,[7–9] and different time frames[7–9] and assessment methods[9] for pre- and postoperative periods) it remains unclear whether bariatric surgery influences risk of AUD.

There is evidence that some bariatric surgical procedures (i.e. RYGB and sleeve gastrectomy) alter alcohol pharmacokinetics. Given a standardized quantity of alcohol, postoperative patients reach a higher peak alcohol level compared to case controls[10–11] or their preoperative values.[12–13] In addition, some studies have shown that postoperative patients reach peak alcohol level more quickly[11] or take more time to return to a sober state.[10;12;13] Patient surveys have revealed similar changes in alcohol sensitivity following RYGB (feeling intoxicated more rapidly, after drinking less, for longer[8;14]), as well as more difficulty controlling postoperative alcohol intake.[14] Alcohol sensitivity studies have not been done in LAGB patients, most likely because the anatomical and physiological changes from LAGB are less likely to impact alcohol absorption and metabolism. To address limitations in the literature, this study aimed to determine whether the prevalence of AUD changed following bariatric surgery in a large multicenter observational study, comparing reported AUD in the year prior to surgery to the first and second years after surgery. In addition, this study aimed to identify independent predictors of postoperative AUD. We hypothesized that preoperative AUD and undergoing RYGB would increase the likelihood of postoperative AUD. In addition, we hypothesized that many of the factors associated with AUD in the general population[15] would be associated with increased odds of postoperative AUD.

## Methods

### Participants

The Longitudinal Assessment of Bariatric Surgery-2 (LABS-2) is an observational study designed to assess the risks and benefits of bariatric surgery.[16] Patients at least 18 years old seeking a first bariatric surgical procedure by participating surgeons at ten centers throughout the United States were recruited between February, 2006 and February, 2009. All participating centers had institutional review board approval and all participants provided written informed consent. By study enrollment closure (April 2009), 2458 participants attended a preoperative research visit, which occurred after the surgery approval process was complete and within 30 days of their scheduled surgery date, and underwent a bariatric surgical procedure (RYGB, LAGB, sleeve gastrectomy, biliopancreatic diversion with duodenal switch, or banded gastric bypass) as part of clinical care (see Figure 1). The study, #NCT00465829, is registered at www.clinicaltrials.gov.

### Measures

Measures were collected independently of the surgery approval process and clinical care. Participants were informed that their responses were confidential, although the informed consent document specified that investigators could take steps to prevent serious harm (e.g., if suicidal ideation was reported).

**Alcohol Use and AUD—**The Alcohol Use Disorders Identification Test (AUDIT)[17] is a 10 item test developed by the World Health Organization to assess alcohol use and consequences in the prior 12 months, with well-established validity and reliability.[18] A total score (0–40) is calculated using all ten items (see eTable 1), a higher score reflecting greater severity of AUD. Additionally, subsets of items indicate whether respondents are positive for ‘consumption at a hazardous level’ (typically consuming at least 3 drinks per occasion or ever having 6 or more drinks on one occasion), ‘symptoms of alcohol dependence’ (not being able to stop drinking once started, needing a drink in the morning to get going, or failing to meet normal expectations because of drinking), and ‘alcohol-related harm’ (not being able to remember, feeling guilt, injuring someone, or eliciting concern due to drinking). For this analysis participants were categorized as having AUD symptoms (referred to as "AUD" throughout) if their total AUDIT score was at least 8[17] or if they were positive for 'symptoms of alcohol dependence' or 'alcohol-related harm.'

**Other Measures—**Anthropometric measurements were made using standardized protocols.[19] Sociodemographics were self-reported; race was set to missing for participants who did not self-report their race as one or more of the investigator-defined categories (i.e., white/Caucasian, black/African-American, Asian, American Indian/Alaska Native, Native Hawaiian/other Pacific Islander). For analysis, race categories other than white and black were combined as "other" race due to low representation (see Table 1). Physical and mental health were measured using the norm-based physical component and mental component scores from the Medical Outcomes Study 36-item Short-Form Health Survey (SF-36), higher scores (range 0–100) indicating better functioning.[20] Depressive symptomatology was measured with the Beck Depression Inventory (BDI) version 1, a higher score (range 0–63) indicating greater severity.[21] Past-year use of recreational drugs, smoking status, and binge eating disorder were assessed with the LABS-2 Behavioral form,[16] which includes questions to assess all five criteria for binge eating disorder.[30] Treatment for psychiatric or emotional problems (hospitalization or outpatient treatment in the past 12 months or current medication use) was assessed with the LABS-2 Psychiatric and Emotional Test Survey.[16] Perceived social support was measured using three domain scores (appraisal, belonging and tangible) from the 12-item Interpersonal Support Evaluation List (ISEL-12), higher scores (range 4–16) indicating greater support availability.[23] Several LABS-2 forms (Subsequent Surgery form, Surgeon's Questionnaire, surgical procedure-specific forms, and Health Care Utilization form) were used to collect information on surgical revisions, reversals and new bariatric procedures that occurred after the initial bariatric procedure and before the 2 year assessment.

## Analysis

Potential selection bias was examined by comparing preoperative characteristics of LABS-2 participants in the analysis sample (n=1945) to those excluded (n=513) for failure to complete the AUDIT preoperatively or during one of the postoperative time points using Pearson's chi-square test for categorical variables and the Wilcoxon rank-sum test for continuous variables. Descriptive statistics of alcohol-related measures were limited to participants with AUDIT data at all three time points (n=1400). Missing data were assumed to be missing at random (MAR), i.e., the probability of missing depends only on the observed data.[24] Differences in distributions of alcohol-related measures over time were tested using generalized linear mixed models (GLMM) using all available observations. Pair-wise comparisons ($P$<.05) were made between each combination of the three time points.

GLMM was also used to determine predictors of postoperative AUD using all available observations, by modeling AUD as the dependent variable over time (i.e., yes/no at 1 year and yes/no at 2 years). Independent variables were selected according to the alcohol literature: sex,[15;25;26] age,[15;25;26] race [15;25;26] ethnicity,[15;25;26] marital status,[15] education,[25;26] employment status,[25;26] household income,[27] BMI,[28] SF-36 physical and mental component scores,[15] BDI score,[29] binge eating,[6] treatment for psychiatric or emotional problems,[29] ISEL appraisal, belonging, and tangible support scores,[30] smoking status,[26] regular alcohol consumption (i.e., ≥ 2 times/week), recreational drug use,[26] surgical procedure,[10,11,13] and percentage weight loss.[31] The following model-fitting strategies were adopted. First, preoperative characteristics and surgical procedure were considered, with site as a random effect. Variables that were not significant in the model (i.e., $P \geq .05$) were removed by using backward elimination. Because backward elimination can lead to biased models and to over-fitting of data, the analysis was confirmed using forward selection. Next, to assess associations between postoperative characteristics (i.e., SF-36 physical and mental component scores, BDI score, binge eating, treatment for psychiatric or emotional problems, ISEL appraisal, belonging, and tangible support scores, smoking status, recreational drug use, and percentage weight loss) and postoperative AUD, a separate GLMM was fit for each postoperative characteristic controlling for its preoperative value (data not shown). Then, postoperative characteristics that were significantly associated with postoperative AUD, and their preoperative values, were added to the best preoperative multivariable GLMM. Again, backward elimination and forward selected were used for model selection; variables that were significantly related to postoperative AUD ($P$<.05), and their preoperative values were retained. Once independent variables were determined, all potential interactions were evaluated. Sample sizes for GLMM predicting postoperative AUD reflect the exclusion of participants with indeterminate preoperative AUD (n=4), participants who had a reversal of their surgical procedure (n=4) or a new surgical procedure (n=4) before their 1 year assessment, and participants missing covariate data (n=20–97 depending on the model). Participants who had a reversal (n=4) or new procedure (n=5) between their first and second assessment were retained. However, their 2 year data were censored. All tests were two-sided. Adjusted odds ratios [OR] and 95% confidence intervals [CI] are reported. Statistical analyses were performed with SAS software (version 9.2; SAS Institute Inc, Cary, North Carolina).

# Results

## Preoperative participant characteristics

Of 2458 LABS-2 participants, 2280 completed at least some self-assessment forms at the preoperative visit; 2265 completed the AUDIT. The current analysis is limited to 1945 of these 2265 participants (86%) who completed the AUDIT one (n=1763) or two (n=1582) years postoperatively (see Figure 1). Characteristics of LABS participants included in this analysis are shown in Table 1. Compared to those not included in these analyses, those included were older (median 47 years vs. 42 years; $P$<.0001), a greater percentage were white (87.0% vs. 82.0%; $P$<.01), and a smaller percentage were smokers (2.2% vs. 4.1%; $P$=.02) preoperatively. There were no significant differences between groups with respect to other characteristics.

## Alcohol use and AUD by time point

Table 2 presents select AUDIT item responses and summary measures, as well as alcohol and drug abuse treatment, pre- and 1 and 2 years postoperatively (all AUDIT item responses by time point are shown in eTable 1, available at http://jama.ama-assn.org/). Number of alcoholic drinks consumed on a typical drinking day was significantly higher preoperatively and 2 years postoperatively than in the first postoperative year. ‘Consumption at a hazardous level’ was significantly more common preoperatively than postoperatively. However, there was a significant increase between the first and second postoperative years. Frequency of alcohol consumption and AUD (and all three of its components: dependence symptoms, alcohol-related harm and AUDIT score ≥8,) significantly increased in the second postoperative year compared to preoperatively or the first postoperative year.

## Relationship between pre- and postoperative AUD

More than half (62.3%; CI, 53.0%–71.5%; 66/106) of those reporting AUD at the preoperative assessment continued to have, or had recurrent AUD within the first two postoperative years. In contrast, 7.9% (CI, 6.4%–9.4%; 101/1283) of participants not reporting AUD at the preoperative assessment had postoperative AUD. Nonetheless, more than half (60.5%; CI, 53.1%–67.9%;101/167) of postoperative AUD was reported by those not reporting AUD at the preoperative assessment.

### Predictors of postoperative AUD

Male sex, younger age, smoking, regular alcohol consumption, AUD, recreational drug use and lower ‘belonging’ interpersonal support preoperatively, and undergoing a Roux-en-Y gastric bypass were independently related to an increased likelihood of AUD postoperatively (Table 3). The adjusted odds of AUD in the second compared to the first postoperative year was 1.6 (CI, 1.3–2.0; $P<.0001$). There was an interaction between preoperative AUD and age such that the odds ratio for postoperative AUD associated with preoperative AUD increased with age (eFigure 1, available at http://jama.ama-assn.org/). There were no other significant interactions between covariates. Race, ethnicity, marital status, education, employment status, household income, BMI, SF-36 physical and mental component scores, BDI score, binge eating, treatment for psychiatric or emotional problems, and ISEL ‘appraisal’ and ‘tangible’ support scores measured preoperatively were not independently related to postoperative AUD. However, a lower postoperative SF-36 mental component score was independently related to postoperative AUD, as were postoperative smoking, recreational drug use, and treatment for psychiatric or emotional problems (Table 4).

### Alcohol use and AUD by time point, by surgical procedure

Given the striking relationship between RYGB (in comparison to LAGB) and AUD (Tables 3 and 4), we repeated the analysis evaluating alcohol consumption and AUD by time point stratifying by surgical procedure (eTable 2, available at http://jama.ama-assn.org/). Frequency of alcohol consumption significantly increased in the second postoperative year compared to preoperatively or the first postoperative year among participants who underwent RYGB or LAGB. Among participants who underwent RYGB, the number of drinks on a typical drinking day was significantly lower in the first, but not the second postoperative year, compared to preoperatively, and the prevalence of AUD significantly increased in the second postoperative year (i.e., 7.0% (CI, 5.4%–8.6%) preoperatively and 7.9% (CI, 6.3%–9.8%) 1 year postoperatively vs. 10.7% (CI, 8.8%–12.7%) 2 years postoperatively; $P<.01$), whereas there was no significant difference in number of drinks on a typical drinking day by time among participants who underwent LAGB, nor was there a significant change in prevalence of AUD (i.e., 9.3% (CI, 6.3%–12.3%) preoperatively and 5.6% (CI, 3.2%–8.0%) 1 year postoperatively vs. 7.0% (CI, 4.4%–9.7%) 2 years postoperatively; $P=.24$).

## Discussion

Despite physician[32] and patient[6] concerns that bariatric surgery increases risk of AUD, to our knowledge, this is the first prospective investigation of AUD before and after bariatric surgery. This study found a significantly higher prevalence of AUD in the second postoperative year, overall, and specifically post-RYGB, compared to the years immediately before and following surgery. Although the increase in prevalence of AUD from 7.6% preoperatively to 9.6% 2 years postoperatively may seem small, that 2% increase potentially represents more than 2000 additional people with AUD in the U.S. each year[33] with accompanying personal, financial, and societal costs.[34]

Participants were categorized as having AUD if they endorsed at least one symptom of alcohol-related harm or alcohol dependence, likely identifying some participants who would not meet DSM-IV criteria for AUD.[22] Thus, comparisons with prevalence rates of AUD should be made with caution. Nonetheless, in contrast to previous studies in which preoperative prevalence of AUD has been very low (0–2%),[35–39] whether assessed as part of the surgical evaluation[35–37] or independently for research,[38;39] the preoperative prevalence of AUD identified in this study was high (7.6%), but similar to the prevalence of AUD in the general U.S. population (8.5%[15]; 6.4% adjusted to match the sex distribution of bariatric surgery patients[5]). Given that current AUD is a contraindication for bariatric surgery,[40;41] it is unclear whether the prevalence of AUD preoperatively reflects prior removal of those with current AUD from the surgery pool, or under-reporting. There is some evidence that prevalence of lifetime AUD is higher among bariatric surgery candidates (e.g., 31%[38]) compared to the general U.S. population (30%[15]; 24% if adjusted to match the sex distribution of bariatric surgery patients[5]), although results are conflicting.[35–39]

The significant increase in prevalence of AUD following RYGB, but not LAGB is consistent with observational[9] and pharmacokinetic[10;11;13] studies. The prevalence of AUD overall, and specifically among participants who underwent RYGB, did not significantly increase until the second postoperative year, when alcohol consumption in general, and consumption at a hazardous level in particular, increased compared to the first postoperative year among participants who underwent RYGB. Therefore it was likely an increase in alcohol sensitivity following RYGB combined with resumption of higher levels of alcohol consumption in the second postoperative year, which led to the increase in AUD.

AUD in the year prior to surgery substantially increased the odds of AUD in the first two postoperative years, consistent with the chronic and recurrent nature of AUD.[15] Regular alcohol consumption preoperatively also independently increased the likelihood of postoperative AUD. A lower sense of ‘belonging’ (i.e., availability of people to do things with) preoperatively was predictive of postoperative AUD, suggesting that interpersonal social support may protect against AUD. Most other predictors of AUD identified in this study (i.e., male sex, younger age, smoking, recreational drug use) have been associated with AUD in the general U.S. population.[15;26]

We did not find a significant association between preoperative depressive symptoms, binge eating, mental health, or past-year treatment for psychiatric or emotional problems, and postoperative AUD. However, worse mental health and treatment for psychiatric or emotional problems postoperatively were significantly associated with AUD, consistent with cross-sectional studies reporting associations between psychiatric disorders and AUD.[10;12;13;15] The direction of these relationships is unclear.

Percentage weight loss was not independently related to postoperative AUD. However, results require replication. Only a few studies, to our knowledge, have investigated the inverse, with various measures of alcohol consumption, alcohol-related problems, and treatment. In a sample of 440 LAGB patients there was a significant positive relationship between preoperative alcohol consumption and percentage excess weight loss at 1 year ($R=0.23$; $P<.005$).[42] In addition, two studies (n=80 RYGB[43] and n=413 RYGB, LAGB and sleeve gastrectomy[44]) found that a history of preoperative substance use disorder (including AUD and drug abuse/dependence), in remission at time of surgery, predicted better postoperative weight loss, while one study (n=207 RYGB[45]) reported no significant association. Finally, among 160 patients who reported some weight regain post-RYGB, those who reported someone had expressed concern about their postoperative alcohol or drug use (<10% of participants) had an increased odds (OR=12.7, CI, 1.7–93.8; $P=.01$) of significant regain.[31] Future studies are needed to clarify if and how postoperative weight loss is related to alcohol use and AUD and vice versa.

Although safe levels of alcohol consumption have yet to be established for the postoperative patient, it is concerning that one in eight participants reported consuming at least 3 drinks per typical drinking day and one in six participants reported ‘consumption at a hazardous level' in the second postoperative year, given the negative impact heavy drinking may have on vitamin and mineral status,[46] hepatic function,[46] and weight loss.[31] It is also noteworthy that alcohol or drug abuse treatment was uncommon both pre- and postoperatively (e.g., 0.5%–0.8%; 7–10% of those with AUD).

Major strengths of this study include the prospective design, large sample from 10 hospitals throughout the U.S., and use of a validated and reliable alcohol screening tool. Some study limitations with respect to interpretation of results should be noted. First, lifetime history of AUD was not assessed. Thus, we were unable to determine whether postoperative AUD was 'new-onset' vs. 'recurrent.' Second, while research data was collected independently of the surgery approval process and clinical care, some participants may have under-reported their alcohol use due to concerns that their responses would affect their surgery eligibility or social desirability. However, the fact that 7.8% of study participants reported symptoms of AUD at their preoperative research visit indicates that participants who may have withheld symptoms of AUD during their clinical assessment in order to qualify for surgery did not withhold this same information when completing the AUDIT for research purposes. Third, when participants reported having at least 5 drinks on a typical drinking day (per AUDIT item 2) a safety protocol was triggered to assess the need for referral, which may have led to under-reporting of alcohol consumption or problems at future (i.e., postoperative) assessments. Fourth, because this study does not have a control group, we cannot rule out the possibility that reporting of AUD would increase independent of surgery 2 years after baseline assessment. However, the relationship between surgical procedure and postoperative AUD (i.e., higher likelihood with RYGB compared to LAGB) provides evidence that the most common surgical procedure was likely at least partially responsible for the increase in postoperative AUD at 2 years. Finally, we were underpowered to determine if risk of postoperative AUD was related to race or ethnicity, or lower incidence surgical procedures.

To summarize, the prevalence of AUD was greater in the second postoperative year than preoperatively or in the first postoperative year; this finding appears to be driven by RYGB, which accounted for 70% of surgeries and doubled the likelihood of postoperative AUD compared to LAGB. Several factors associated with AUD in the general population, including history of AUD and regular alcohol consumption, also increased the likelihood of postoperative AUD in this bariatric surgery sample. Although preoperative AUD greatly increased the likelihood of postoperative AUD, over half of participants with postoperative AUD did not report AUD in the year prior to surgery.

This study has important implications for the care of pre- and postoperative bariatric surgery patients. Regardless of alcohol history, patients should be educated on the potential effects of bariatric surgery, in particular RYGB, to increase the risk of postoperative AUD. In addition, alcohol screening and, if indicated, referral should be offered as part of routine pre- and postoperative clinical care. Further research should examine the long-term impact of bariatric surgery on AUD, and the relationship of AUD to postoperative weight control.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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## Reference List

1. Flegal KM, Carroll MD, Ogden CL, Curtin LR. Prevalence and trends in obesity among US adults, 1999–2008. JAMA. 2010; 303(3):235–241. [PubMed: 20071471]
2. Buchwald H, Estok R, Fahrbach K, et al. Weight and type 2 diabetes after bariatric surgery: systematic review and meta-analysis. Am J Med. 2009; 122(3):248–256. [PubMed: 19272486]
3. Flum DR, Dellinger EP. Impact of gastric bypass operation on survival: a population-based analysis. J Am Coll Surg. 2004; 199(4):543–551. [PubMed: 15454136]
4. Sjostrom L, Narbro K, Sjostrom CD, et al. Effects of bariatric surgery on mortality in Swedish obese subjects. N Engl J Med. 2007; 357(8):741–752. [PubMed: 17715408]
5. Flum DR, Belle SH, King WC, et al. Perioperative safety in the longitudinal assessment of bariatric surgery. N Engl J Med. 2009; 361(5):445–454. [PubMed: 19641201]
6. Sogg S. Alcohol misuse after bariatric surgery: epiphenomenon or “Oprah” phenomenon? Surg Obes Relat Dis. 2007; 3(3):366–368. [PubMed: 17452022]
7. Mitchell JE, Lancaster KL, Burgard MA, Howell LM, Krahn DD, Crosby RD, Wonderlich SA, Gosnell BA. Long-term follow-up of patients’ status after gastric bypass. Obes Surg. 2001; 11(4): 464–8. [PubMed: 11501356]
8. Ertelt TW, Mitchell JE, Lancaster K, Crosby RD, Steffen KJ, Marino JM. Alcohol abuse and dependence before and after bariatric surgery: a review of the literature and report of a new data set. Surg Obes Relat Dis. 2008; 4(5):647–650. [PubMed: 18420465]
9. Suzuki J, Haimovici F, Chang G. Alcohol use disorders after bariatric surgery. Obes Surg. 2010; 22(2):201–7. [PubMed: 21188544]
10. Hagedorn JC, Encarnacion B, Brat GA, Morton JM. Does gastric bypass alter alcohol metabolism? Surg Obes Relat Dis. 2007; 3(5):543–548. [PubMed: 17903777]
11. Klockhoff H, Naslund I, Jones AW. Faster absorption of ethanol and higher peak concentration in women after gastric bypass surgery. Br J Clin Pharmacol. 2002; 54(6):587–591. [PubMed: 12492605]
12. Maluenda F, Csendes A, De Aretxabala X, et al. Alcohol absorption modification after a laparoscopic sleeve gastrectomy due to obesity. Obes Surg. 2010; 20(6):744–748. [PubMed: 20358306]
13. Woodard GA, Downey J, Hernandez-Boussard T, Morton JM. Impaired alcohol metabolism after gastric bypass surgery: a case-crossover trial. J Am Coll Surg. 2011; 212(2):209–214. [PubMed: 21183366]
14. Buffington CK. Alcohol use and health risks: Survey results. Bariatric Times. 2007; 4(2):1, 21–3.
15. Hasin DS, Stinson FS, Ogburn E, Grant BF. Prevalence, correlates, disability, and comorbidity of DSM-IV alcohol abuse and dependence in the United States: results from the National Epidemiologic Survey on Alcohol and Related Conditions. Arch Gen Psychiatry. 2007; 64(7): 830–842. [PubMed: 17606817]
16. Belle SH, Berk PD, Courcoulas AP, et al. Safety and efficacy of bariatric surgery: longitudinal assessment of bariatric surgery. Surg Obes Relat Dis. 2007; 3(2):116–126. [PubMed: 17386392]
17. Barbor, TF.; Higgins-Biddle, JC.; Saunders, JB.; Monteiro, MG. AUDIT The Alcohol Use Disorders Identification Test: Guidelines for Use in Primary Care. 2. Geneva: World Health Organization; 2001.

18. Reinert DF, Allen JP. The alcohol use disorders identification test: an update of research findings. Alcohol Clin Exp Res. 2007; 31(2):185–199. [PubMed: 17250609]
19. King WC, Engel SG, Elder KA, et al. Walking capacity of bariatric surgery candidates. Surg Obes Relat Dis. 2012; 8(1):48–59. [PubMed: 21937285]
20. Ware JE Jr, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. Med Care. 1992; 30(6):473–483. [PubMed: 1593914]
21. Beck AT, Ward CH, Mendelson M, Mock J, Erbaugh J. An inventory for measuring depression. Arch Gen Psychiatry. 1961; 4:561–571. [PubMed: 13688369]
22. American Psychiatric Association. Diagnostic and Statistical Manual of Mental Disorders (DSM-IV). 4. Washington, D.C: APA; 1994.
23. Brookings JB, Bolton B. Confirmatory factor analysis of the Interpersonal Support Evaluation List. Am J Community Psychol. 1988; 16(1):137–147. [PubMed: 3369379]
24. Molenberghs, G.; Kenward, MG. Missing Data in Clinical Studies. 1. Chichester, UK: John Wiley & Sons Ltd; 2007. Terminology and framework; p. 27-38.
25. Naimi TS, Brewer RD, Mokdad A, Denny C, Serdula MK, Marks JS. Binge drinking among US adults. JAMA. 2003; 289(1):70–75. [PubMed: 12503979]
26. Results from the 2010 National Survey on Drug Use and Health: Summary of National Findings. Substance Abuse and Mental Health Services Administration; website. http://www.samhsa.gov/data/NSDUH/2k10NSDUH/2k10Results.htm#3.1.7 [Accessed January 24, 2012]
27. Peltzer K, Davids A, Njuho P. Alcohol use and problem drinking in South Africa: findings from a national population-based survey. Afr J Psychiatry (Johannesbg). 2011; 14(1):30–37. [PubMed: 21509408]
28. Kleiner KD, Gold MS, Frost-Pineda K, Lenz-Brunsman B, Perri MG, Jacobs WS. Body mass index and alcohol use. J Addict Dis. 2004; 23(3):105–118. [PubMed: 15256347]
29. Dawson DA, Grant BF, Stinson FS, Chou PS. Psychopathology associated with drinking and alcohol use disorders in the college and general adult populations. Drug Alcohol Depend. 2005; 77(2):139–150. [PubMed: 15664715]
30. Schuckit MA, Smith TL. The relationships of a family history of alcohol dependence, a low level of response to alcohol and six domains of life functioning to the development of alcohol use disorders. J Stud Alcohol. 2000; 61(6):827–835. [PubMed: 11188488]
31. Odom J, Zalesin KC, Washington TL, et al. Behavioral predictors of weight regain after bariatric surgery. Obes Surg. 2010; 20(3):349–356. [PubMed: 19554382]
32. Holt PR. Changes in alcohol metabolism after gastric bypass surgery. Lancet. 2011; 378(9793):767–768. [PubMed: 21872743]
33. Livingston EH. The incidence of bariatric surgery has plateaued in the U. S Am J Surg. 2010; 200(3):378–385.
34. Thavorncharoensap M, Teerawattananon Y, Yothasamut J, Lertpitakpong C, Chaikledkaew U. The economic impact of alcohol consumption: a systematic review. Subst Abuse Treat Prev Policy. 2009; 4:20. [PubMed: 19939238]
35. Black DW, Goldstein RB, Mason EE. Psychiatric diagnosis and weight loss following gastric surgery for obesity. Obes Surg. 2003; 13(5):746–751. [PubMed: 14627470]
36. Rosenberger PH, Henderson KE, Grilo CM. Psychiatric disorder comorbidity and association with eating disorders in bariatric surgery patients: A cross-sectional study using structured interview-based diagnosis. J Clin Psychiatry. 2006; 67(7):1080–1085. [PubMed: 16889451]
37. Sarwer DB, Cohn NI, Gibbons LM, et al. Psychiatric diagnoses and psychiatric treatment among bariatric surgery candidates. Obes Surg. 2004; 14(9):1148–1156. [PubMed: 15527626]
38. Kalarchian MA, Marcus MD, Levine MD, et al. Psychiatric disorders among bariatric surgery candidates: relationship to obesity and functional health status. Am J Psychiatry. 2007; 164(2):328–334. [PubMed: 17267797]
39. Muhlhans B, Horbach T, de Zwaan M. Psychiatric disorders in bariatric surgery candidates: a review of the literature and results of a German prebariatric surgery sample. Gen Hosp Psychiatry. 2009; 31(5):414–421. [PubMed: 19703634]

40. Gastrointestinal Surgery for Severe Obesity. NIH Consens Statement Online 1991 Mar 25–27. 2012 Jan 10; 9(1):1–20.
41. Mechanick JI, Kushner RF, Sugerman HJ, Gonzalez-Campoy JM, Collazo-Clavell ML, Spitz AF, Apovian CM, Livingston EH, Brolin R, Sarwer DB, Anderson WA, Dixon J, Guven S. American Association of Clinical Endocrinologists; Obesity Society; American Society for Metabolic & Bariatric Surgery. American Association of Clinical Endocrinologists, The Obesity Society, and American Society for Metabolic & Bariatric Surgery medical guidelines for clinical practice for the perioperative nutritional, metabolic, and nonsurgical support of the bariatric surgery patient. Obesity (Silver Spring). 2009; (Suppl 1):S1–70. Erratum in: Obesity (Silver Spring) 2010,18 (3), 649. [PubMed: 19319140]
42. Dixon JB, Dixon ME, O'Brien PE. Pre-operative predictors of weight loss at 1-year after Lap-Band surgery. Obes Surg. 2001 Apr; 11(2):200–7. [PubMed: 11355027]
43. Clark MM, Balsiger BM, Sletten CD, Dahlman KL, Ames G, Williams DE, Abu-Lebdeh HS, Sarr MG. Psychosocial factors and 2-year outcome following bariatric surgery for weight loss. Obes Surg. 2003 Oct; 13(5):739–45. [PubMed: 14627469]
44. Heinberg LJ, Ashton K. History of substance abuse relates to improved postbariatric body mass index outcomes. Surg Obes Relat Dis. 2010 Jul-Aug;6(4):417–21. Epub 2010 Apr 24. [PubMed: 20655025]
45. Kalarchian MA, Marcus MD, Levine MD, Soulakova JN, Courcoulas AP, Wisinski MS. Relationship of psychiatric disorders to 6-month outcomes after gastric bypass. Surg Obes Relat Dis. 2008 Jul-Aug;4(4):544–9. Epub 2008 Jun 2. [PubMed: 18514586]
46. Lieber CS. Metabolism of alcohol. Clin Liver Dis. 2005; 9(1):1–35. [PubMed: 15763227]

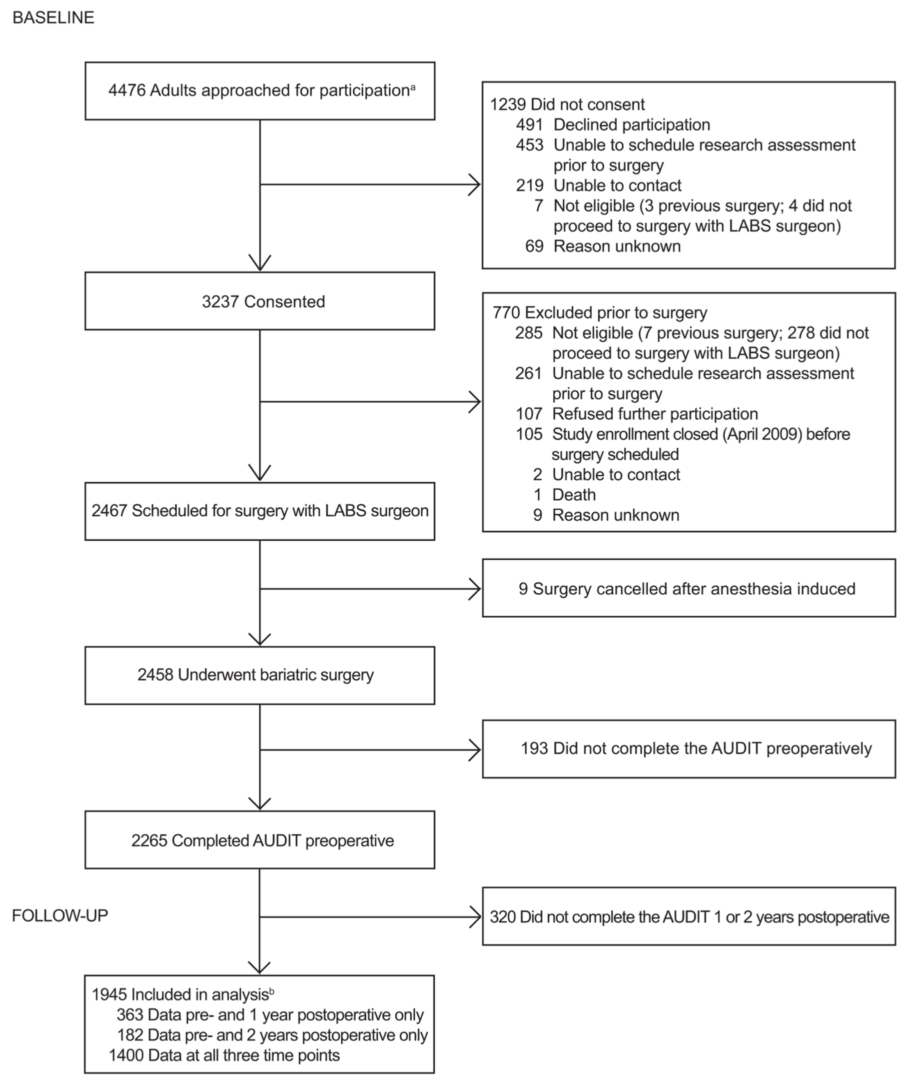


**Figure 1.**

Longitudinal Assessment of Bariatric Surgery-2 (LABS-2) Study Flow from Approached Patients to Analysis Samples.

[a]Patients 18 years or older, with no previous bariatric surgery, planning to undergo bariatric surgery by a participating surgeon.

[b]Presentation of descriptive statistics was limited to participants with AUDIT data at all three time points. Some analyses included slightly smaller samples due to missing covariate data.

## Table 1

Preoperative Characteristics of LABS-2 Participants Included in Analysis

| | No. (%) N=1945[a] |
|---|---|
| **Sociodemographics** | |
| Male | 413 (21.2) |
| Age, years | |
| median (quartiles) | 47 (38,55) |
| range | 19–78 |
| Race | |
| White | 1681 (87.0) |
| Black | 182 (9.4) |
| Asian | 3 (0.2) |
| American Indian/Alaska Native | 13 (0.7) |
| Native Hawaiian/other Pacific Islander | 4 (0.2) |
| Multiple races | 37 (1.9) |
| Unknown | 12 (0.6) |
| Hispanic ethnicity | 89 (4.6) |
| Married/living as married | 1239 (64.0) |
| Education | |
| High school or less | 445 (23.0) |
| Some college | 768 (39.7) |
| College degree or higher | 722 (37.3) |
| Work for pay | 1322 (68.2) |
| Household income | |
| less than $25,000 | 340 (18.0) |
| $25,000–$49,000 | 483 (25.6) |
| $50,000–$74,999 | 434 (23.0) |
| $75,000–$99,999 | 307 (16.3) |
| $100,000 or more | 321 (17.0) |
| **Anthropometrics** | |
| Body Mass Index, kg/m$^2$ | |
| median (quartiles) | 45.8 (41.8,51.3) |
| range | 33.7–94.3 |
| **Quality of Life and Mental Health** | |
| SF-36 Physical component score | |
| median (quartiles) | 36.3 (27.8,44.9) |
| range | 8.7–70.3 |
| SF-36 Mental component score | |
| median (quartiles) | 51.5 (42.8,57.1) |
| range | 12.6–75.9 |
| Beck Depression Inventory score | |
| median (quartiles) | 7 (3,12) |

| | No. (%) N=1945[a] |
|---|---|
| range | 0–39 |
| Binge eating | 308 (16.1) |
| Past-year treatment for psychiatric or emotional problems | 1106 (57.4) |
| **Interpersonal support** | |
| ISEL Appraisal score | |
| median (quartiles) | 16 (13,16) |
| range | 4–16 |
| ISEL Belonging score | |
| median (quartiles) | 16 (12,16) |
| range | 4–16 |
| ISEL Tangible score | |
| median (quartiles) | 15(13,16) |
| range | 4–16 |
| **Smoking, Alcohol and Drug Use** | |
| Current smokers | 43 (2.2) |
| Regular alcohol consumption (≥2 times/week) | 137 (7.0) |
| Alcohol Use Disorder[b] | 152 (7.8) |
| Past-year recreational drug use | 83 (4.3) |
| **Surgical Procedure** | |
| Roux-en-Y gastric bypass | 1360 (69.9) |
| Laparoscopic adjustable gastric band | 490 (25.2) |
| Banded gastric bypass[c] | 30 (1.5) |
| Sleeve gastrectomy | 50 (2.6) |
| Biliopancreatic diversion with switch | 15 (0.8) |

Abbreviations: SF-36, Medical Outcomes Study 36-item Short-Form Health Survey; ISEL, Interpersonal Support Evaluation List; AUDIT, Alcohol Use Disorders Identification Test.

[a]The number of participants across categories may not sum to the total number of participants because of missing data.

[b]AUDIT score ≥8, alcohol dependence symptoms, or alcohol-related harm.

[c]Roux-en-Y gastric bypass with a non-adjustable band during the same operation.

**Table 2**

Alcohol Use, Related-Problems, and Treatment Before and 1 and 2 Years After Bariatric Surgery

| | No. (%)[a] | | | *P* | | |
|---|---|---|---|---|---|---|
| | **Preoperative** | **1 year Postoperative** | **2 years Postoperative** | **Pre vs. 1** | **Pre vs. 2** | **1 vs. 2** |
| **Select AUDIT items** | | | | | | |
| In the past 12 months…. | | | | | | |
| Frequency of alcohol consumption | | | | 0.89 | <.0001 | <.0001 |
| Never | 578 (41.3) | 628 (44.9) | 580 (41.4) | | | |
| Monthly or less | 523 (37.4) | 455 (32.5) | 414 (29.6) | | | |
| 2–4 times / month | 197 (14.1) | 200 (14.3) | 238 (17.0) | | | |
| 2–3 times / week | 65 (4.6) | 74 (5.3) | 97 (6.9) | | | |
| 4+ times / week | 37 (2.6) | 43 (3.1) | 71 (5.1) | | | |
| Alcoholic drinks on a typical drinking day | | | | <.0001 | 0.22 | <.01 |
| Not applicable (0 drinks) | 568 (41.8) | 619 (45.5) | 571 (42.0) | | | |
| 1–2 drinks | 611 (44.9) | 607 (44.6) | 623 (45.8) | | | |
| 3–4 drinks | 134 (9.9) | 106 (7.8) | 129 (9.5) | | | |
| 5–6 drinks | 35 (2.6) | 18 (1.3) | 25 (1.8) | | | |
| 7–9 drinks | 8 (0.6) | 8 (0.6) | 11 (0.8) | | | |
| 10+ drinks | 4 (0.2) | 2 (0.2) | 1 (0.1) | | | |
| **AUDIT summary measures** | | | | | | |
| Consumption at a hazardous level, missing=43 | 266 (19.6) | 180 (13.3) | 224 (16.5) | <.0001 | <.001 | 0.02 |
| AUDIT score ≥8, missing=8 | 36 (2.6) | 43 (3.1) | 76 (5.5) | 0.36 | <.0001 | <.001 |
| Alcohol dependence symptoms, missing=9 | 39 (2.8) | 44 (3.2) | 77 (5.5) | 0.44 | <.0001 | <.01 |
| Alcohol-related harm, missing=9 | 94 (6.8) | 93 (6.7) | 119 (8.6) | 0.65 | <.01 | 0.02 |
| Alcohol Use Disorder,[b] missing=11 | 106 (7.6) | 101 (7.3) | 133 (9.6) | 0.98 | <.01 | 0.01 |
| **Treatment for alcohol or drug abuse in past 12 months** | | | | | | |
| Admitted to hospital for treatment, missing=34 | 1 (0.1) | 3 (0.2) | 2 (0.2) | 0.40 | 0.52 | 0.87 |
| Out-patient treatment (i.e. counseling), missing=101 | 6 (0.5) | 9 (0.7) | 9 (0.7) | 0.29 | 0.18 | 0.74 |
| Treatment (in hospital or out-patient), missing=115 | 6 (0.5) | 10 (0.8) | 9 (0.7) | 0.16 | 0.25 | 0.84 |

Abbreviation: AUDIT, Alcohol Use Disorders Identification Test

[a] No.(%) limited to participants with AUDIT data at all three time points (n=1400). The number of participants across categories may not sum to 1400 because of missing data. Differences by time point determined with generalized linear mixed models using all available data (n=1945).

[b] Alcohol Use Disorder defined as AUDIT score ≥8 or indication of alcohol dependence symptoms or alcohol-related harm.


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## Table 3

Preoperative Predictors of Alcohol Use Disorder in the First or Second Postoperative Year

| Characteristics | Group N | n(%) 1 year Post-op | n(%) 2 year Post-op | Adjusted OR(95%CI)[a] | *P* |
|---|---|---|---|---|---|
| **Preoperative** | | | | | |
| Female sex | 1514 | 95(6.3) | 110(7.3) | 1 [Reference] | - |
| Male sex | 399 | 39(9.8) | 45(11.3) | 2.14(1.51–3.01) | <.0001 |
| Age*AUD interaction | - | - | - | - | <.01 |
| Age, per 10 years younger[b] | - | - | - | - | <.0001 |
| Age, per 10 years younger with AUD | - | - | - | 1.31(1.03–1.68) | 0.03 |
| Age, per 10 years younger without AUD | - | - | - | 1.95(1.65–2.30) | <.0001 |
| Non-smoker | 1871 | 126(6.7) | 148(7.9) | 1 [Reference] | - |
| Smoker | 42 | 8(19.1) | 7(16.7) | 2.58(1.19–5.58) | 0.02 |
| Does not consume alcohol regularly | 1778 | 89(5.0) | 108(6.1) | 1 [Reference] | - |
| Regular (≥2/week) alcohol consumption | 135 | 45(33.3) | 47(34.8) | 6.37(4.17–9.72) | <.0001 |
| No Alcohol Use Disorder | 1765 | 72(4.1) | 93(5.3) | 1 [Reference] | - |
| Alcohol Use Disorder[c] | 148 | 62(41.9) | 62(41.9) | - | 0.33 |
| Alcohol Use Disorder at age 20 | - | - | - | 4.15(2.00–8.63) | <.001 |
| Alcohol Use Disorder at age 45 | - | - | - | 11.14(7.71–16.10) | <.0001 |
| Alcohol Use Disorder at age 60 | - | - | - | 20.14(10.77–37.65) | <.0001 |
| No past-year recreational drug use | 1830 | 119(6.5) | 135(7.4) | 1 [Reference] | - |
| Past-year recreational drug use | 83 | 15(18.1) | 20(24.1) | 2.38(1.37–4.14) | <.01 |
| ISEL belonging score, per 1 point lower | - | - | - | 1.09(1.04–1.15) | <.01 |
| **Surgical Procedure** | | | | | <.01 |
| Laparoscopic adjustable gastric band | 485 | 26(5.4) | 27(5.6) | 1 [Reference] | - |
| Roux-en-Y gastric bypass | 1339 | 103(7.7) | 122(9.1) | 2.07(1.40–3.08) | <.001 |
| Banded gastric bypass | 28 | 1(3.6) | 0(0.0) | 0.26(0.02–3.04) | 0.28[d] |
| Sleeve gastrectomy | 46 | 1(2.2) | 3(6.5) | 0.80(0.24–2.75) | 0.73[d] |
| Biliopancreatic diversion with switch | 15 | 3(20.0) | 3(20.0) | 2.72(0.70–10.52) | 0.15[d] |
| **Time** | | | | | |
| First postoperative year | 1913 | 134(7.0) | - | 1 [Reference] | - |

| Characteristics | Group N | n(%) 1 year Post-op | n(%) 2 year Post-op | Adjusted OR(95%CI)[a] | *P* |
|---|---|---|---|---|---|
| Second postoperative year | 1913 | - | 155(8.1) | 1.57(1.26–1.96) | <.0001 |

Abbreviations: Alcohol Use Disorder, AUD CI, confidence interval, OR, odds ratio, ISEL, Interpersonal Support Evaluation List

[a]Odds ratios and associated 95% CIs were adjusted for all other variables in the table. N=1913 of 1933 due to missing covariate data.

[b]OR differs by AUD status.

[c]OR differs by age. Three examples are provided. The reference category for each is no AUD at the same age. In addition, adjusted odds ratios are presented by age in eFigure 1, available at http://jama.ama-assn.org/.

[d]Analysis is underpowered to detect a difference between this surgical procedure and the reference category.

**Table 4**

Pre- and Postoperative Predictors of Alcohol Use Disorder in the First or Second Postoperative Year

| | Group N | | n(%) | | | |
|---|---|---|---|---|---|---|
| **Characteristics** | **1 year pre-op** | **2 year pre-op** | **1 year pre-op** | **2 year pre-op** | **Adjusted OR(95%CI)** | ***P*** |
| **Preoperative** | | | | | | |
| Female sex | 1454 | 1454 | 94(6.5) | 110(7.6) | 1 [Reference] | - |
| Male sex | 386 | 386 | 38(9.8) | 45(11.7) | 2.30(1.63–3.26) | <.0001 |
| Age*AUD interaction | - | - | - | - | - | 0.03 |
| Age, per 10 years younger[b] | - | - | - | - | - | <.0001 |
| Age, per 10 years younger with AUD | - | - | - | - | 1.32(1.03–1.69) | 0.03 |
| Age, per 10 years younger without AUD | - | - | - | - | 1.80(1.53–2.13) | <.0001 |
| Non-smoker | 1800 | 1800 | 125(6.9) | 148(8.2) | 1 [Reference] | - |
| Smoker | 40 | 40 | 7(17.5) | 7(17.5) | 1.51(0.64–3.55) | 0.34 |
| Does not consume alcohol regularly | 1709 | 1709 | 88(5.2) | 108(6.3) | 1 [Reference] | - |
| Regular (≥2/week) alcohol consumption | 131 | 131 | 44(33.6) | 47(35.9) | 7.60(4.94–11.68) | <.0001 |
| No Alcohol Use Disorder | 1695 | 1695 | 72(4.3) | 93(5.5) | 1 [Reference] | - |
| Alcohol Use Disorder[c] | 145 | 145 | 60(41.4) | 62(42.8) | - | 0.17 |
| Alcohol Use Disorder at age 20 | - | - | - | - | 4.54(2.15–9.56) | <.0001 |
| Alcohol Use Disorder at age 45 | - | - | - | - | 9.90(6.82–14.38) | <.0001 |
| Alcohol Use Disorder at age 60 | - | - | - | - | 15.82(8.47–29.57) | <.0001 |
| No recreational drug use | 1759 | 1759 | 117(6.7) | 135(7.7) | 1 [Reference] | - |
| Recreational drug use | 81 | 81 | 15(18.5) | 20(24.7) | 1.10(0.57–2.09) | 0.78 |
| ISEL belonging score, per 1 point lower | - | - | - | - | 1.07(1.01–1.13) | 0.03 |
| SF-36 Mental component score, per 10 fewer points | - | - | - | - | 0.99(0.83–1.17) | 0.87 |
| No treatment for psychiatric or emotional problems | 788 | 788 | 51(6.5) | 66(8.4) | 1 [Reference] | - |
| Treatment for psychiatric or emotional problems | 1052 | 1052 | 81(7.7) | 89(8.5) | 0.65(0.45–0.94) | 0.02 |
| **Surgical Procedure** | | | | | | <.01 |
| Laparoscopic adjustable gastric band | 470 | 470 | 24(5.1) | 27(5.7) | 1 [Reference] | - |
| Roux-en-Y gastric bypass | 1286 | 1286 | 103(8.0) | 122(9.5) | 2.12(1.43–3.15) | <.001 |
| Banded gastric bypass | 26 | 26 | 1(3.9) | 0(0.0) | 0.24(0.02–2.55) | 0.24[d] |

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| | Group N | | n(%) | | | |
|---|---|---|---|---|---|---|
| **Characteristics** | **1 year pre-op** | **2 year pre-op** | **1 year pre-op** | **2 year pre-op** | **Adjusted OR(95%CI)** | ***P*** |
| Sleeve gastrectomy | 43 | 43 | 1(2.3) | 3(7.0) | 0.84(0.26–2.78) | 0.77[d] |
| Biliopancreatic diversion with switch | 15 | 15 | 3(20.0) | 3(20.0) | 1.82(0.39–8.55) | 0.45[d] |
| **Postoperative** | | | | | | |
| Non-smoker | 1541 | 1356 | 106(6.9) | 118(8.7) | 1 [Reference] | - |
| Smoker | 133 | 150 | 25(18.8) | 36(24.0) | 1.83(1.22–2.76) | <.01 |
| No past-year recreational drug use | 1610 | 1438 | 112(7.0) | 128(8.9) | 1 [Reference] | - |
| Past-year recreational drug use | 63 | 60 | 19(30.2) | 27(45.0) | 3.09(1.76–5.43) | <.0001 |
| SF-36 Mental component score, per 10 fewer points | - | - | - | - | 1.28(1.12–1.45) | <.001 |
| No treatment for psychiatric or emotional problems | 1029 | 896 | 69(6.7) | 77(8.6) | 1 [Reference] | - |
| Treatment for psychiatric or emotional problems | 639 | 591 | 62(9.7) | 77(13.0) | 1.73(1.23–2.45) | <.01 |
| **Time** | | | | | | |
| First postoperative year | 1840 | - | 132(7.2) | - | 1 [Reference] | - |
| Second postoperative year | - | 1840 | - | 155(8.4) | 1.55(1.24–1.95) | <.001 |

Abbreviations: Alcohol Use Disorder, AUD CI, confidence interval, OR, odds ratio, ISEL, Interpersonal Support Evaluation List

[a]Odds ratios and associated 95% CIs were adjusted for all other variables in the table. N=1840 of 1933 due to missing covariate data.

[b]OR differs by AUD status.

[c]OR differs by age. Three examples are provided. The reference category for each is no AUD at the same age.

[d]Analysis is underpowered to detect a difference between this surgical procedure and the reference category.