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Obesity effects on sleep quality with anthropometric and metabolic changes

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SUMMARY

OBJECTIVE: Obesity is one of the etiological factors of sleep disorders (e.g., obstructive sleep apnea and restless leg syndrome). The aim of this study was to determine the effect of obesity on sleep quality by using the Pittsburgh Quality İndex and Berlin Question are and evaluate the association of sleep with anthropometric and metabolic parameters.

METHODS: A total of 76 patients (41 females and 35 males) between the ages of 18 and 70 years with a body mass index >30 kg/m^2 were included in this study. Homeostatic model assessment-insulin resistance, hemoglobin A1c, alanine aminotransferase, aspartate transaminase, total cholesterol, low-density lipoprotein, triglyceride, high-density lipoprotein, and thyroid-stimulating hormone levels were analyzed. Sleep quality was evaluated with the Pittsburgh Sleep Quality Index, Berlin Questionnaire, and the Restless Leg Syndrome Questionnaire.

RESULTS: A significant correlation was observed between Pittsburgh sleep quality index and body mass index, neck circumference, body fat index, muscle mass, hip and waist circumference, hemoglobin A1c, and homeostatic model assessment-insulin resistance (ps<0.005). The Pittsburgh sleep quality index median (2.5–97.5 percentile) value was 8 (2–18.6) in the patient group and 3.5 (0.1–7.9) in the control group (p<0.0001). Body mass index was found to be the predictor on Pittsburgh sleep quality index (R^2=0.162, F=3.726, analysis of variance p=0.008). Notably, 88% (67) and 95% (57) of the poor sleepers were found to be at high risk for obstructive sleep apnea according to Berlin Questionnaire and Pittsburgh Sleep Quality Index, respectively. Also, the frequency of restless leg syndrome was 45% in obese individuals.

CONCLUSIONS: We observed a significant correlation between Pittsburgh sleep quality index and the anthropometric and metabolic parameters. Also, the frequency of obstructive sleep apnea and restless leg syndrome was 88% and 45%, respectively, in obese individuals.

KEYWORDS: Obesity. Obstructive sleep apnea. Restless leg syndrome. Sleep quality. Sleep screening test. Sleep disturbance.

INTRODUCTION

Sleep disorders are common in modern society, and the prevalence of chronic insomnia varies between 6 and 76.3% depending on diagnostic and screening methods used[1]. The prevalence of obesity and sleep disorders is increasing worldwide[2].

The impact of sleep quality on the development of metabolic syndrome was evaluated in several studies[3,4]. Sleep quality affects energy balance through appetite, hypothalamic-pituitary-adrenal axis activity, gut-peptide concentrations, and substrate oxidation[5]. Poor sleep quality enhances positive energy balance through endocrine changes, such as lower leptin and higher ghrelin concentrations, which result in excess food intake and weight gain[6]. Obese patients experience sleeplessness more likely with a reciprocal relationship whereby poor sleep leads to weight gain, which may, in turn, induce more sleep impairment[7,8].

Obstructive sleep apnea (OSA) and restless leg syndrome (RLS) are common sleep disturbances with higher prevalence in obese individuals[2,9]. In OSA, the activity of respiratory tract upper muscle is decreased because of the fat deposits that cause airway narrowing and finally result in hypoxic episodes[9,10]. RLS is composed of sensory symptoms that are accompanied by an irresistible urge to move legs[2,9,11]. The prevalence of RLS in adults was reported as 4–29%[2,12].

To evaluate sleep disorders, the Stanford Sleepiness Scale, Epworth Sleepiness Scale, Pittsburgh Sleep Quality Index (PSQI), Stop-Bang test, Berlin Questionnaire (BQ), and Restless Leg Syndrome (RLS) Questionnaire are used[13,14]. The PSQI is an easy index that provides a standardized measure of sleep quality and discriminates “good” and “poor” sleepers[14].

The aim of this study was to determine the effect of obesity on sleep and the association of sleep with anthropometric and metabolic parameters. The secondary objective was to evaluate the frequency of OSA and RLS in obese individuals.

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METHODS

The study was approved by the Ethics Committee of Dr. Lutfi Kırdar Kartal City Hospital (decision number: 2020/514/182/20, dated: July 27, 2020).

The medium effect size (effect size=0.3) was predicted to be statistically significant, and the alpha significance level (0.05) was calculated the sample size as 68 with 80% power. A total of 76 patients (41 females and 35 males; body mass index [BMI] >30 kg/m^2) between the ages of 18 and 70 years who were followed up in the obesity outpatient clinic between July 2020 and February 2021 participated in this study. Notably, 27 volunteers with a BMI <30 kg/m^2 were determined as the control group. Participants were informed about the study and a written consent form was obtained.

Patients using medication for sleep disorders, malignancies, and severe psychiatric disorders were not included in the study.

Body mass index; waist, hip, and neck circumference; soft lean mass (SLM); and percent body fat (PBF) were measured. BMI was calculated as follows: body weight/height^2 (in kg/m^2). Anthropometric measurements were done with Tanita MC-580 body composition analysis (TANITA, MC-580, Japan). Venous blood samples were taken after 8 h of fasting, and glucose, total cholesterol, low-density lipoprotein (LDL), triglyceride, and high-density lipoprotein (HDL) measurements were analyzed with AU 5800 (Beckman Coulter, Brea, CA, USA). Insulin and thyroid-stimulating hormone (TSH) values were analyzed with Unicel DxI 800 (Beckman Coulter). Homeostatic model assessment-insulin resistance (HOMA-IR) was calculated as follows: fasting blood glucose (mg/dL) × insulin (IU/mL) / 405. Finally, PSQI, BQ, and RLS Questionnaire were performed to evaluate sleep quality.

Pittsburgh sleep quality index

Pittsburgh Sleep Quality Index consists of a 19-item questionnaire. Using this index, subjective sleep quality, sleep latency, sleep duration, sleep efficiency, daytime dysfunction, use of medications to sleep, and the presence of sleep disorders are evaluated. Individual with a total PSQI score >5 was considered poor sleeper[15].

Berlin questionnaire

Berlin Questionnaire consists of 11 items with three categories. The first category consists of questions related to snoring and breathing pause during sleep, the second category consists of questions related to daytime sleepiness, fatigue, and drowsiness during driving, and the third category consists of questions about obesity and hypertension. A positive answer to two or more questions from these three categories is considered to be a high risk for OSA[16].

Restless leg syndrome questionnaire

The diagnosis and severity of RLS are determined according to the 2012 IRLSSG criteria[17], including the feeling of restlessness that make ones to move their legs, relaxation when moving, worsening of symptoms during the resting and inactive period, and an increase in the symptoms in the evening and at night. Patients who met these four criteria are considered to be at risk for RLS[7,18].

Statistical analysis

Statistical analysis was performed using the SPSS program (Statistical Package for Social Science, version 11.7; Chicago, IL, USA). The Kolmogorov-Smirnov test was used to determine the distribution of the parameters, and data were expressed as median (2.5–97.5 percentile). The comparison of the group medians was done with the Mann-Whitney U test. Correlations between clinical and anthropometric parameters and the PSQI were determined by Spearman's correlation analysis. Multiple regression analyses were performed, considering PSQI as a dependent variable and BMI, HbA1c, neck circumference, and HOMA-IR as independent variables. Statistical significance for all tests was set at $p<0.05$.

RESULTS

The median (2.5–97.5 percentile) age and BMI values of the patients were 41 (19–69 years) and 40 (30–52) kg/ m^2, respectively.

A significant correlation was observed between PSQI and BMI, body fat index, muscle mass, hip, waist, and neck circumference, HbA1c, and HOMA-IR (Table 1). Poor sleep quality (PSQI>5) was observed in 79% (60) of the obese group and 36% (8) of the control group. Multiple regression analyses showed BMI as the predictor of PSQI (R^2=0.162, F=3.726, analysis of variance [ANOVA] p=0.008) (Table 2). Among the Pittsburgh components, a significant correlation was observed between sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, and BMI. A significant difference was found between groups with and without RLS in terms of sleep latency and drug use (p=0.044, p=0.019, respectively) (Table 3).

According to BQ, 88% (67) of the patients were found to be at high risk for OSA. Out of 16 patients whose sleep quality was not impaired according to the PSQI, 12 patients were found to be at high risk for OSA by BQ. Notably, 95% (57) of the poor sleepers defined by PSQI also had high risk for OSA and 45% (34) of them had risk for RLS.

Table 1. Partial correlation of Pittsburgh sleep quality index with anthropometric and clinical parameters.

Parameter	r	p
BMI (kg/m²)	0.416	<0.0001
Neck circumference (cm)	0.223	*0.023
Body fat mass %	0.326	*0.009
Waist circumference (cm)	0.339	*0.005
SLM (cm)	0.210	*0.032
Hip circumference (cm)	0.387	*0.001
HOMA-IR	0.275	*0.011
HbA1c (%)	0.214	*0.030
TSH (IU/L)	0.058	0.559
LDL-cholesterol (mg/dL)	0.157	0.113
Triglyceride (mg/dL)	0.157	0.115

*p<0.05 is accepted as significant.

DISCUSSION

Obesity and sleeping disorders may be related to prevalent biological mechanisms, which encourage researchers to investigate the biological basis of these associations[9,12].

Poor sleep quality (PSQI>5) was observed in 79% (60) of the obese group and 36% (8) of the control group. There was a significant correlation between PSQI and BMI, body fat index, muscle mass, hip, waist, and neck circumference, HbA1c, and HOMA-IR values ($p<0.005$). BMI was found to be the predictor on PSQI ($R^2=0.162$, F=3.726, ANOVA p=0.008). A significant correlation was observed between BMI and sleep quality, sleep latency, sleep duration, sleep efficiency, and sleep disorder ($p<0.005$).

Pearson et al. stated that there is an association between sleep problems and comorbid diseases like hypertension, congestive heart failure, anxiety or depression, and obesity, but not with diabetes[19]. Bidulescu et al. reported that cognitive function was impaired with chronic sleep restriction, which also has an impact

Table 2. Multiple regression analyses with Pittsburgh sleep quality index as dependent variable and body mass index, hemoglobin A1c, neck circumference, and homeostatic model assessment-insulin resistance as independent variables

Variables	Unstandardized coefficients		Standardized coefficients	t	p
	B	Std. error	β		
Constant	-1.560	3.539		-0.441	0.661
BMI (kg/m²)	0.089	0.042	0.252	2.149	0.035
Hba1c (%)	0.522	0.353	0.162	1.478	0.143
Neck circumference (cm)	0.057	0.088	0.074	0.648	0.519
HOMA-IR	0.021	0.019	0.115	1.089	0.280

$R^2=0.162$, F=3.726, ANOVA p=0.008.

Table 3. Comparison of Pittsburgh sleep quality index components in patients with and without restless leg syndrome.

	RLS N=34 (Mean±SD)	Non-RLS N=36 (Mean±SD)	p
Sleep quality	1.500±0.915	1.342±0.802	0.466
Sleep latency	2.843±1.985	1.971±1.484	*0.044
Sleep duration	1.312±0.895	1.228±0.877	0.699
Sleep efficiency	0.500±0.803	0.514±0.950	0.947
Sleep disorder	1.593±0.665	1.400±0.650	0.232
Use of medication	0.500±0.983	0.085±0.284	*0.019
Daytime dysfunction	1.937±2.213	1.371±1.554	0.227
Total score	10.294±4.994	7.833±2.922	*0.013

*p<0.05 is accepted as significant.

on cardiovascular and metabolic disorders[8]. Metabolic disorders may be the result of sleep deprivation, which can also be the reason for increased inflammation and elevated sympathetic tone. Besides, the upward trend of ghrelin and lower trend of leptin result in the subsequent increase of hunger and appetite[20].

Pinto et al. revealed that bariatric surgery caused a significant improvement in the PSQI and BQ, with PSQI decreasing from 6.4±4.7 to 4.1±2.8 and the risk of OSA decreasing from 68.3 to 5% after operation[7].

Obstructive sleep apnea has been observed in 58% of obese individuals and polysomnography is the gold-standard method in diagnosis[21]. Marta et al. defined the sensitivity, specificity, positive predictive value, and negative predictive value of the BQ for OSA as 87.2%, 11.8%, 73.2%, and 25%, respectively[10]. They concluded that BQ was a valuable screening test and patients with high risk for OSA should be directed to polysomnography[10]. In our study, 88% (67) of the obese patients were found to be at high risk for OSA. Likewise, 95% (57) of the poor sleepers had a high risk for OSA.

Several studies found a significant association between obesity and RLS[2,22-24]. In a cross-sectional study with 1,803 adults; an increase of 5 kg/m^2 in BMI was found to be associated with a 31% increased likelihood of having RLS[25]. In our study, 45% (34) of the obese patients also had RLS and 40% (23) of the patients with RLS also had OSA. In addition, patients with RLS had shorter sleep latency and showed more drug use.

Pittsburgh Sleep Quality Index is a valid tool for both clinicians and researchers, but it was not developed for a specific population and might function differently in different populations and settings. Nevertheless, if the sample size is sufficiently large, it will provide a sufficient estimate for sleep quality in the given population[14].

In our study, we defined OSA according to BQ and did not evaluate the polysomnography results of our patients, which may be the limitation of our study.

CONCLUSIONS

We observed a significant correlation between PSQI and the anthropometric and metabolic parameters in obese patients and BMI was the predictor on PSQI. The frequency of OSA and RLS was 88% and 45%, respectively, in obese individuals.

EHICAL APPROVAL

The study was carried at Dr. Lutfi Kırdar Kartal City Hospital in Istanbul.

AUTHORS' CONTRIBUTIONS

MKT: Conceptualization, Data curation, Formal Analysis, Investigation, Resources, Writing – original draft, Writing – review & editing. **ACI**: Project administration. **ÖÇM**: Funding acquisition, Methodology, Supervision, Validation, Writing – review & editing. **KSK**: Software, Visualization, Writing – review & editing.

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