ONLINE FIRST

Substance Use Following Bariatric Weight Loss Surgery

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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, hereafter referred to as composite substance use) 24 months after 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 $P \leq .002$). 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.

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BARIATRIC WEIGHT LOSS SURGERY (WLS) leads to markedly reduced food intake and body weight over a relatively short period of time. Patients may lose upwards to 60% of their excess body weight or about 30% of their initial body weight within 1 year after gastric bypass surgery.[1-3] Although WLS is often an effective treatment for clinically severe obesity and comorbid medical conditions, it requires major changes in lifestyle for which many patients may be inadequately prepared.

There have been anecdotal accounts in the popular media[4-6] (but few research publications to date[7-10]) of symptom substitution in patients after they have undergone WLS. One of the few studies on this topic found that post-WLS patients are overrepresented in substance abuse treatment centers.[7] A retrospective study by Ertlet et al[8] concluded that a small percentage of patients (less than 3% of their sample) spontaneously developed alcohol dependence approximately 7 years after surgery. Another retrospective study[10] found that 28.4% of participants reported having a problem with alcohol after WLS compared with 4.5% prior to WLS. All these previous studies were limited by the absence of preoperative baseline measurements and a lack of longitudinal data.

Table 1. Characteristics of 155 Participants Who Underwent Bariatric Weight Loss Surgery

Characteristic	Participants, No. (%)
Age, y	
Mean (SD)	40 (11)
Range	18-69
Baseline BMI[a]	
Mean (SD)	46 (7)
Range	34-85
Sex	
Male	23 (15)
Female	132 (85)
Ethnicity	
Hispanic	73 (47)
Black (not Hispanic)	49 (32)
White (not Hispanic)	27 (17)
Asian	2 (1)
Other	4 (3)
Education	
Less than high school	13 (8)
High School graduate or GED	21 (14)
Some college or associates degree	67 (43)
College graduate	54 (35)
Baseline BED status[b]	
BED	9 (6)
Subthreshold BED symptoms	59 (40)
Non-BED symptoms	79 (54)

Abbreviations: BED, binge-eating disorder; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); GED, General Education Development.
[a] For 153 participants (99%).
[b] For 147 participants (95%).

Recently, another study[9] was published that examined alcohol use from a longitudinal perspective. King et al[9] used data from the multicenter Longitudinal Assessment of Bariatric Surgery–2 project to assess 1945 participants before WLS, 1 year after WLS, and 2 years after WLS. They found that the frequency of alcohol use significantly increased for participants who underwent either Roux-en-Y gastric bypass (RYGB) surgery or adjustable gastric band (AGB) surgery; however, only participants who underwent RYGB surgery experienced a significant increase in alcohol use disorders 2 years after WLS compared with before WLS and 1 year after WLS. In contrast, participants who underwent AGB surgery did not experience a significant increase in alcohol use disorders after WLS.

Symptom substitution theory posits that the successful elimination of a particular symptom without treating the underlying cause will result in the appearance of a substitute symptom.[11] Symptom substitution theory would predict an increase in substance use following WLS because the surgery largely eliminates excessive eating[12] without adequately addressing potential underlying psychopathology. Studies have shown that drugs, alcohol, and food trigger similar responses in the brain[13-15] and that bariatric surgery candidates whose condition has been diagnosed as binge-eating disorder (BED) display addictive personalities similar to individuals addicted to substances.[16] Therefore, alcohol and drugs (including nicotine) are likely to substitute for overeating following WLS. The present study was designed to test the hypothesis 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 (QEWP-R), which included participants' self-reported height and weight, and the Compulsive Behaviors Questionnaire (CBQ) (eAppendix, http://www.jamasurg.com).

The QEWP-R is a 28-item self-report measurement to assess eating disorders, including BED.[17] The QEWP-R has demonstrated adequate test-retest reliability ($\phi = 0.42$),[18] significant convergence ($\kappa = 0.57$) with the Structured Clinical Interview for *Diagnostic and Statistical Manual of Mental Disorders* (Third Edition Revised) for diagnosing BED,[19] good sensitivity (0.74), and good specificity (0.35)[20] at distinguishing BED from other disorders.

The CBQ was developed by the authors of the present study to assess the following behaviors (eAppendix): 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? (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-

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

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

[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 ($P < .05$).
[e] Post hoc tests show significant differences when compared with 6 months ($P < .05$).
[f] *F* value significant at $P < .001$.

mately 3 weeks prior to the patients' surgery dates. Patients were instructed that participation in this research study would not affect the surgical process and that their responses to questionnaire items would be kept confidential from the surgery staff. After agreeing to participate in the study and after signing the informed consent form, participants were given the packet of questionnaires that included the QEWP-R and the CBQ. In addition to this baseline assessment, participants were assessed with the same measures 1, 3, 6, 12, and 24 months after undergoing WLS. The postsurgery data collection was coordinated with the participants' scheduled surgery follow-up appointments. A research assistant was present at all assessments. If a participant did not attend the follow-up appointment with the surgeon, then the questionnaires were mailed with a self-addressed stamped envelope to the participant to complete at home and mail back to the researchers. All participants received a $4.50 MetroCard (or equivalent cash value) as compensation each time they filled out the packet of questionnaires. All questionnaires were scored by 2 independent scorers and then entered into an SPSS (SPSS Inc) database. The data entered were checked by 3 independent scorers to minimize errors.

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.

RESULTS

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**) ($F_{5,350.6} = 8.3$, $P < .001$). 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-

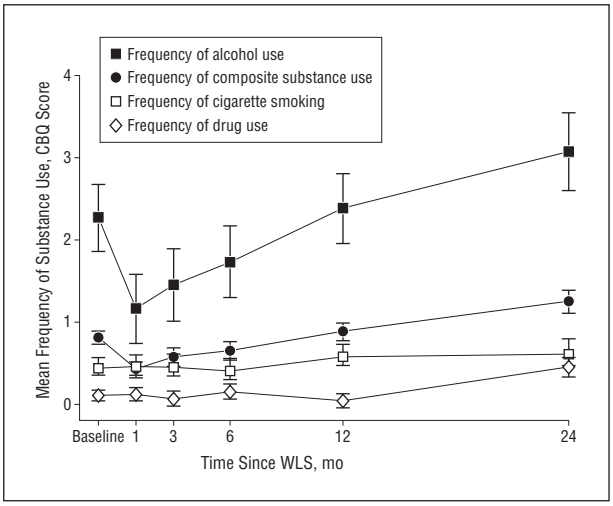

Figure 1. Estimated mean frequency of substance use by category for bariatric weight loss surgery (WLS) based on Compulsive Behaviors Questionnaire (CBQ) scores of 155 participants. The values represent mean values, and the error bars indicate SEM.

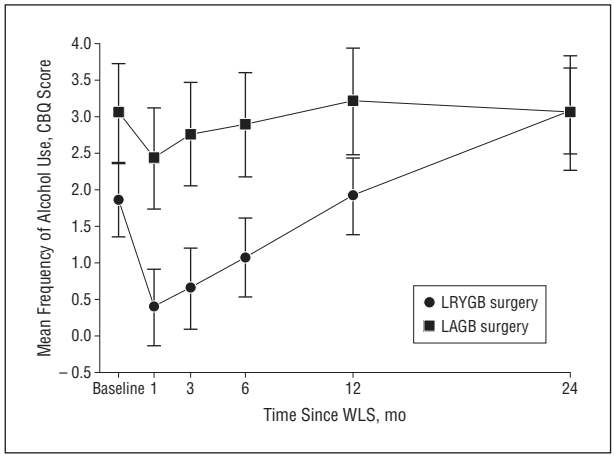

Figure 2. Estimated mean frequency of alcohol use for laparoscopic Roux-en-Y gastric bypass (LRYGB) surgery and laparoscopic adjustable gastric band (LAGB) surgery based on Compulsive Behaviors Questionnaire (CBQ) scores of 155 participants. The values represent mean values, and the error bars indicate SEM.

nificantly 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 ($F_{5,300.6} = 2.93$, $P = .013$) 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 ($F_{5,288.2} = 0.75$, $P = .59$), frequency of recreational drug use ($F_{5,381.32} = 0.17$, $P = .97$), 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 ($F_{5,343.3} = 0.51$, $P = .77$), frequency of recreational drug use ($F_{5,398.0} = 0.82$, $P = .53$), 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,[4-6] 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,[9] 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.[24] 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[25] 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,[26] the Brief Alcohol Screening Instrument for Medical Care,[27] or the Michigan Alcohol Screening Test.[28] 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.

Critical revision of the manuscript for important intellectual content: Conason, Teixeira, Puma, and Geliebter. *Statistical analysis:* Conason, Hsu, and Geliebter. *Administrative, technical, and material support:* Hsu and Puma. *Study supervision:* Teixeira, Hsu, Knafo, and Geliebter.

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Online-Only Material: The eAppendix is available at http://www.jamasurg.com.

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