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Alcohol Use Risk In Adolescents 2 Years After Bariatric Surgery

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Abstract

Background—Problematic alcohol use and increased sensitivity post-operatively in adult weight loss surgery (WLS) patients heightens concerns. No data have characterized these behaviors in adolescents, a gap given adolescent alcohol use and heavy drinking are public health concerns.

Setting—Five academic medical centers.

Methods—Utilizing a prospective controlled design, adolescents undergoing WLS (n=242) and non-surgical adolescents with severe obesity (n=83) completed the Alcohol Use Disorders Test. Analyses included 216 surgical ($M_{age}=17.1\pm1.5$, $M_{BMI}=52.9\pm9.3$, 91.8% female, 67.6% White) and 79 non-surgical participants ($M_{age}=16.2\pm1.4$, $M_{BMI}=46.9\pm6.1$, 82.3% female, 53.2% White) with baseline data and at 12- or 24-months post-operatively.

Results—The majority reported “never” consuming alcohol within the year prior to surgery (surgical: 92%, non-surgical: 91%) or by 24-months (surgical: 71%, non-surgical: 74%), when alcohol use disorder (AUD) approached 9%. Among alcohol users at 24 months (n=52 surgical, n=17 non-surgical), 35% surgical and 29% non-surgical consumed 3+ drinks on a typical drinking day; 42% surgical and 35% non-surgical consumed 6+ drinks on at least one occasion. For the surgical group, alcohol use changed as a function of older age (OR=2.47, p=0.01) and lower BMI

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(OR=0.94, $p<0.001$). Greater percent change in weight (0–24 months) was associated with increased odds of alcohol use at 24 months (OR=1.01, 95% CI: 1.002–1.02).

Conclusions—Alcohol use was lower than national base rates. AUD rates and harmful consumption raise concerns given extant adult literature. Alcohol education focused on harm reduction (i.e., lower consumption, managing situations conducive to alcohol-related harm) and monitoring by healthcare providers as patients mature is indicated.

Keywords

adolescent; alcohol; bariatric surgery; pediatric

Introduction

A growing empirical literature is focusing on problematic alcohol use behaviors in adults with severe obesity that undergo weight loss surgery (WLS). While an active substance use disorder is widely accepted as a contraindication for WLS,¹ concerning reports suggest that rates of alcohol use as well as abuse begin to increase by the second post-operative year, including among patients with no prior history of problematic alcohol use.^{2–4} A majority (59%) of adult WLS patients enrolled in the Longitudinal Assessment of Bariatric Surgery (LABS) study report at least some alcohol use, with alcohol use disorder (AUD) rates estimated at approximately 8–9% of patients at 2 and 3-years post-operatively.^{2,3} Data characterizing links between adult alcohol use behavior and weight loss outcomes are equivocal.^{5,6} Finally, increased alcohol sensitivity occurs post-operatively, particularly for Roux-en-Y gastric bypass (RYGB) patients, including increased rate of absorption and serum peak levels, intoxication, perceived drunkenness, and in some work, a longer elimination half-life from the bloodstream.^{7–10} Recognizing our understanding of alcohol metabolism following sleeve gastrectomy is far more limited,^{11,12} these alcohol-related outcomes are clinical safety concerns. As a direct result, Heinberg and colleagues⁶ published recommendations for the management and assessment of alcohol use in adults following WLS. Further, American Society for Metabolic and Bariatric Surgery (ASMBS) clinical practice guidelines for support of the adult WLS patient¹ asserted, “following RYGB, high-risk groups should eliminate alcohol consumption.”

To date, there are no empirical data characterizing alcohol use behaviors in the adolescent WLS population. This is a critical knowledge gap. Epidemiological surveillance data demonstrate alcohol use behaviors typically onset and then increase across the adolescent/young adult years^{13,14} placing some on a trajectory to abuse and dependence by young adulthood.^{15,16} National Comorbidity Study estimates have indicated that 4.7% of adolescents meet criteria for alcohol abuse with/without dependence,¹⁷ with the highest period of adult lifetime risk of AUD onset being between the ages of 19–31 years.¹⁸ Alcohol is the most frequently used substance among adolescents, including in those with severe obesity.^{19–21} Further, when adolescents and young adults consume alcohol, they consume more drinks per occasion than adults (i.e., binge drinking).²² Alcohol use, and binge drinking in particular, are primary contributors to the leading cause of death and/or unintentional injury in this age group.^{23,24} For these reasons, the study of alcohol use

behaviors in adolescents before WLS and early in the post-operative course is both timely and imperative to appropriately inform patient care.

The Teen Longitudinal Assessment of Bariatric Surgery (Teen-LABS) study prospectively tracked alcohol use behaviors in adolescents undergoing WLS²⁵ while a parallel ancillary study (TeenView) recruited and tracked adolescents with severe obesity not undergoing surgery. The aims of the current analysis were to document the prevalence of alcohol use behaviors in these groups over time, including general usage rates as well as indicators of risk. We were also interested in exploring whether the frequency of participants who endorsed any drinking changed over time, and to identify predictors of this change. Specifically, was an adolescent more/less likely to drink over time because of their age or degree of excess weight (i.e., BMI). An exploratory cross-sectional analysis examined whether percent weight loss at 24-months predicted any past year alcohol use at 24 months for the surgical group. It is noteworthy that these initial questions regarding adolescents are decidedly different than those asked in the extant adult literature which focus more specifically on predictors of alcohol use severity (i.e., number of drinks consumed, prevalence of AUD).

Methods

Overview of Study Design

Teen-LABS is a multi-center prospective longitudinal observational study evaluating safety, efficacy, health, and quality of life outcomes of consecutive adolescent patients with severe obesity (body mass index [BMI] ≥ 40 kg/m²) undergoing a bariatric surgical procedure (March 2007 – February 2012) at five academic medical centers in the United States. Teen-LABS's purpose, inclusion criterion, and methodology were previously reported.²⁶ TeenView is an ancillary study to Teen-LABS, conducted in parallel and designed to investigate the psychosocial health of adolescents with severe obesity and the benefits and emerging psychosocial risks associated with surgery. TeenView enrolled both Teen-LABS participants and a demographically similar non-surgical comparator group composed of treatment-seeking adolescents with severe obesity presenting to lifestyle modification programs at the Teen-LABS clinical sites. TeenView was not designed as a comparative intervention trial (i.e., WLS vs. lifestyle modification), but rather, to elucidate psychosocial benefits and risks associated with adolescent WLS relative to severe obesity's "natural course". Teen-LABS and TeenView protocols were approved by each institution's Institutional Review Board with study conduct overseen by an independent Data and Safety Monitoring Board and data managed in a central database by a data-coordinating center.

Participants

Two cohorts participated in the present analyses: (1) Teen-LABS participants and their caregivers; and (2) the TeenView study non-surgical comparator adolescents and their caregivers. Recruitment and participation rates are detailed in Figure 1 along with information regarding samples used in analyses (see Statistical Methods).

Surgery—Two hundred and forty-two consecutive adolescents (ages 13–19 years) approved for WLS at Teen-LABS centers.²⁶

Non-surgical Comparators—Adolescents with severe obesity were identified from lifestyle modification programs whose families consented to being contacted for TeenView enrollment should their adolescent become a demographic match (i.e., gender, race, +/- 6 months in age) to a surgery participant at any Teen-LABS site, n=83.

Procedures

Adolescents and caregivers provided written assent/consent and independently completed self-report measures. Baseline assessments were completed at an in-person visit at a clinical center by study trained personnel. Data were collected at study entry (i.e., within 30 days prior to surgery) and 12- and 24-month postoperative/follow-up research visits. The majority of follow-up study visits occurred in-person at the clinical centers. The surgical group also used home-based data collection (n=7 at 12-months, n=23 at 24-months) or self-reported information (n=5 at 24-months). The TeenView protocol included a web-based home administration option (n=1 at 12-months, n=5 at 24-months), with height and weight self-reported. Participants were informed via the consent/assent process that responses were confidential.

Alcohol Use Disorders Test (AUDIT)

The AUDIT²⁷ is a validated 10-item screening tool to assess alcohol use, including hazardous consumption. Participants reported “past 12-month” alcohol use including frequency/level of consumption. Scoring criteria for AUD requires a total score > 8, or a positive subscore for alcohol dependence (3 items) or alcohol-related harm (4 items). Criteria for hazardous consumption requires consuming “> 3 drinks per occasion on a typical drinking day” or “6 or more drinks on >1 occasion” in the past year. The AUDIT has been validated for use in respondents as young as 14.²⁸

BMI and Weight Change

Height and weight were measured using a standardized protocol and were used to calculate BMI (kg/m²). If a protocol measured weight was not obtained, a self-reported weight was used as differences between measured and self-reported weights in this cohort were negligible.²⁹ For analyses, weight change was reported as the percent change from baseline.

Other measures

Participants and caregiver sociodemographics were self-reported, including gender, race/ethnicity (recoded as White versus non-White), age, and caregiver highest year of education (recoded as < high school graduate, 1+ years post-secondary). Participants also self-reported history of outpatient or inpatient drug and/or alcohol abuse treatment within the past 12-months at each time-point.

Statistical Methods

Missing data were handled via maximum likelihood estimation in Mplus (Version 7.11). Descriptive statistics were calculated to summarize participant characteristics. Frequencies and percentages were reported for categorical measures. Means and standard deviations were calculated for continuous variables. Prevalence rates were based on participants with AUDIT data at all three time-points (N=180 WLS and 66 Non-surgical). The nesting of participants within the five sites was controlled via specialized variable and analysis commands (i.e., 'Cluster = site' and 'Type = Complex') to minimize type-1 errors. Change over time in prevalence of alcohol use was *explored* separately by group (WLS, Non-surgical) via multi-level longitudinal analyses with a binary response variable, with age and BMI as covariates. To maximize statistical power, all available observations were used (i.e., participants with data at baseline and either 12 or 24-months; N=216 WLS and 79 non-surgical). Logistic regression *explored* if percent change in weight from *at 24 months* was predictive of past year alcohol use at 24 months for WLS participants with baseline and 24-month data (n= 196 WLS). For this analysis, confidence intervals (CI) were generated with a bootstrapping procedure with 1,000 re-samples.

Results

Sample Characteristics

Surgery participants were older than non-surgical comparators likely due to lower age eligibility criteria for the TeenView study (Table 1). Surgery participants were also more likely than comparators to be White. All participants were severely obese at baseline, although the nonsurgical group had a lower BMI. Attrition analyses determined that membership in the longitudinal analysis sample (i.e., baseline and either 12 or 24 month data) versus the non-longitudinal sample was unrelated to group, gender, race, baseline BMI, or past year alcohol use at baseline. There was an association for baseline age, whereby the non-longitudinal group was younger ($p=0.05$).

Prevalence of alcohol use behaviors

Any consumption of alcohol—The majority of participants in both groups reported “never” in response to frequency of consuming alcohol within the year prior to surgery (WLS: 91.7%_{baseline}, 95% CI: 87.6–95.7); Non-surgical: 90.9%_{baseline}, 95% CI: 84.0–97.8) or either post-operative time point (WLS: 83.3%_{12-months}, 95% CI: 77.9–88.8; 70.6%_{24-months}, 95% CI: 63.9–77.2; Non-surgical: 84.8%_{12-months}, 95% CI: 76.2–93.5; 74.2%_{24-months}, 95% CI: 63.7–84.8) (Table 2, Table 3 by surgical procedure type).

Alcohol Use Disorder—Overall AUD prevalence was low for surgical and non-surgical comparators across time points: WL: 5.0%_{baseline}, 95% CI: 1.8–8.2; 3.3%_{12-months}, 95% CI: 0.7–6.0; 8.9%_{24-months}, 95% CI: 4.7–13.0; non-surgical 6.1%_{baseline}, 95% CI: 0.3–11.8; 4.5%_{12-months}, 95% CI: 0.0–9.6; 9.1%_{24-months}, 95% CI: 2.2–16.0 (Tables 2–3). Nine WLS met criteria for AUD prior to surgery (baseline). At 24-months, 8 had remitted, 1 continued to screen positive, however an additional 15 were new onset AUD, which is 28.3% of the WLS group (n=53) who consumed alcohol in the past year (non-surgical: baseline = 4; 24-

months: 3 remitted, 1 continued, with 5 new onset [i.e., 29.4% of 17 in non-surgical group who consumed any alcohol in the past year]).

Level of consumption, hazardous use, and alcohol-related harm—Overall prevalence for hazardous consumption based on AUDIT criteria was low for surgery and non-surgical comparators across time points: WLS: 5.0%_{baseline}, 95% CI: 1.8–8.2; 8.9%_{12-months}, 95% CI: 4.7–13.0; 13.3%_{24-months}, 95% CI: 8.4–18.3; non-surgical 7.6%_{baseline}, 95% CI: 1.2–14.0; 12.1%_{12-months}, 95% CI: 4.2–20.0; 12.1%_{24-months}, 95% CI: 4.2–20.0 (Tables 2–3). Further descriptive subgroup analyses focused on consumption on a “typical drinking day” among those participants who did consume alcohol. Among participants who consumed alcohol and reported their typical patterns of consumption at baseline (see Table 2), 6 of 14 (42.8%) surgical and 5 of 6 (83.3%) comparators reported consuming 3+ drinks on a typical drinking day. At 24-months, 18 of 52 (34.6%) surgical and 5 of 17 (29.4%) non-surgical consumed 3+ drinks on a typical drinking day.

In addition, subgroup analyses restricted to those who consumed any alcohol in the past year were completed to describe prevalence of drinking > 6 drinks on one or more occasion (Tables 2). Among participants who consumed any alcohol in the year prior to the baseline assessment, 8 of 15 (53.3%) surgical and 5 of 6 (83.3%) comparators reported consuming > 6 drinks on at least one occasion in the past year. At 24-months, 22 of 53 (41.5%) surgical and 6 of 17 (35.3%) comparators reported consuming > 6 drinks on at least one occasion in the past year. Finally, of these 53 WLS participants who had consumed alcohol during the second post-operative year, 13 (24.5%) reported experiencing at least one symptom of alcohol-related harm (n=9 felt guilt/remorse, n=7 unable to remember night before, n=1 injured someone, n=3 told to cut down).

Exploratory Analyses: Understanding who chooses to drink

Exploratory longitudinal analyses of change in prevalence over time of those who report any alcohol consumption were completed separately for surgery participants and non-surgical comparators. For both groups, the number of participants who reported any past year alcohol use did not significantly change as a function of time. Rather, for the surgical group only, alcohol use prevalence changed significantly as a function of age ($B=0.95$; OR=2.47, 95% CI: 1.44–4.23) and BMI ($B=-0.06$; OR=0.94, 95% CI: 0.92–0.97). Specifically, for every one-year increase in age at each time point, a surgery participant was 2.5 times more likely to have consumed alcohol. In addition, for every ten-unit decrease in BMI at each time point, a surgery participant was 79% ($OR = 1/0.94 = 1.06^{10} = 1.79$) more likely to have consumed alcohol. For the non-surgical group, alcohol use was unrelated to age or BMI.

Separate *cross-sectional* analyses also *explored* whether percent weight loss at 24 months predicted past year alcohol use at 24 months for the WLS group. Given the small number of adjustable gastric band cases (n=11), analyses were limited to the 135 bypass and 50 sleeve participants. An initial analysis indicated female gender (OR=2.49, 95% CI: 1.32–4.71) and age (OR=1.79, 95% CI: 1.48–2.16) were significantly associated with past year alcohol use at 24 months, while no significant associations were observed with race or primary caregiver

education. Controlling for gender and age, greater percent change in weight (OR=1.01, 95% CI: 1.002–1.02) was associated with higher odds of past year alcohol use at 24 months.

Discussion

Underage alcohol use and heavy drinking are significant public health concerns in the United States. At first glance, results from Teen-LABS suggest normative or even attenuated alcohol use rates for the adolescent/young adult WLS patient across the first two post-operative years. Descriptively, past year alcohol use rates (i.e., frequency of participants who endorse drinking) appear similar for surgical and non-surgical groups, yet were lower than national base rates across time points for both groups. For example, during a comparable time range (i.e., 2007–2013) Monitoring the Future³⁰ reported 47–66% of 10th–12th graders and 76–84.0% of college students and young adults self-reported having used alcohol within the past 12-months.

Initial exploratory analyses suggested that being of older age, whether pre- or post-surgery, significantly increased the likelihood of an adolescent or young adult WLS patient choosing to consume alcohol, arguably an expected finding based on normative developmental trends.^{13,14} More interestingly, we observed preliminary signals that adolescents and young adults of lower BMI (pre- or post-surgery) or those having better weight loss outcomes at 24-months, were also more likely to report alcohol use. Although determinants of alcohol use are likely complex, one can speculate that adolescent/young adult patients of lower severity of excess weight may be more socially engaged and thus exposed to social settings where alcohol is consumed.

The most provocative signals from these initial data highlight harmful patterns of alcohol consumption for the subgroup of adolescent/young adult surgical patients who choose to drink, particularly in the context of the “heightened alcohol sensitivity” data discussed previously and documented in the adult literature.^{7–10} One in every 2 to 3 Teen-LABS participants who consumed alcohol post-operatively reported typically consuming 3+ drinks when drinking, or one or more instances when they consumed 6+ drinks in a single sitting. In addition, nearly 1 in 4 reported having experienced alcohol-related harm. These drinking patterns are deemed hazardous for any adolescent or young adult, regardless of weight status, with 5+ drinks frequently used as the “binge drinking” metric found to be prognostic of alcohol-related consequences in this age group.^{22,31} However, a recent controlled laboratory study demonstrated that adult females post RYGB who ingested 2 alcoholic drinks exceeded legal driving limits for 30 minutes after ingestion, with peak blood alcohol content equated with approximately twice the ingested amount (i.e., approximately 4 drinks).⁹ While adolescent-specific pharmacokinetic studies are needed and which include the sleeve gastrectomy, this potential doubling of serum levels and the attendant elevated risk of intoxication and impairment represent an immediate safety concern for the adolescent or young adult RYGB patient who drinks, even if in “age-normative” ways.

While overall AUD prevalence rates at 24 months for the surgery group (8.9%) was similar to the non-surgical comparators (9.1%), their rates approached those of reported by the LABS adult cohort (9.6%) at the same post-operative time point, patients who were notably

several decades older (i.e., median age, 47 years).² Further, nearly all adolescents or young adults with AUD at 24-months, whether surgical or non-surgical, were new onset since baseline, indicating they were either newly drinking (i.e., normative age effect) or drinking in more hazardous ways over time. Finally, it is important to note that the majority of participants were non-drinkers over the course of the survey period. Conceivably, as they age, many WLS patients will be introduced to alcohol for the first time post-operatively, at a heightened level of intoxication, and within the known developmental window of greatest lifetime risk of developing AUD.¹⁸

There are several limitations to be noted. Although consistent with national WLS trends in adults,³² the Teen-LABS patient population is primarily White and female. Over the course of enrolling consecutive surgical patients, the Teen-LABS cohort resulted in representation of 3 surgical procedures, but was not designed or sufficiently powered to examine procedural differences. There are also known potential limitations of self-report data of adolescent health-risk behaviors due to both cognitive (i.e., recall accuracy) and situational (i.e., fear or reprisal, social desirability) factors, although recent reviews support their reliability and validity when confidentiality is assured.³³ Thus, while under- or over-reporting is possible, this would be true of both the surgical and non-surgical comparator groups, who report remarkably similar behaviors. The AUDIT is intended as a screening tool and is not a comprehensive diagnostic assessment. Of note, there is debate that the commonly used AUDIT cut points should be lowered for adolescents below the age of 19.^{28,34,35} However, suggested alternate cut points have varied across studies, relied on modified AUDIT scoring, and arguably may not be generalizable to the present sample (i.e., severely obese having undergone WLS and therefore potentially more sensitive to the effects of alcohol). Thus, the current estimates of risk may indeed be conservative.

Finally, the Teen-LABS consortium provides the first prospective observation of alcohol use behaviors in adolescents pre-/post-operatively, with prevalences to date entirely unknown. We demonstrated these behaviors are low prevalence across the first two post-operative years. Power to examine group differences, be it procedure type or surgical versus non-surgical, will require significantly larger samples given these are low prevalence behaviors in this age group. Replication of these findings is critically important. Nonetheless, these early signals of risk with regard to level of consumption in those who chose to drink inform what is the beginning of the discussion of adolescent patient care needs.

Conclusions

There is no definition of what would be an acceptable level of alcohol consumption for a WLS patient, of any age. That said, it is important to recognize the social norms and conventions surrounding alcohol consumption (when, how often, level, availability) differ for adolescent and adult patients, including alcohol consumption is illegal for those < 21 years of age in the United States. Of immediate importance to adolescent WLS care is the routine screening of alcohol use behaviors pre- and post-operatively. Further, alcohol education that promotes abstinence but also incorporates information on harm reduction (i.e., lower consumption level, how to manage or avoid situations conducive to alcohol-related harm) is critical to mitigate potential clinical and safety risks. Ongoing monitoring

should extend beyond the surgical program to providers in all pediatric healthcare settings and continue as these patients transition to adult care. Longer-term follow-up is currently ongoing with these study groups to determine alcohol abuse and dependence trajectories, with consideration of potential age-salient factors that would heighten risk for developing alcohol difficulties independent of the effect of surgery and weight loss. Such research will inform clinical guidelines as well as targets and timing of education and adjunctive intervention to optimize safety and health outcomes for this age group.

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Figure 1.

Teen-LABS surgical and TeenView non-surgical comparator flow from approached patients to analysis sample.

Note: AUDIT=Alcohol Use Disorder Identification Test

Table 1

Demographic, anthropometric, and procedural characteristics of bariatric surgery adolescents and non-surgical comparator adolescents and their families.

	Total (N=295) Mean + SD %	Surgical (n =216) Mean + SD %	Non-Surgical (n = 79) Mean + SD %	<i>p</i> ^a
Demographics				
Adolescent				
Age at baseline	16.85 + 1.54	17.10 + 1.53	16.15 + 1.35	<0.001
% Female	77.0%	75.0%	82.3%	0.19
% White	63.7%	67.6%	53.2%	0.02
Caregiver^b				
Age	44.16 + 7.16	44.28 + 6.32	43.85 + 9.05	0.70
% Female	92.3%	91.8%	93.7%	0.59
Education				0.40
% < High School	42.8%	41.3%	46.8%	
Graduation				
% 1+ Years Post-Secondary	57.2%	58.7%	53.2%	
Family				
% Single Caregiver Home	34.4%	33.5%	36.7%	0.61
Adolescent Anthropometrics				
BMI at baseline ^c	51.30 + 8.96	52.92 + 9.31	46.86 + 6.05	<0.001
Weight (kg) at baseline ^c	144.60 + 29.52	149.86 + 31.02	130.24 + 18.64	<0.001
Weight (kg) at 24 months ^{c,d}	113.84 + 31.03	105.73 + 29.37	137.66 + 22.46	<0.001
Percent change in weight at 24 months ^{d,e}	-19.94% + 19.87	-29.09% + 12.59	6.98% + 10.81	<0.001
Surgical Procedure				
Gastric Bypass	—	69.4%	—	
Adjustable Band	—	5.1%	—	
Sleeve Gastrectomy	—	25.5%	—	

Note: BMI= Body Mass Index

^a p-values are based on two-tailed independent t-tests when examining mean values and on Chi-Square tests when examining percentages.

^b Demographic information was available for 204–206 surgical caregivers and 78–79 non-surgical comparator caregivers.

^c Medians by group are also provided as follows. BMI at baseline: Surgical: 51.08; Non-Surgical: 46.22; Weight (kg) at baseline: Surgical: 144.40; Non-Surgical: 126.70; Weight (kg) at 24 months: Surgical: 100.80; Non-Surgical: 136.08.

^d Weight at 24 months and percent change in weight at 24 months were available for 197 surgical adolescents and 67 non-surgical adolescents. Weight was self-reported for 5 surgical and 5 non-surgical.

^e For the purposes of this table, percent change in weight was defined as $\text{weight}_{24\text{-months}} - \text{weight}_{\text{pre-surgery}} / \text{weight}_{\text{pre-surgery}} * 100$.

Alcohol use, severity, and treatment before bariatric surgery and 12 and 24 months after surgery as compared to non-surgical comparators.

Table 2

Select AUDIT items ^a	Surgical (n=180)				Non-Surgical (n=66)			
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Frequency of alcohol consumption								
Never	165 (91.7)	150 (83.3)	127 (70.6)	60 (90.9)	56 (84.8)	49 (74.2)		
Monthly	13 (7.2)	25 (13.9)	39 (21.7)	4 (6.1)	8 (12.1)	12 (18.2)		
2-4 times/month	2 (1.1)	3 (1.7)	7 (3.9)	2 (3.0)	2 (3.0)	4 (6.1)		
2-3 times/week	0	2 (1.1)	7 (3.9)	0	0	1 (1.5)		
4 times/week	0	0	0	0	0	0		
Alcoholic drinks on a typical drinking day^b								
0	165 (92.2)	150 (83.3)	127 (70.6)	60 (90.9)	56 (84.8)	49 (74.2)		
1-2	8 (4.5)	18 (10.1)	34 (19.0)	1 (1.5)	3 (4.5)	12 (18.2)		
3-4	2 (1.1)	9 (5.0)	12 (6.7)	1 (1.5)	4 (6.1)	1 (1.5)		
5-6	2 (1.1)	1 (0.6)	2 (1.1)	1 (1.5)	1 (1.5)	2 (3.0)		
7-9	1 (0.6)	0	0	2 (3.0)	0	2 (3.0)		
10	1 (0.6)	1 (0.6)	4 (2.2)	1 (1.5)	2 (3.0)	0		
> 6 drinks on one occasion	8 (4.4)	11 (6.1)	22 (12.2)	5 (7.6)	6 (9.1)	6 (9.1)		
AUDIT summary measures								
Consumption at hazardous level ^b	9 (5.0)	16 (8.9)	24 (13.3)	5 (7.6)	8 (12.1)	8 (12.1)		
AUDIT score 8	1 (0.6)	1 (0.6)	3 (1.7)	2 (3.0)	1 (1.5)	2 (3.0)		
Alcohol dependence symptoms	3 (1.7)	3 (1.7)	8 (4.4)	1 (1.5)	2 (3.0)	2 (3.0)		
Alcohol-related harm	7 (3.9)	4 (2.2)	13 (7.2)	4 (6.1)	3 (4.5)	4 (6.1)		
Alcohol use disorder (AUD)	9 (5.0)	6 (3.3)	16 (8.9)	4 (6.1)	3 (4.5)	6 (9.1)		
Treatment for alcohol or drug abuse in past 12 months								
Admitted to hospital for treatment	0	0	1 (0.6)	1 (1.5)	1 (1.5)	2 (3.1)		
Outpatient treatment (i.e., counseling)	0	1 (0.6)	3 (1.7)	0	0	2 (3.0)		

Select AUDIT items ^a	Surgical (n=180)			Non-Surgical (n=66)		
	0	12	24	0	12	24
In hospital or outpatient treatment						
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
	0	1 (0.6)	3 (1.7)	1 (1.5)	1 (1.5)	2 (3.1)

Note: AUDIT= Alcohol Use Disorder Identification Test

^aFor participants with Audit data at 0, 12, and 24 months.

^bMissing data for surgical group: n=1 at 0 months, n=1 at 12 months, n=1 at 24 months.

Alcohol use, severity, and treatment before bariatric surgery and 12 and 24 months after surgery as compared to non-surgical comparators by surgical procedure.

Table 3

Select AUDIT items ^a	Non-Surgical (n=66)				Gastric Bypass (n=124)				Sleeve Gastrectomy (n=46)				Adjustable Band (n=10)			
	0	12	24	(%)	0	12	24	(%)	0	12	24	(%)	0	12	24	(%)
Frequency of alcohol consumption																
Never	60 (90.9)	56 (84.8)	49 (74.2)	115 (92.7)	107 (86.3)	91 (73.4)	42 (91.3)	34 (73.9)	27 (58.7)	8 (80.0)	9 (90.0)	9 (90.0)				
Monthly	4 (6.1)	8 (12.1)	12 (18.2)	8 (6.5)	13 (10.5)	25 (20.2)	3 (6.5)	11 (23.9)	13 (28.3)	2 (20.0)	1 (10.0)	1 (10.0)				
2-4 times/month	2 (3.0)	2 (3.0)	4 (6.1)	1 (0.8)	2 (1.6)	4 (3.2)	1 (2.2)	1 (2.2)	3 (6.5)	0 (0.0)	0 (0.0)	0 (0.0)				
2-3 times/week	0	0	1 (1.5)	0	2 (1.6)	4 (3.2)	0	0	3 (6.5)	0	0	0				
4 times/week	0	0	0	0	0	0	0	0	0	0	0	0				
Alcoholic drinks on a typical drinking day ^b																
0	60 (90.9)	56 (84.8)	49 (74.2)	115 (93.5)	107 (87.0)	91 (74.0)	42 (93.1)	34 (73.9)	27 (58.7)	8 (80.0)	9 (90.0)	9 (90.0)				
1-2	1 (1.5)	3 (4.5)	12 (18.2)	5 (4.1)	11 (8.9)	22 (17.9)	3 (6.5)	7 (15.2)	12 (26.1)	0	0	0				
3-4	1 (1.5)	4 (6.1)	1 (1.5)	1 (0.8)	3 (2.4)	6 (4.9)	1 (2.2)	5 (10.9)	5 (10.9)	0	1 (10.0)	1 (10.0)				
5-6	1 (1.5)	1 (1.5)	2 (3.0)	0	1 (0.8)	1 (0.8)	0	0	1 (2.2)	2 (20.0)	0	0				
7-9	2 (3.0)	0	2 (3.0)	1 (0.8)	0	0	0	0	0	0	0	0				
10	1 (1.5)	2 (3.0)	0	1 (0.8)	1 (0.8)	3 (2.4)	0	0	1 (2.2)	0	0	0				
AUDIT summary measures																
Consumption at hazardous level ^b	5 (7.6)	8 (12.1)	8 (12.1)	4 (3.3)	8 (6.5)	15 (12.2)	3 (6.5)	7 (15.2)	8 (17.4)	2 (20.0)	1 (10.0)	1 (10.0)				
AUDIT score 8	2 (3.0)	1 (1.5)	2 (3.0)	1 (0.8)	0 (0.0)	1 (0.8)	0 (0.0)	1 (2.2)	2 (4.3)	0 (0.0)	0 (0.0)	0 (0.0)				

Select AUDIT items ^a	Non-Surgical (n=66)				Gastric Bypass (n=124)				Sleeve Gastrectomy (n=46)				Adjustable Band (n=10)			
	0	12	24	0	12	24	0	12	24	0	12	24	0	12	24	0
	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)	N (%)
Alcohol dependence symptoms	1 (1.5)	2 (3.0)	2 (3.0)	1 (0.8)	2 (1.6)	5 (4.0)	1 (2.2)	1 (2.2)	3 (6.5)	1 (2.2)	1 (2.2)	1 (2.2)	1 (10.0)	0 (0.0)	0 (0.0)	0 (0.0)
Alcohol-related harm	4 (6.1)	3 (4.5)	4 (6.1)	5 (4.0)	3 (2.4)	10 (8.1)	1 (2.2)	1 (2.2)	3 (6.5)	1 (2.2)	1 (2.2)	3 (6.5)	1 (10.0)	0 (0.0)	0 (0.0)	0 (0.0)
Alcohol use disorder (AUD)	4 (6.1)	3 (4.5)	6 (9.1)	5 (4.0)	5 (4.0)	12 (9.7)	2 (4.3)	2 (4.3)	4 (8.7)	1 (2.2)	1 (2.2)	4 (8.7)	2 (20.0)	0 (0.0)	0 (0.0)	0 (0.0)

Note: AUDIT= Alcohol Use Disorder Identification Test

^aFor participants with Audit data at 0, 12, and 24 months.

^bMissing data for Gastric Bypass group: n=1 at 0 months, n=1 at 12 months, n=1 at 24 months.