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ORIGINAL CONTRIBUTIONS

Sleep Quality Before and After Bariatric Surgery

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Abstract

Purpose Sleep deprivation is associated with growth hormone deficiency and an elevated cortisol level, both of which have been linked to obesity. However, assessing sleep quality is often not established in the multidisciplinary peribariatric evaluation program. This study aimed to determine sleep quality in patients who are seeking or underwent bariatric surgery by using Pittsburgh Sleep Quality Index (PSQI) measurements.

Materials and Methods In this observational study, patients who underwent or were seeking bariatric surgery between April and November 2021 were included. Self-reported patients' demographics, operative techniques, and sleep quality measured by PSQI were collected. Baseline characteristics were compared between the preoperative group (PRE), patients who underwent surgery < 1.5 years ago (EARLY), and > 1.5 years ago (LATE). A multivariate linear regression model was built.

Results In total, 270 patients filled out the questionnaire of which 100 (37.1%) were preoperative, 87 (32.2%) early, and 83 (30.7%) late postoperative. The PSQI significantly improved in the EARLY group compared to PRE (4.8 vs 6.1). This effect disappeared in the LATE group (6.1) even though their body mass index was less. Linear regression revealed that age ($p = 0.004$) and body mass index ($p = 0.003$) predicted worse sleep quality.

Conclusion Sleep quality improves early after bariatric surgery; however, this benefit does not seem to last in the long term. Other factors than weight regain should be considered for this finding, future studies with longer follow-up periods are recommended, including other variables associated with sleep quality such as health conditions and socioeconomic status.

Keywords Sleep quality · Bariatric surgery · Sleep monitoring

Introduction

According to clinical guidelines, sleep quality analysis should be part of the preoperative evaluation for bariatric surgery candidates [1]. There is a relationship between obesity and sleep deprivation, it causes metabolic changes in glucose metabolism, appetite, calorie intake, and energy expenditure [2–8]. More specifically, sleep deprivation might cause hyperphagia, possibly by reducing levels of leptin and increasing ghrelin and therefore increased food intake. Due to sleep deprivation, individuals have simply more time to eat and are physically less active as a consequence to fatigue, and it lowers body core temperature causing lower energy expenditure [3]. However, guidelines do not describe how sleep quality should be assessed. A commonly used method is determining the Pittsburgh Sleep Quality Index (PSQI) [9]. To date, there is no literature on the reference values of the PSQI in patients with obesity. The literature that investigated the PSQI preoperatively and postoperatively describes improvement in sleep quality postoperative; however, sample sizes are small, and whether this improvement remains has not been described yet [10–12]. Weight regain after bariatric surgery could influence these results [13–15]. According to Cooper et al., patients regain 21–29% of their lost weight after Roux-en-Y gastric bypass [16]. This could result in return of obesity-related comorbidities and decrease in health-related quality of life, which in turn might decrease sleep quality [17]. This study aimed to

Key points

- Sleep quality is mostly not assessed in preoperative work up in bariatric surgery.
- The sleep quality significantly improved early after bariatric surgery.
- Age and body mass index predicted worse sleep quality.

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determine the sleep quality of patients in a bariatric surgery trajectory using the PSQI questionnaire in a large population both preoperatively as mid- to long-term postoperative.

Methods

In this observational study, patients who underwent or were seeking bariatric surgery between April and November 2021 were included. Self-reported patients' demographics, operative techniques, and sleep quality measured by PSQI were collected. Patients who received revisional surgery were excluded from analysis. All potential candidates for bariatric surgery underwent screening before surgery and thereafter gain access to an eHealth platform on which informational videos, e-learning, and screening questionnaires were provided. The PSQI questionnaire was added to this list as a voluntary option, a self-administered questionnaire that assesses subjective sleep quality of the previous month. It comprises 19 items which evaluates 7 components: sleep duration, sleep disturbance, sleep latency, day dysfunction due to sleepiness, sleep efficiency, overall sleep quality, and the use of sleep medication. Using a formula, the PSQI could be calculated ranging from 0 to 21, with higher scores indicating worse sleep quality.

Both preoperative and postoperative patients had access to this platform and completed this questionnaire. In standard practice, follow-up aided by this platform is up to 5 years. Additionally, the difference between mid- and long-term postoperative was set on 1.5 years. This study was approved by the local Institutional Review Board and informed consent was retrieved for all participating patients.

Statistical Analysis

Baseline characteristics were compared between the preoperative group (PRE), patients who underwent surgery < 1.5 years ago (EARLY) and > 1.5 years ago (LATE). A multivariate linear regression model was built. The chi-square test for categorical data and one-way ANOVA were used for continuous data if normally distributed. The Kruskal–Wallis test was used if data was not normally distributed. The PSQI values were presented as categorical data and continuous data for better interpretation over time; a PSQI ≤ 5 is associated with good sleep quality, above 5 as poor sleep quality [9]. A multivariate linear regression model was built to correct for confounders and to estimate the relationship between the independent variables on sleep quality. Backward selection of the clinically relevant and univariate significant confounders was used ($p < 0.1$). Additionally, modification effects of included variables were investigated. Continuous variables in normally distributed data were presented as mean and standard deviation, not normally distributed data were reported as median and interquartile range.

Statistical analyses were performed using SPSS software (version 26). Significance levels were set for p-value < 0.05.

Results

A total of 270 patients filled out the questionnaire completely, of which 100 (37.1%) were in the preoperative phase, 87 (32.2%) in the early postoperative phase (< 1.5 years), and 83 (30.7%) in the late postoperative phase (> 1.5 years).

The majority was female 228 (84.4%), most of them aging between 45 and 54 years, 49% underwent a sleeve gastrectomy (SG) and 51% a Roux-en-Y gastric bypass (RYGB). The patient characteristics of all three groups, before and after surgery, are described in Table 1. There were significant differences between age groups and body mass index (BMI, kg/m^2), as well as PSQI. The preoperative phase had a higher percentage of younger participants aging between 18 and 34 years old (26%) compared to the late postoperative phase which consisted of older participants aging between 55 and 64 years (42%). The BMI was significantly lower early postoperative but was even less in the late operative phase. The PSQI score improved in the early postoperative phase (4.8); however, it deteriorated after 1.5 years of surgery to the same score as preoperatively (both 6.1). The highest percentage of good sleep quality (PSQI ≤ 5) was observed in the early years (65.5%), the highest percentage of poor sleep quality in late years (49.4%). Comparing the two surgical techniques, the SG group had a mean PSQI of 5.13 compared to the RYGB group with a PSQI of 5.79.

Table 2 represents the univariate and multivariate linear regression model; there was no multicollinearity. In the univariate model, patients who were in the early phase significantly predicted higher sleep quality compared to the preoperative phase. In the multivariate model, the operative phase lost its significance when corrected for other included variables. Nevertheless, in this linear model, higher age and BMI significantly predict lower sleep quality. Although not significant, women had a higher median PSQI of 5 compared to men (4), suggesting poorer sleep quality.

Discussion

This observational study, including 270 patients who filled in the Pittsburgh Sleep Quality Index, showed the effect of different phases in bariatric surgery on sleep quality. It seems that sleep quality significantly improved early after surgery compared to preoperatively, however, deteriorated to the same score in long term. In an univariate linear model,

Table 1 Patient characteristics and sleep quality

	Preoperative $n = 100$	Postoperative < 1.5 years $n = 87$	Postoperative > 1.5 years $n = 83$	*P*-value
Gender				
Male	13 (31%)	17 (19.5%)	12 (14.5%)	0.444
Female	87 (87%)	70 (80.5%)	71 (85.5%)	
Age				0.001
18–34 years	26 (26%)	13 (14.9%)	8 (9.6%)	
35–44 years	27 (27%)	25 (28.7%)	14 (16.9%)	
45–54 years	34 (34%)	32 (36.8%)	26 (31.1%)	
55–64 years	12 (12%)	17 (19.5%)	35 (42.2%)	
65 and older	1 (1%)	0 (0%)	0 (0%)	
BMI, mean, kg/m^2 (SD)	43.3 (6.3)	32.1 (5.9)	29.1 (5.1)	0.001
Type of surgery	N.A			0.650
Sleeve gastrectomy		41 (47.1%)	42 (50.6%)	
Roux-en-Y gastric bypass		46 (52.9%)	41 (49.4%)	
PSQI, mean (SD)	6.1 (3.7)	4.8 (3.5)	6.1 (4.4)	0.046
Good sleep quality ≤ 5	55 (55%)	57 (65.5%)	42 (50.6%)	0.127
Poor sleep quality > 5	45 (45%)	30 (34.5%)	41 (49.4%)	

BMI, body mass index; *PSQI*, Pittsburgh Sleep Quality Index

Table 2 Univariate and multivariate linear regression model

	B (SE)	Confidence intervals	*P* value	B (SE)	Confidence intervals	*P* value
Phase bariatric surgery						
Early	− 1.221 (0.564)	− 2.331; − 0.111	0.031			
Late	0.073 (0.571)	− 1.052–1.197	0.899			
Gender (male/female)	0.534 (0.651)	− 0.749–1.816	0.413	0.933 (0.654)	− 0.353–2.220	0.154
Age, years, (≤ 44/ > 45)	0.478 (0.238)	0.010–0.946	0.045	0.708 (0.246)	0.224–1.193	0.004
BMI, mean, kg/m^2	0.066 (0.027)	0.012–0.120	0.017	0.083 (0.028)	0.028–0.137	0.003
Only postoperative ($n = 170$)						
Type of surgery	0.661 (0.611)	− 0.545–1.866	0.281			

patients in the early postoperative phase experienced significantly improved sleep quality compared to other preoperative patients. However, when other factors such as gender and BMI were added in the model, this variable lost its significance. Although it was anticipated patients would experience weight regain during follow-up and therefore possible decreased sleep quality, patients seem to continue to lose weight even after 1.5 years postoperatively as their BMI was 3 points lower compared to the early postoperative phase. An older study by Charuzi et al. investigated sleep apnea in 47 patients 1 year and 7 years after bariatric surgery, although regaining weight was associated with reappearance of sleep apnea the patients still felt that they slept better compared to before surgery, although excess weight was the main contributing factor for the severity of the syndrome [18]. Merged data from two randomized controlled trials evaluated 398 patients 5 years after RYGB and SG [19]. It appears that Roux-en-Y gastric bypass induced greater weight loss, but there was no difference in remission of obstructive sleep apnea. In a propensity score matching study, 285 patients were compared for surgical technique; there were no differences found for BMI reduction or sleep apnea [20]. Sleep quality seems to improve after bariatric surgery, but evidence if this improvement lasts in long term is lacking [10–12, 21]. To the best of our knowledge, the longest follow-up period on sleep quality after bariatric surgery is 6 months and therefore has not been investigated yet. In our study, theoretically patients could be up to 5 years postoperative. However, due to the questionnaire design, exact numbers are unavailable. Additionally, there was no literature found regarding the differences between surgical techniques and sleep quality.

Other studies investigated factors influencing sleep quality such as genetics, depressed mood, and physical illness

[22, 23]. This might be an explanation for the contradicting results in our study, anticipating bariatric surgery would have a greater influence in predicting sleep quality. Sleep is a complex physiological process and affected by multiple factors including individual behavior, environment, socioeconomics, and physical well-being, and therefore hard to investigate in a cohort using questionnaires [23–25]. This study focused on the impact of weight loss on sleep quality. However, the literature also suggests that sleep disturbance itself plays an important role in obesity and thereby a bidirectional relationship [3, 26]. It is important to not only treat obesity by weight loss, but also include treatment of sleep deprivation.

Although higher age was a significant predictor for poorer sleep quality in the linear regression, age itself does not seem to be identified as a consistent, independent predictor of sleep disturbances according to multiple studies [23, 27, 28]. The differences in sleep quality in different age groups are hypothesized to be due to depressed mood and physical health problems. As for sex, our study describes higher PSQI scores in women. A cross-sectional study of 458 patients investigated whether the influence of sleep and BMI on the risk of developing metabolic syndrome differed by gender [29]. Yeom et al. found that the indirect effect of sleep quality on the risk of metabolic syndrome was significant in women, but not in men and therefore plays a greater role for women. Other studies found that women have a stronger inversely association between sleep duration and BMI and that women have higher PSQI scores which are more prominent to deteriorate over time [30–32]. Additionally, poor sleep quality is associated with altered gray matter volume in women which may develop cognitive deficits in contrast to men [33].

The study is limited by the lack of information on the presence of obstructive sleep apnea syndrome; the Pittsburgh Sleep Quality questionnaire does not cover this aspect nor was this information assessed when patients completed the questionnaire. According to a recent quality registry, covering 8157 patients with obesity 20% had been diagnosed with obstructive sleep apnea syndrome (OSAS) [34]. Multiple studies underline the effect of bariatric surgery on improvement of OSAS and therefore potentially sleep quality [35–37]. There was no evidence found on the relationship between sleep apnea and the PSQI. Additionally, to the limitations, the observational design is prone to selection bias. A random cohort was approached for filling out the questionnaire, rather than using a longitudinal design for follow-up of the same patient. A regression model was built to correct for variables, although included variables were scarce due to the short design of the questionnaire. Despite of its limitations, this study is one of the first to report on sleep quality using the PSQI in patients before and after bariatric surgery in the long term. For future studies, a longitudinal study is recommended, to observe the same patients and their sleep quality over time postoperatively, rather than comparing different individuals in this study as non-obese controls in other studies [11, 21, 38]. Additionally, it should take other variables into account influencing sleep quality such as the presence of sleep apnea and other physical conditions, socioeconomics, and mental disorders as sleep itself is a complex process.

Conclusion

In conclusion, sleep quality asses with a PSQI seems to improve after bariatric surgery and deteriorates in the long term to the same preoperative index. Although it does not seem to relate with weight regain as expected in the long term, this study encourages to focus on other factors associated with decreased sleep quality in postoperative patients. With this study, a starting point has been set for future studies, preferably with a prospective design.

Declarations

Ethics Approval 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.

Informed Consent Informed consent was obtained from all individual participants included in the study.

Conflict of Interest The authors declare no competing interests.

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