Objective: To assess substance use before and after bariatric weight loss surgery (WLS). There is a paucity of research investigating the occurrence of substance use following bariatric WLS. It was hypothesized that patients who underwent WLS would exhibit an increase in substance use (drug use, alcohol use, and cigarette smoking) following surgery to compensate for a marked decrease in food intake.

Design: Prospective study.

Setting: A major urban community hospital.

Participants: A total of 155 participants (132 women and 23 men) who underwent WLS were recruited from a preoperative information session at a bariatric surgery center.

Intervention: Participants received either laparoscopic Roux-en-Y gastric bypass surgery (n=100) or laparoscopic adjustable gastric band surgery (n=55). Participants completed questionnaires to assess eating behaviors and substance use at preoperative baseline and 1, 3, 6, 12, and 24 months after surgery.

Main Outcome Measure: Substance use as assessed by the Compulsive Behaviors Questionnaire.

Results: Participants reported significant increases in the frequency of substance use (a composite of drug use, alcohol use, and cigarette smoking) following surgery. Specifically, participants experienced a significant increase in the frequency of composite substance use from baseline to 24 months after surgery (P=.02), as well as significant increases from 1 month, 3 months, and 6 months to 24 months after surgery (all P<.002). In addition, participants who underwent laparoscopic Roux-en-Y gastric bypass surgery reported a significant increase in the frequency of alcohol use from baseline to 24 months after surgery (P=.011). The response rate to the survey was 61% at 1-month follow-up, 41% at 3-month follow-up, 43% at 6-month follow-up, 49% at 12-month follow-up, and 24% at 24-month follow-up.

Conclusions: Patients may be at increased risk for substance use following bariatric WLS. In particular, patients who undergo laparoscopic Roux-en-Y gastric bypass surgery may be at increased risk for alcohol use following WLS. Our study is among the first to document significant increases in substance use following WLS using longitudinal data.
that, following WLS, participants experience an increase in substance use, specifically alcohol, cigarettes, and recreational drugs, compared with baseline (ie, before WLS).

### METHOD

#### PARTICIPANTS

Our study included 155 participants (132 women and 23 men) (Table 1) who were recruited from a preoperative information session at a bariatric surgery center at a major urban community hospital. Patients underwent either laparoscopic RYGB (LRYGB) surgery (n=100) or laparoscopic AGB (LAGB) surgery (n=55) (Table 1). All participants provided informed consent, and our study was approved by the hospital's institutional review board.

#### MATERIALS

The materials included a demographic questionnaire, the Questionnaire on Eating and Weight Patterns—Revised (QEW-P-R), which included participants' self-reported height and weight, and the Compulsive Behaviors Questionnaire (CBQ) (eAppendix, http://www.jamasurg.com).

The QEW-P-R is a 28-item self-report measurement to assess eating disorders, including BED. The QEW-P-R has demonstrated adequate test-retest reliability ($\phi = 0.42$), significant convergence ($\kappa = 0.57$) with the Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders (Third Edition Revised) for diagnosing BED, good sensitivity (0.74), and good specificity (0.35) at distinguishing BED from other disorders.

The CBQ was developed by the authors of the present study to assess the following behaviors: alcohol use, recreational drug use, cigarette smoking, shopping, gambling, sexual activity, internet use, and exercise during the past month. The present study focuses on the substance use items from the CBQ. Ratings were on a 10-point Likert scale with scores ranging from 0 to 10 for each item: (1) How often do you engage in [the behavior] (frequency); (2) have other people complained about [the behavior]? (complaining); and (3) do you feel that you have a problem with [the behavior]? (self-diagnosed problem). Participants were also asked 2 yes/no questions: (1) Are you currently in therapy? and (2) Since your surgery, have you engaged in any behaviors that you feel substitute for eating? If participants responded “yes” to question 2, they were then asked, “if so, what behaviors?” and provided space to answer in an open-ended format. The 2 yes/no questions (including the open-ended portion of the question asking about substitute behaviors) were not analyzed in the present study. The quantitative responses for frequency, complaining, and self-diagnosed problem regarding substance use (alcohol use, recreational drug use, and cigarette smoking) were analyzed separately and as a combined mean. In addition, data were categorized into nonusers (score of 0 on CBQ frequency item) and users (score of >0 on CBQ frequency item). The number of users at each time point is expressed as a percentage of the total sample in Table 2.

#### DESIGN AND PROCEDURE

The present prospective study used a repeated-measures design to assess participants at baseline prior to undergoing WLS and to follow them for 24 months after WLS. Patients were presented with the opportunity to participate in a research study at a presurgery consultation meeting that occurred approxi-
test has the ability to assess if missingness is dependent on any
errors. entered were checked by 3 independent scorers to minimize
and then entered into an SPSS (SPSS Inc) database. The data
completed at random to analyze missing data because this
test has the ability to assess if missingness is dependent on any
variables in the data set and to examine all variables while controlling for risk of type I error.21 The test for missing completely at random was not significant for any of the variables in the data analysis, indicating that the data met the assumptions required to be missing completely at random. Mixed-model repeated-measures analysis of variance was used to analyze the data set. The mixed-model repeated-measures analysis can accommodate missing data.22,23 Based on the mixed-models method, estimated means and variances are reported. Data were clustered by participant, and time was used as the within-subjects factor. Type of surgery and BED status before WLS were used as between-subject factors, and body mass index (calculated as weight in kilograms divided by height in meters squared) before WLS and changes in body mass index over time were entered as covariates. When the overall F value was significant, Sidak post hoc analysis (which controls for type I error in multiple comparisons) was used to conduct paired comparisons for differences between time points.

DATA ANALYSIS

Data were analyzed using SPSS version 18.0 with missing values. Descriptive analyses were performed, and frequencies were added to provide demographic information at baseline (Table 1). The missing values analysis function in SPSS was used to analyze the pattern of missing data. We used Little’s test for missing completely at random to analyze missing data because this test has the ability to assess if missingness is dependent on any
variables in the data set and to examine all variables while controlling for risk of type I error.21 The test for missing completely at random was not significant for any of the variables in the data analysis, indicating that the data met the assumptions required to be missing completely at random. Mixed-model repeated-measures analysis of variance was used to analyze the data set. The mixed-model repeated-measures analysis can accommodate missing data.22,23 Based on the mixed-models method, estimated means and variances are reported. Data were clustered by participant, and time was used as the within-subjects factor. Type of surgery and BED status before WLS were used as between-subject factors, and body mass index (calculated as weight in kilograms divided by height in meters squared) before WLS and changes in body mass index over time were entered as covariates. When the overall F value was significant, Sidak post hoc analysis (which controls for type I error in multiple comparisons) was used to conduct paired comparisons for differences between time points.

Participants reported a change in the frequency of substance use (a composite of drug use, alcohol use, and cigarette smoking, hereafter referred to as composite substance use) over time points (Table 2, Figure 1) \( (F_{5,350} = 8.3, P < .001) \). The frequency of composite substance use decreased from baseline \( (M = 0.81) \) to 1-month follow-up \( (M = 0.42, P = .001) \) but was no longer decreased at 3-month follow-up \( (M = 0.57, P = .39) \). Then, the frequency of composite substance use increased sig-

Table 2. Data From Compulsive Behaviors Questionnaire (CBQ)a

<table>
<thead>
<tr>
<th>Type of Substance Use</th>
<th>Baseline</th>
<th>1 mo</th>
<th>3 mo</th>
<th>6 mo</th>
<th>12 mo</th>
<th>24 mo</th>
<th>F Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Composite substance use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>0.81 (0.08)</td>
<td>0.42 (0.10)b</td>
<td>0.57 (0.11)</td>
<td>0.65 (0.65)</td>
<td>0.88 (0.88)c</td>
<td>1.25 (1.25)b,c,d,e</td>
<td>8.3f</td>
</tr>
<tr>
<td>Participants, No.</td>
<td>155</td>
<td>94</td>
<td>64</td>
<td>67</td>
<td>76</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Users, %</td>
<td>60.0</td>
<td>22.3</td>
<td>42.2</td>
<td>41.8</td>
<td>57.9</td>
<td>63.2</td>
<td></td>
</tr>
<tr>
<td>Other people complain</td>
<td>0.25 (0.06)</td>
<td>0.20 (0.07)</td>
<td>0.20 (0.08)</td>
<td>0.24 (0.08)</td>
<td>0.28 (0.08)</td>
<td>0.18 (0.11)</td>
<td>0.22</td>
</tr>
<tr>
<td>Self-diagnose</td>
<td>0.17 (0.06)</td>
<td>0.15 (0.07)</td>
<td>0.18 (0.08)</td>
<td>0.14 (0.08)</td>
<td>0.20 (0.08)</td>
<td>0.17 (0.11)</td>
<td>0.10</td>
</tr>
<tr>
<td>Alcohol use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>2.29 (0.41)</td>
<td>1.16 (0.42)b</td>
<td>1.45 (0.44)b</td>
<td>1.73 (0.44)</td>
<td>2.38 (0.43)c,d</td>
<td>3.10 (0.47)c,d,e</td>
<td>11.5f</td>
</tr>
<tr>
<td>Participant, No.</td>
<td>155</td>
<td>95</td>
<td>64</td>
<td>67</td>
<td>76</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Users, %</td>
<td>61.3</td>
<td>20.2</td>
<td>40.6</td>
<td>40.3</td>
<td>53.9</td>
<td>63.2</td>
<td></td>
</tr>
<tr>
<td>Other people complain</td>
<td>0.34 (0.08)</td>
<td>0.28 (0.11)</td>
<td>0.19 (0.13)</td>
<td>0.51 (0.12)</td>
<td>0.20 (0.12)</td>
<td>0.14 (0.16)</td>
<td>1.20</td>
</tr>
<tr>
<td>Self-diagnose</td>
<td>0.15 (0.05)</td>
<td>0.10 (0.06)</td>
<td>0.08 (0.07)</td>
<td>0.07 (0.07)</td>
<td>0.13 (0.07)</td>
<td>0.09 (0.09)</td>
<td>0.30</td>
</tr>
<tr>
<td>Drug use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>0.11 (0.06)</td>
<td>0.12 (0.08)</td>
<td>0.07 (0.09)</td>
<td>0.15 (0.09)</td>
<td>0.04 (0.09)</td>
<td>0.45 (0.12)</td>
<td>2.08</td>
</tr>
<tr>
<td>Participants, No.</td>
<td>155</td>
<td>94</td>
<td>64</td>
<td>67</td>
<td>76</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Users, %</td>
<td>4.5</td>
<td>5.3</td>
<td>1.6</td>
<td>3.0</td>
<td>2.6</td>
<td>13.2</td>
<td></td>
</tr>
<tr>
<td>Other people complain</td>
<td>0.05 (0.03)</td>
<td>0.09 (0.04)</td>
<td>0.07 (0.05)</td>
<td>0.01 (0.05)</td>
<td>0.04 (0.05)</td>
<td>0.03 (0.06)</td>
<td>0.50</td>
</tr>
<tr>
<td>Self-diagnose</td>
<td>0.07 (0.03)</td>
<td>0.10 (0.04)</td>
<td>0.04 (0.06)</td>
<td>0.00 (0.06)</td>
<td>0.02 (0.05)</td>
<td>0.00 (0.07)</td>
<td>0.87</td>
</tr>
<tr>
<td>Cigarette use</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequency</td>
<td>0.44 (0.12)</td>
<td>0.46 (0.14)</td>
<td>0.45 (0.15)</td>
<td>0.41 (0.15)</td>
<td>0.58 (0.15)</td>
<td>0.61 (0.18)</td>
<td>0.49</td>
</tr>
<tr>
<td>Participants, No.</td>
<td>153</td>
<td>90</td>
<td>64</td>
<td>67</td>
<td>75</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>Users, %</td>
<td>10.4</td>
<td>6.7</td>
<td>14.1</td>
<td>7.5</td>
<td>16.0</td>
<td>8.1</td>
<td></td>
</tr>
<tr>
<td>Other people complain</td>
<td>0.44 (0.12)</td>
<td>0.30 (0.15)</td>
<td>0.34 (0.17)</td>
<td>0.19 (0.17)</td>
<td>0.48 (0.16)</td>
<td>0.30 (0.21)</td>
<td>0.64</td>
</tr>
<tr>
<td>Self-diagnose</td>
<td>0.41 (0.13)</td>
<td>0.35 (0.15)</td>
<td>0.42 (0.16)</td>
<td>0.31 (0.16)</td>
<td>0.36 (0.16)</td>
<td>0.45 (0.20)</td>
<td>0.16</td>
</tr>
</tbody>
</table>

a Based on mixed-models method; hence, estimated mean values are reported.
b Post hoc tests show significant differences when compared with baseline \( (P < .05) \).
c Post hoc tests show significant differences when compared with 1 month \( (P < .05) \).
d Post hoc tests show significant differences when compared with 3 months \( (P < .05) \).
0 Post hoc tests show significant differences when compared with 6 months \( (P < .05) \).
f F value significant at \( P < .001 \).
Significantly at 24 months ($M = 1.25$) relative to baseline ($P = .019$), 1 month, 3 months, and 6 months ($P < .002$). There was no significant change over time in the ratings of complaints or self-diagnosed problems with composite substance use.

In the overall sample, the frequency of reported alcohol use changed significantly over time (Table 2; Figure 1) ($F_{5,305.8} = 11.53, P < .001$). The frequency decreased significantly from baseline ($M = 2.29$) to 1 month ($M = 1.16$; $P < .001$) and from baseline to 3 months ($M = 1.45$; $P = .009$). There were no significant increases from baseline ($M = 2.29$) to 24 months ($M = 3.07$; $P = .10$), but there were significant increases from 1 month ($M = 1.16$) to 12 months ($M = 2.38$; $P < .001$), from 1 month ($M = 1.16$) to 24 months ($M = 3.07$; $P < .001$), from 3 months ($M = 1.45$) to 12 months ($M = 2.38$; $P = .016$), from 3 months ($M = 1.45$) to 24 months ($M = 3.07$; $P < .001$), and from 6 months ($M = 1.735$) to 24 months ($M = 3.07$; $P = .001$). There was no significant change over time in the ratings of complaints or self-diagnosed problems.

There was a significant interaction between type of surgery and frequency of alcohol use ($F_{5,302.6} = 2.93, P = .013$) over time points (Figure 2). Those who underwent LRYGB surgery reported decreases in the frequency of alcohol use from baseline ($M = 1.86$) to 1 month ($M = 0.39$; $P < .001$) and from baseline to 3 months ($M = 0.64$; $P = .002$). The frequency of alcohol use then increased at 24 months ($M = 3.08$) relative to baseline ($P = .011$) and 12 months ($M = 1.91$; $P = .048$). There were no significant changes in the reported frequency of alcohol use for participants who underwent LAGB surgery. There were no significant changes in complaints or self-diagnosed problems in either the LRYGB group or the LAGB group.

There was no significant effect of time on the frequency of recreational drug use (Table 2; Figure 1) ($F_{5,406.13} = 2.085, P = .07$) and no significant change over time in the ratings of complaints or self-diagnosed problems. There was no significant effect of time on the frequency of cigarette smoking (Table 2; Figure 1) ($F_{5,323.1} = 0.49, P = .78$) or on the frequency of complaints or self-diagnosed problems.

There was no significant interaction between receiving a BED diagnosis at baseline (based on the QEWP-R) and any of the following types of substance use over time: frequency of composite substance use ($F_{5,328.2} = 0.86, P = .51$), frequency of alcohol use ($F_{5,208.2} = 0.75, P = .59$), frequency of recreational drug use ($F_{5,301.3} = 0.17, P = .97$), or frequency of cigarette smoking ($F_{5,304.10} = 0.60, P = .70$). There was also no significant interaction between surgery type and frequency of composite substance use ($F_{5,345.3} = 0.51, P = .77$), frequency of recreational drug use ($F_{5,308.0} = 0.82, P = .53$), or frequency of cigarette smoking ($F_{5,316.4} = 0.97, P = .44$). Controlling for baseline body mass index or change in body mass index did not have any significant effect and did not change any of the findings.

**COMMENT**

Although there have been anecdotal reports of increases in substance use following WLS, this is one of the first research studies to investigate the phenomenon from a longitudinal perspective. Our study examined the course of substance use (alcohol, cigarettes, recreational drugs, and composite substance use) during the first 24 months after WLS. Based on symptom substitution theory, we hypothesized that participants would experience an increase in frequency of substance use following WLS, which was supported by our findings.

The frequency of composite substance use among our participants appeared to follow a “J”-shaped curve over time. Participants experienced an immediate decrease in the frequency of composite substance use following WLS, but these improvements were not maintained by 3-month follow-up, and there was a significant increase in the frequency of composite substance use from baseline to 24-month follow-up. Furthermore, results indicated that participants who had undergone LRYGB surgery experienced significant increases in the frequency of alcohol use over...
time. Participants experienced an initial decrease in the frequency of alcohol use immediately following RYGB surgery and then a significant increase 24 months after RYGB surgery. These increases were not reported in those who underwent LAGB surgery. This result of increased alcohol use associated with RYGB surgery but not AGB surgery is consistent with the recent findings by King et al, who reported an increased prevalence of alcohol use disorders following RYGB surgery but not following AGB surgery. The present study did not find any significant changes in participants’ reported frequencies of cigarette smoking or recreational drug use.

The initial decrease in the frequency of substance use (both alcohol use and composite substance use) within the month following surgery may be related to the WLS recovery process. In the first month after surgery, patients are requested to follow a strict liquid diet and then progress to a pureed food diet. Patients are still recovering from surgery and adjusting to dietary changes during this time. In addition, patients are advised to refrain from alcohol use after surgery, owing to excess caloric intake and changes in the metabolism of alcohol following gastric bypass surgery. Participants tend to adhere to the postsurgical dietary recommendations more closely immediately following surgery and less so further along the postoperative time line. Compliance with postsurgical diet is likely reflected in the decreased frequency of substance use reported during the immediate postoperative period.

Recent research has revealed that patients become intoxicated more quickly with less alcohol following RYGB surgery and take longer to return to sobriety than before surgery. Because patients have a reduced tolerance for alcohol after RYGB surgery, they may experience the rewarding aspects of alcohol use sooner and more frequently, which may contribute to the increase in frequency of alcohol use after LRYGB surgery.

Our study did not find any significant changes over time in the reported frequency of other people complaining about participants’ substance use or participants thinking they have a problem with substance use. These questions may be less sensitive than the frequency questions. Future research should examine the problematic nature of substance use following WLS with other validated measurements. Our study provides evidence that patients experience an increase in the frequency of their substance use; it does not provide evidence of a quantitative increase in substance or alcohol use (ie, number of drinks) or that these behaviors are problematic for either the participant or others.

Although the baseline data were collected approximately 3 weeks prior to undergoing WLS, the CBQ has patients rating their frequency of substance use in the past month (from 7 to 3 weeks before surgery), which provides a more accurate depiction of true baseline substance use. Participants were instructed that participation in this research study would not affect their surgical process and that their responses to questionnaire items would be kept confidential from the surgery staff. Despite these efforts to encourage accurate reporting, it is possible that participants underreported substance use at baseline in attempt to present themselves as a good candidate for surgery. However, the significant increases in the frequency of alcohol use found in only the participants who had undergone RYGB surgery and the lack of significant changes in the frequency of cigarette smoking and recreational drug use bolster our confidence that we are capturing actual increases in the frequency of substance use (alcohol use and composite substance use). Had effects been due primarily to underreporting at baseline, we would have expected increases in the frequency of other substance uses and no differences for type of surgery.

Other limitations of our study include missing data (Table 2) (common in longitudinal research studies) because some participants missed 1 or more of the follow-up time points. Because the data were determined to be missing completely at random, there were no unique characteristics inherent in those who missed a follow-up time point. In addition, substance use was assessed using a nonstandardized self-report questionnaire. However, the questions had a high level of face validity and contained basic questions about the frequency and problematic nature of substance use.

Despite these limitations, our study provides evidence that the frequency of substance use increased following WLS; more specifically, the frequency of alcohol use increased following LRYGB surgery. Heinberg et al suggested the need to identify patients who may be at increased risk for alcohol problems following WLS and proposed a preoperative preventative intervention for these patients. Based on the present study, undergoing RYGB surgery appears to increase the risk for alcohol use following WLS. Risks and benefits should be weighted when recommending LRYGB surgery to patients who may be at increased risk of developing problems with alcohol after WLS, such as those with a personal or family history of alcohol abuse or dependence. Further research is needed to identify factors related to increased risk of alcohol use following WLS. In addition, patients should be screened at their follow-up visits with surgeons and other medical professionals to determine whether they have developed substance use problems by using simple, easy-to-use screening measures, such as the Alcohol Use Disorders Test, the Brief Alcohol Screening Instrument for Medical Care, or the Michigan Alcohol Screening Test. Evaluation should focus on the time period starting 1 year after RYGB surgery, when alcohol problems seem most likely to develop.

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Author Contributions: Dr Conason had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Study concept and design: Conason, Teixeira, Hsu, Knafo, and Geliebter. Acquisition of data: Conason, Hsu, and Puma. Analysis and interpretation of data: Conason and Geliebter. Drafting of the manuscript: Conason, Hsu, and Knafo.
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