



# Examining Sleep Quality Following Sleeve Gastrectomy Among Patients with Loss-of-Control Eating

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## Abstract

**Background** Sleep is associated with post-bariatric surgical outcomes; however, little is known about sleep in bariatric patients with loss-of-control (LOC) eating, a consistent predictor of poorer weight outcomes. This study examined sleep quality and clinical correlates in sleeve gastrectomy patients with LOC eating.

**Methods** Participants ( $N = 145$ ) were treatment-seeking post-operative sleeve gastrectomy patients with LOC eating. Eating-disorder features were assessed with the Eating Disorder Examination-Bariatric Surgery Version Interview (EDE-BSV) and participants completed established measures assessing sleep, health-related quality of life, perceived stress, depression, and night eating.

**Results** 58.6% of participants were characterized with “poor” sleep. Poor sleep quality was significantly associated with greater eating-disorder psychopathology, physical and mental functioning, night eating, perceived stress, and less % excess weight loss (EWL); these findings remained significant after controlling for %EWL and race. Regression analyses, adjusting for correlated variables, revealed that sleep quality significantly predicted mental functioning.

**Conclusions** Poor sleep quality was common among post-operative sleeve gastrectomy patients with LOC eating. Sleep quality was significantly associated with eating-disorder psychopathology, less post-operative weight loss, and psychosocial and physical functioning problems. These findings suggest the importance of assessment and treatment of sleep problems following sleeve gastrectomy.

**Clinical Trial Registration** [ClinicalTrials.gov](https://clinicaltrials.gov/ct2/show/study/NCT02259322) identifier NCT02259322.

**Keywords** Sleep quality · Sleeve gastrectomy · Loss-of-control eating · Psychosocial functioning

## Introduction

Increasing evidence suggests a bidirectional relationship between disordered sleep and obesity [1–3]. Poor sleep quality and short sleep duration are known comorbidities of obesity and specifically associated with the development and progression of obesity, which can undermine weight loss efforts [2]. In turn, obesity contributes to numerous physical and

emotional problems that can disturb sleep, including obstructive sleep apnea [4], insomnia [5], increased stress levels [6, 7], and mood disorders [8]. Although bariatric surgery is considered one of the most effective interventions for the treatment of obesity [9], little is known about the nature of sleep problems and associations with weight and psychosocial correlates post-operatively.

Recently, more attention has been directed towards examining the role of post-surgical sleep duration and quality [10–12]. For instance, average sleep duration was less in a sample of pre-operative bariatric patients ( $M = 6.0$  h) compared with non-obese matched controls ( $M = 7.2$  h); however, importantly, improvements in sleep duration ( $M = 6.8$  h) and quality up to 12 months post-operatively were observed for the bariatric surgery group [11]. Psychological factors have also been found to impact the relationship between poor sleep and disordered eating among individuals with obesity [8]. In a

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sample of bariatric surgery candidates with obesity, clinical insomnia (e.g., difficulty initiating and/or maintaining sleep accompanied by distress or impairment; [13]) and depressive symptoms were associated with increased daily consumption of snack foods, eating in response to emotion, and night eating thereby supporting a relationship between disordered sleep and problematic eating habits prior to surgery [3]. Collectively, such findings suggest a link between mood symptoms, sleep quality, obesity, and eating patterns.

Loss-of-control (LOC) eating, defined as the subjective experience of being unable to stop eating or control what or how much one is eating, is a disordered eating behavior that is well documented among bariatric surgery populations. It is associated with poorer weight loss and psychological outcomes and the continued expression of eating pathology post-operatively [14–17]. The relationship between sleep and LOC eating has not yet been examined post-operatively, but previous research with bariatric candidates provides support for the aims of the present study. Bariatric candidates with LOC eating endorsed significantly higher levels of depression, eating-disorder psychopathology, and night eating compared with individuals without LOC eating [3, 18]. Similarly, poor sleep is associated with obesity, depression, lower quality of life, and disordered eating patterns such as increased night eating [5, 6, 8]. These results suggest that post-operative bariatric patients with LOC eating might be more vulnerable to lower psychological and health-related quality of life sequelae, including lower sleep quality, and emphasize the importance of examining psychological correlates of sleep among this patient group.

The converging findings across the obesity, sleep, bariatric surgery, and eating-disorder literature highlight the need to better understand how sleep is implicated in weight, eating, and psychological outcomes after surgery. Thus, the present study investigated sleep quality and clinical correlates in a sample of post-operative sleeve gastrectomy patients with LOC eating. We hypothesized that sleep quality would be significantly associated with eating-disorder psychopathology, less weight loss outcomes, and lower psychological functioning. Given the literature supporting the importance of sleep on overall quality of life [8], we also explored the relationship between sleep quality and physical and mental health functioning.

## Methods

### Participants

Participants were 145 adults seeking treatment for eating concerns 6 months ( $M = 6.34$  months;  $SD = 1.51$ ; range 4–9 months) after undergoing sleeve gastrectomy surgery at the Yale Bariatric/Gastrointestinal Surgery Center of

Excellence. The participants were directly referred by the bariatric surgery team or self-referred after viewing mailings and/or flyers soliciting patients with post-operative eating concerns. The eligible participants were between the ages of 18 and 65 with LOC eating (defined as a subjective sense of LOC while eating, difficulty stopping eating, or difficulty preventing themselves from eating) that occurred at least once weekly during the past month, regardless of the amount eaten. Exclusion criteria included current use of medications known to influence eating or weight, current substance dependence, or severe psychiatric condition that required immediate treatment.

All study assessments were performed independently from the bariatric program. All the participants provided informed consent, and this study received approval from the *name blinded for review* Institutional Review Board. The trial is registered at [clinicaltrials.gov](https://clinicaltrials.gov) with the following identifying number NCT02259322.

### Measures

Pittsburgh Sleep Quality Index (PSQI) is a 19-item self-report measure of sleep quality during the past month [19]. The PSQI yields a global score (range 0 to 21) comprised of seven component scores (e.g., sleep quality, sleep duration, sleep efficiency, and daytime dysfunction). Scores greater than 5 are indicative of poor sleep quality [19]. The measure has been widely used in clinical and non-clinical samples [20].

Eating Disorder Examination-Bariatric Surgery Version (EDE-BSV) is a semi-structured clinical interview, adapted for bariatric surgery patients from the original version [21] that assesses eating-disorder psychopathology during the past 28 days [22]. The EDE-BSV assesses various forms of over-eating behaviors including LOC eating and was administered by trained doctoral level clinicians. In addition, the EDE-BSV has a global eating-disorder score which reflects overall levels/severity of eating-disorder psychopathology (including restraint behaviors and different facets of body-image disturbance). LOC eating is not included in that global score. Confirmatory factor analytic studies provide support for an alternative briefer three-scale structure of the EDE-BSV [23, 24], which was used in the present study. Higher scores reflect greater frequency and/or severity of eating-disorder psychopathology (range = 0–6).

Medical Outcomes Study Short Form Health Survey (SF-36) is a widely used measure of health-related quality of life, including two summary scores: physical and mental health functioning [25]. Scores are transformed and computed as  $t$  scores with a mean of 50 and standard deviation of 10. The SF-36 has well-established psychometric validity and reliability and is appropriate for use in bariatric surgery samples [26].

Beck Depression Inventory Second Edition (BDI-II) is a 21-item self-report measure of current symptoms of

depression. It has been widely validated in clinical populations, including bariatric surgery patients [27].

Night Eating Questionnaire (NEQ) is a 24-item self-report questionnaire assessing night eating syndrome [28]. Items are assessed on a 5-point Likert scale and summed to yield a global score, with higher scores indicative of greater night eating behaviors, and a score of  $\geq 30$  suggesting night eating syndrome. The NEQ has good reliability and construct validity [28].

Perceived Stress Scale (PSS) is a 14-item self-report measure of perceived life stressful situations during the past month [29].

## Statistical Analyses

Nominal variables were summarized with frequencies and proportions. Interval variables were summarized with minimums, maximums, means, and standard deviations. Pearson's correlations were used to explore the relationship between sleep quality, eating-disorder psychopathology, night eating, stress, depression, physical and mental health functioning, percent excess weight loss (%EWL), and percent total weight loss (%TWL). Analysis of covariance (ANCOVA) was used to test for mean group differences between participants with poor sleep and good sleep with respect to eating-disorder psychopathology, night eating, stress, depression, and physical and mental health functioning, while controlling for confounds (race and %EWL). Multivariate regression modeling examined the independent contributions of sleep quality, after adjusting for correlated variables, on physical and mental health functioning.

## Results

Participants were primarily female ( $n = 120$ , 82.8%), and the racial-ethnic distribution was as follows: White non-Hispanic (51.0%), Black non-Hispanic (33.8%), Latina/o (9.7%), and other (5.5%). The mean age and body mass index (BMI) were 45.4 ( $SD = 11.1$ ) years and 37.7 ( $SD = 7.3$ )  $\text{kg/m}^2$ , respectively. The mean pre-surgical BMI was 46.8  $\text{kg/m}^2$  ( $SD = 8.9$ ). The mean %EWL, calculated using standardized outcome reporting guidelines [30], was 43.8% ( $SD = 16.5$ ). The mean %TWL was 19.3% ( $SD = 6.9$ ).

Of the overall participant group, the mean PSQI total score was 7.58 ( $SD = 4.00$ ). Based on the established PSQI cut-off scores ( $> 5$  suggests poor sleep quality), 58.6% ( $n = 85$ ) endorsed poor sleep quality. The overall mean duration of sleep was 6.13 h per night ( $SD = 1.38$ ); however, sleep duration for those meeting criteria for good sleep quality ( $M = 7.04$  h per night,  $SD = 1.32$ ) was significantly higher than those with poor sleep quality ( $M = 5.62$  h per night,  $SD = 1.14$ ),  $t(130) = 6.46$ ,  $p < .001$ . Table 1 describes the most commonly

**Table 1** Self-reported sleep problems occurring at least once per week

Sleep problem	Percentage endorsing $\geq 1/\text{week}$
Night time or early awakening	57.9%
Getting up to use bathroom	50.3%
> 30 min to fall asleep	37.2%
Pain	29.0%
Too hot	25.5%
Excess weight	20.7%
Too cold	20.0%
Needing/wanting to eat	13.8%
Coughing or snoring	13.1%
Bad dreams	12.4%
Difficulty with CPAP machine	12.4%
Need to be elevated	12.4%
Heartburn	9.7%
Difficulty breathing	6.9%
Other	7.6%

endorsed sleep problems as per the PSQI, occurring at least once weekly. Notably, 57.9% of the sample endorsed nighttime or early awakenings. Pain (29.0%), excess weight (20.7%), and needing or wanting to eat during the night (13.8%) were also commonly reported as problematic.

The PSQI total score was not correlated with age ( $r = .06$ ,  $p = .53$ ) and there were no significant differences between participants with poor sleep and good sleep based on sex,  $\chi^2(1, N = 132) = 2.13$ ,  $p = .14$ . Participants who identified as White reported significantly lower scores on the PSQI ( $M = 6.85$ ,  $SD = 3.77$ ) when compared with non-White participants ( $M = 8.32$ ,  $SD = 4.12$ ),  $t(130) = 2.14$ ,  $p < .05$ . The PSQI total score was not correlated with current BMI ( $r = .11$ ,  $p = .22$ ), but it was significantly negatively correlated with %EWL from pre-surgery to intake ( $r = -.23$ ,  $p < .01$ ) and likewise, with %TWL ( $r = -.26$ ,  $p < .01$ ).

Table 2 reports the bivariate correlations of the PSQI total score with the other clinical variables as well as group differences between participants with good and poor sleep quality. Poorer sleep (as indicated by higher scores on the PSQI) was associated with losing less excess weight after surgery. Scores on the PSQI were significantly positively correlated with eating-disorder psychopathology (as measured by the EDE-BSV), night eating, depression, and perceived stress. Poorer sleep quality was also significantly associated with both mental and physical functioning. When considered as a group, participants with poor sleep quality had a significantly lower %EWL as compared with participants with good sleep. Participants with poor sleep quality also endorsed higher levels of eating-disorder psychopathology, night eating, depression, and perceived stress as well as poorer physical and mental health functioning. The largest effect sizes were

**Table 2** Means and standard deviations of weight variables, eating-disorder psychopathology, and psychosocial functioning by group and bivariate correlations with PSQI

	Total sample		Good sleep quality	Poor sleep quality	<i>t</i> test	Effect size	ANCOVA
	<i>M</i> (SD)	PSQI total score ( <i>r</i> )	<i>M</i> (SD)	<i>M</i> (SD)	<i>t</i>	Cohen's <i>d</i>	%EWL & race $\eta^2$
<b>Weight</b>							
Mean %EWL	43.83 (16.53)	-.23***	46.44 (16.47)	42.10 (15.93)	1.48	.27	–
Current BMI	37.68 (7.28)	.11	36.44 (5.80)	38.34 (7.73)	-1.47	.28	–
<b>Eating-related psychopathology</b>							
EDE global	2.95 (1.30)	.33***	2.68 (1.20)	3.19 (1.24)	-2.31*	-.42	.04
Night eating	17.93 (7.06)	.62***	14.57 (4.36)	20.10 (7.63)	-4.88***	-.89	.13
<b>General psychopathology</b>							
SF mental function	48.05 (10.66)	-.59***	53.84 (6.35)	44.81 (11.22)	5.89***	.99	.17
SF physical function	46.69 (10.69)	-.33***	50.20 (7.99)	44.72 (11.52)	3.20**	.55	.05
BDI-II	12.10 (10.32)	.58***	6.64 (7.18)	15.26 (10.52)	-5.56***	-.96	.15
PSS	16.66 (7.05)	.51***	13.11 (6.18)	18.74 (6.69)	-4.76***	-.87	.15

%EWL, percent excess weight loss; BMI, body mass index; EDE, Eating Disorder Examination Bariatric Surgery Version; SF, Short Form Health Survey; BDI-II, Beck Depression Inventory II; PSS, perceived stress scale

\* $p < .05$ ; \*\* $p < .01$ ; \*\*\* $p \leq .001$

observed for night eating, mental health functioning, depression, and perceived stress; the remaining effects were in the small to medium range (see Table 2). Analyses of covariance (ANCOVA) were performed to adjust for %EWL and race due to the significant differences between those with poor and good sleep quality. After adjusting for %EWL and race, the overall pattern of findings did not change; individuals with poor sleep endorsed significantly greater symptoms on all measures assessed.

Table 3 summarizes the multivariate regression models predicting physical and mental health functioning. Sleep quality did not independently predict physical functioning. Likewise, race, BDI-II, PSS, and %EWL scores were not significant predictors of physical functioning. The EDE-BSV global score was the only significant predictor of physical functioning. Sleep quality was an independent significant predictor of mental functioning as well as the BDI and PSS scores, while all other variables assessed were not significant predictors.

## Discussion

This study adds evidence to the growing body of literature addressing the relationship between sleep, eating, and weight patterns. These data suggest the clinical relevance of assessing and treating disordered sleep in bariatric patients following surgery, and especially those with LOC eating. Sleep quality (examined dimensionally and categorically) was significantly associated with %EWL, depression, perceived stress, and functioning measures.

Nearly 60% of this sample of sleeve gastrectomy patients endorsed poor sleep quality, and for this subgroup, the mean sleep duration was 5.6 h per night, which falls below the National Sleep Foundation's recommended 7–9 h per night [31]. The total PSQI score in the present study ( $M = 7.58$ ) was indicative of poor sleep quality at approximately 6 months following surgery and is higher than reported in two previous studies assessing post-operative sleep quality with means of 3.0 (at 3–12 months post-operatively; [11]) and 4.6 (at 6 months post-operatively; [12]), respectively. While these studies found significant post-operative gains in sleep quality such that the mean scores indicated "good" sleep quality [11, 12], our results diverge, suggesting that sleep quality might be worse for post-operative bariatric patients with LOC eating. In this sample, White participants endorsed significantly better sleep quality compared with non-White participants, which is consistent with population-based findings [32, 33] and highlights an area for future research and the need for improved screening and treatment of disordered sleep, particularly in racially vulnerable populations [34].

Importantly, patients who met PSQI criteria for poor sleep, had less %EWL and reported greater symptom severity across all assessed psychosocial domains when compared with patients who met criteria for good sleep. Short sleep duration (typically cited as  $< 7$  h/day) has been consistently linked with obesity risk, disease progression, and difficulty losing weight [2, 35]. Though longitudinal research is limited, there is evidence suggesting that greater early weight loss, particularly within the first 6 months following bariatric surgery, predicts more successful weight outcomes [36]. Notably, our patient group was approximately 6 months post-operative and those

**Table 3** Regression analyses predicting SF-36 physical and mental health functioning

	<i>B</i>	SE <i>B</i>	$\beta$	95% confidence interval		<i>p</i> value
				Lower bound	Upper bound	
Model 1: physical functioning						
Race	− 1.43	1.82	.07	− 2.17	5.03	.433
EDE global	− 1.63	.80	− .19	− 3.21	− .05	.043
BDI	− .01	.13	.01	− .27	.25	.938
PSS	− .08	.18	− .05	− .43	.28	.669
%EWL	.11	.06	.17	− .001	.22	.052
PSQI	− .49	.28	− .18	− 1.04	.07	.085
Model 2: mental functioning						
Race	− 1.44	1.16	− .07	− 3.74	.85	.216
EDE global	− .28	.51	− .03	− 1.28	.73	.587
BDI	− .50	.09	− .48	− .67	− .33	< .001
PSS	− .38	.12	− .25	− .61	− .16	.001
%EWL	− .03	.04	− .04	− .10	.05	.464
PSQI	− .50	.18	− .19	− .86	− .15	.006

%EWL, percent excess weight loss; *BDI-II*, Beck Depression Inventory II; *EDE*, Eating Disorder Examination-Bariatric Surgery Version Global Score; *SF-36*, Short Form Health Survey; *PSS*, perceived stress scale; *PSQI*, Pittsburgh Sleep Quality Index

with poor sleep exhibited significantly less %EWL compared with their counterparts with good sleep quality. Moreover, among adults with short sleep duration, high disinhibition eating behavior traits significantly increase the risk of both overeating and weight gain [37]. Our findings suggest the need for studies to examine the frequency and clinical significance of sleep disturbances among post-operative bariatric patients at longer follow-up time points in relation to important outcomes such as weight change.

Mechanistic models including biological, behavioral, and psychological factors are often applied to sleep because of its sweeping importance across these domains. In this study, as hypothesized, poor sleep was associated with numerous psychosocial sequelae. Individuals with poorer sleep endorsed greater severity of eating-disorder psychopathology, depression, stress, and mental and physical functioning. These findings are consistent with prior research suggesting that sleep is associated with disordered eating behaviors [38, 39] and further that these share a common variance with psychological functioning [3, 30]. Our regression analyses suggest the predictive (statistical) strength of sleep on mental health functioning, even after adjusting for other known predictors. While sleep was related to physical functioning in this sample, it was not predictive above and beyond other known and robust predictors. These results align with consensus from a recent meta-analysis [40] assessing cognitive behavioral therapy for insomnia (CBTi) for patients with insomnia and comorbid psychiatric or medical diagnoses. Wu et al., (2015) found that in addition to significant sleep improvements, the therapy also had positive effects across comorbid outcomes. However,

patients with psychiatric disorders demonstrated larger improvements relative to those with medical conditions. Compared with medical or physical functioning problems, disordered sleep might be more strongly associated with the cognitive and emotional symptoms experienced globally across psychiatric conditions [40]. Utilizing brief clinical assessment during routine post-operative visits to assess for sleep quality could help identify patients who would benefit from gold standard psychological intervention such as CBTi targeted at improving sleep.

The results should be interpreted with the following considerations and limitations in mind. For bariatric patients, sleep could be affected by confounding medical comorbidities such as obstructive sleep apnea (OSA), use of CPAP (12.4%, see Table 1), urine incontinence or factors such as diabetes that can lead to increased frequency of urination (50.3%, see Table 1) or other lifestyle factors, such as physical activity and pattern of eating. Future research should examine OSA data and related lifestyle behaviors in post-operative studies on sleep quality. All potential comorbidities and confounding factors were unable to be captured in this study. Sleep quality was assessed through self-report using the PSQI rather than objectively in a sleep clinic. Accuracy of sleep duration in particular may be challenging for participants to assess and is prone to underreporting, especially in individuals who perceive themselves to have short sleep [41]. This study is cross-sectional in design and thus, we were unable to assess change in sleep quality pre- to post-operatively. Additionally, given this design, we were unable to ascertain the temporal relationship between disordered sleep and eating-disorder

psychopathology. A longitudinal approach would allow observation of this relationship over time in the post-operative period, and we offer this as an important direction for future research. Finally, generalizability to other bariatric procedures, such as the Roux-en-Y gastric bypass, or to patients without LOC eating is uncertain; examining differences in sleep quality between patients with and without LOC eating is an important future direction.

## Conclusions

To our knowledge, this is the first study to examine sleep quality and duration among sleeve gastrectomy patients with LOC eating. Our results highlight the rate and clinical relevance of suboptimal sleep quality and duration among this patient group. These findings suggest that clinicians working with post-bariatric patients should routinely ask about concerns with eating behaviors (such as LOC eating) and about sleep habits and quality. Identifying problems in these areas could help optimize clinical management of presenting medical and psychiatric issues as well as quality of life and weight outcomes.

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## Compliance with Ethical Standards

**Conflict of Interest** The authors declare that they have no conflict of interest.

**Human and Animal Rights and Informed Consent** All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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