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Association of Sleep Quality with Body Fat Mass and Metabolic Factors in Iranian Adults in 2020

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Abstract

Background: Poor sleep quality is increasingly recognized as a risk factor for poor health outcomes such as obesity, diabetes and cardiovascular diseases. This study aimed to investigate the association between sleep quality, obesity and glycemic and lipid profiles in Iranian adults in 2020.

Methods: Of 353 adults aged 18–60 years enrolled from community centers in Tehran municipality, after exclusions 326 participants remained for analysis in this cross-sectional study using convenience sampling. Information on anthropometric measurements, physical activity and dietary intake were collected. Sleep quality was assessed through Pittsburgh Sleep Quality Index. Body composition was measured through BIA method. Auto analyzer was used to measure Fasting Blood Sugar (FBS) and lipid profile, and Insulin was measured using the ELISA method.

Results: The mean age was 42.92±11.34 and 39.16±14.18 for women and men, respectively. Each one-point increase in the PSQI total score was associated with a 0.1 cm increase in waist circumference and a 0.3% increase in body-fat percentage ($P < 0.05$). BMI had a positive correlation with subscales of '*sleep disturbances*' and *'use of sleep medications'* ($P < 0.001$). Physical activity had a significant negative correlation with subscales of *"subjective sleep quality"* and *"sleep latency".* FBS and triglyceride had positive correlation with *"sleep latency"* and *"Subjective sleep quality",* respectively ($P < 0.05$).

Conclusion: Some determinants of sleep quality are associated with obesity, disorders of glucose and triglyceride metabolism and low level of physical activity.

Introduction

Chronic sleep deprivation due to lifestyle changes is a common problem in modern societies [1]. The prevalence of sleep disorders has been increasing over the past decades [2]. Poor sleep quality along with changes in other lifestyle habits, such as eating, physical activity, smoking and drinking, are likely of potential risk factors for non-communicable diseases such as obesity, diabetes and cardiovascular disease, [3-5]. There are some studies showing the relationship between sleep duration and glycemia [6-8] and lipid profile [9-18]. Most of these studies have suggested that short sleep duration is associated with lower high density lipoprotein cholesterol (HDL-C) and higher triglyceride (TG) level [19]. Many studies have shown that short sleep duration could also be a significant risk factor for diabetes [6,8], while there are few studies regarding sleep quality. Iyegha and colleagues showed that prediabetes is positively associated with poor sleep quality [3]. On the other hand, sleep quality is associated with appetite and dietary intake [20-22]. Poor sleep quality is also associated with severe fatigue during the day, which can reduce desire to engage in physical activities. All of the mentioned variables are associated with weight gain. Moreover, it has also been documented that physical activity can improve dyslipidemia and blood glucose intolerance [23]. Furthermore, poor sleep quality can increase stress level which in turn, may lead to increase in total and low-density lipoprotein (LDL) cholesterol and glucose serum level [10,24]. Poor sleep quality can increase cortisol secretion and muscular protein synthesis suppression [25]. It may also lead to decrease in insulin-like growth factor 1 (IGF-1) [26], increase in insulin resistance [27], increase in body fat mass [28], decrease in leptin secretion, increase in ghrelin secretion[29] and decrease in adiponectin level which can cause obesity [30]. Although it is not clear which PSQI subscales are most strongly correlated with body weight and metabolic factors. With regard to this point and considering the increasing prevalence of sleep disorders in the last decades [3] and also the lack of attention to sleep quality and its impacts on risk factors of non-communicable diseases, the current study was conducted to investigate the association between sleep quality and BMI, body fat mass, glycemic and lipid profile and physical activity level in Iranian adults, focusing on all sleep quality subsets, separately.

Methods

Participants

The cross-sectional study was conducted on 353 adults, aged 18-60 years from both sexes who referred to community centers in different districts in Tehran with convenience sampling method.

Data collection

Volunteers who were not on any diet, not pregnant or lactating, and not athletes completed the PSQI questionnaire to determine their sleep quality [31]. A PSQI total score ⩽5 indicates good sleep quality; scores >5 indicate poor sleep quality. To calculate BMI, weight was measured using digital scale (Beurer, Germany) to the nearest 100 grams, without shoes, while wearing light clothes. Height was measured to the nearest 0.5 cm, without shoes, using a wall-mounted, non-stretch tape measure. International Physical Activity Questionnaire (IPAQ) [32] and 3-day food recalls were completed for participants. Dietary intakes were assessed by 3-day food recalls and calorie intake was calculated by Nutritionist IV software.

Biochemical and body composition measurements

Biochemical assessments were conducted in a subsample of 90 participants. These Participants were referred to clinic of diet therapy of Shahid Beheshti University of Medical Sciences. 5 mL of blood was taken after 8 to 12 hours of fasting, and the serum samples were frozen immediately at −80°C until assay at the end of the study. Fasting blood sugar (FBS), cholesterol, TG and HDL-C level were determined by autoanalyzer, through commercial kits. Low-density lipoprotein cholesterol (LDL-c) concentration was determined by the Friedewald formula (Friedewald, Levy, & Fredrickson, 1972). Enzyme linked immunosorbent assay (ELISA) method was employed to determine Insulin Level. To assess body composition, bioelectrical impedance analysis (BIA) was used after 8-12 hours fasting in the above-mentioned clinic.

Statistical analysis

To compare anthropometric measurements, biochemical factors and physical activity level between categories of sleep quality, independent-samples t test was used. Pearson correlation was used to analyze correlation between dependent variables and all subscales of sleep quality. Relation between sleep quality and waist circumference and body fat mass was analyzed using linear regression models, before and after adjusting covariates. A two-sided $P < 0.05$ was considered statistically significant in all analyses.

Ethical consideration

The study was approved by the Ethics Committee of the National Nutrition and Food Technology Research Institute, Iran. The ethical code is: IR.SBMU.nnftri.Rec.1398.025.

Results

A total of 353 people participated in this study. After excluding participants whose calorie intake was less than 800 or more than 4200 kcal, 326 people remained for the analysis.

Sociodemographic characteristics

Overall mean age was 41.1 ± 12.4 years; women, 42.92 ± 11.34 years; men 39.16 ± 14.18 years.

Intake of effective drugs on sleep, depression, weight and appetite, was higher in women than men, although there were not significant. Glucose and lipid profile reducing drugs and smoking status did not show any significant difference with sex.

Anthropometric, body composition and biochemical variables

Table 1 shows mean ± SD of anthropometric measurements, body composition and biochemical

Indicator	Sleep quality	Mean	SD	P-value
Height(cm)	Poor	161.48	6.89	0.823
	Good	161.26	10.01	
Weight(kg)	Poor	71.64	10.85	0.508
	Good	70.79	12.19	
BMI(kg/m²)	Poor	27.58	4.59	0.775
	Good	27.42	5.72	
Waist (cm)	Poor	96.30	10.43	0.003
	Good	92.66	11.30	
Body Fat Mass (%)	Poor	35.59	7.76	0.007
	Good	30.32	7.46	
Body Muscle Mass (%)	Poor	64.40	7.76	0.02
	Good	69.08	8.03	
Physical activity level (MET-min/week)	Poor	1681.89	1588.09	0.02
	Good	2130.74	1891.10	
FBS(mg/dl)	Poor	91.78	15.88	0.30
	Good	88	14.26	
Insulin(µIU/ml)	Poor	6.94	6.18	0.20
	Good	5.49	2.97	
Cholesterol(mg/dl)	Poor	189.48	35.72	0.87
	Good	190.85	36.88	
Triglyceride(mg/dl)	Poor	124.42	62.37	0.38
	Good	111.22	62.04	
HDL-C (mg/dl)	Poor	50.51	12.48	0.20
	Good	54.25	11.85	
LDL-C (mg/dl)	Poor	114.08	29.28	0.97
	Good	114.35	41.29	

Table 1: Mean ± SD of anthropometric, body-composition, and biochemical variables by sleep-quality category.

Parameters	Subjective sleep quality	Sleep latency	Sleep duration	Sleep efficiency	Sleep disturbances	Use of sleep medications	Daytime dysfunction	Total score of sleep quality
	R (p-value)	R (p-value)	R (p-value)	R (p-value)	R (p-value)	R (p-value)	R (p-value)	R (p-value)
Weight	-0.27 (0.63)	0.01 (0.79)	0.02 (0.66)	-0.01 (0.79)	0.18 (0.001)*	0.07 (0.19)	0.09 (0.08)	0.79 (0.15)
BMI	-0.03 (0.53)	0.04 (0.44)	0.04 (0.41)	0.03 (0.55)	0.19 (<0.001)*	0.13 (0.01)*	0.006 (0.91)	0.1 (0.06)
Physical activity	-0.14 (0.01)*	-0.1 (0.05)*	0.04 (0.9)	-0.09 (0.09)	0.01 (0.85)	0.06 (0.26)	-0.03 (0.52)	-0.09 (0.10)
FBS	0.006 (0.96)	0.27 (0.02)*	0.09 (0.44)	0.03 (0.78)	0.16 (0.18)	0.11 (0.36)	0.08 (0.50)	0.2 (0.1)
Insulin	0.08 (0.50)	0.12 (0.31)	0.08 (0.48)	0.21 (0.08)	0.18 (0.11)	-0.004 (0.97)	0.04 (0.71)	0.19 (0.1)
Cholesterol	-0.05 (0.68)	-0.08 (0.51)	0.08 (0.49)	0.13 (0.28)	-0.07 (0.55)	-0.29 (0.01)*	0.04 (0.74)	-0.04 (0.69)
TG	0.25 (0.03)*	0.09 (0.42)	-0.12 (0.32)	-0.06 (0.61)	0.03 (0.79)	-0.01 (0.89)	0.09 (0.4)	0.05 (0.64)
HDL-C	0.02 (0.85)	-0.02 (0.85)	0.04 (0.72)	0.21 (0.07)	-0.17 (0.14)	-0.18 (0.12)	-0.13 (0.28)	-0.03 (0.8)
LDL-C	-0.14 (0.23)	-0.10 (0.38)	0.11 (0.36)	0.08 (0.50)	-0.02 (0.84)	-0.22 (0.06)	0.05 (0.68)	-0.05 (0.63)

Table 2: Correlation of sleep-quality subscales and anthropometrics, physical activity and biochemical variables**
* Pearson correlation coefficients (r). P < 0.05 was considered statistically significant

Indicator	Quality	β	P-value
Waist circumference (cm)	Total score of sleep quality	0.167	0.002
	Total score of sleep quality†	0.176	0.002
	Total score of sleep quality††	0.170	0.002
Body fat mass (%)	Total score of sleep quality	0.353	0.004
	Total score of sleep quality†	0.357	0.004
	Total score of sleep quality††	0.354	0.005

Table 3: Relation between sleep quality and waist circumference and body fat mass in order to linear regression model
† Adjusted for sex
†† Adjusted for sex and physical activity level

factors by score of sleep quality. As shown in Table 1, waist circumference and body fat mass were higher in people with weaker sleep quality, while muscle mass and physical activity level were lower in those people. Weight, height, BMI, FBS, Insulin, Cholesterol, TG, HDL-C and LDL-C did not show any significant difference by score of sleep quality.

Table 2 shows correlation between all sleep quality subscales and anthropometrics, physical activity and biochemical variables by Pearson coefficient. Weight and BMI had positive correlation with subscale of "*sleep disturbances*" (P<0.001). BMI also had positive correlation with subscale of *"use of sleep medication".* Physical activity had negative correlation with subscales of *"subjective sleep quality"* and *"sleep latency".* FBS and TG had positive correlation with *"sleep latency"* and *"Subjective sleep quality",* respectively (P <0.05). There was no significant correlation between any sleep-quality subscale and calorie or macronutrient intake (data not shown).

Table 3 shows the relation between waist circumference and body fat mass with sleep quality according to linear regression model. As this table shows, Each one-point increase in PSQI total score was related to 0.1 cm increase in waist circumference and 0.3 % increase in body fat percent (P <0.05). The results remained unchanged after adjusting for sex and physical activity level, as confounders.

Discussion

Despite identification of many effective factors on obesity, the prevalence of obesity is increasing worldwide. So, investigation of other potential effective factors is very important. Our study showed that poorer sleep quality was significantly associated with greater waist circumference and higher body-fat mass. On the other hand, some subscales of sleep quality are associated with FBS, TG, BMI and physical activity level. *Subjective sleep quality* and *sleep latency* were associated with increase in FBS, TG and decrease in physical activity level. We should mention that higher scores of subscales of sleep quality, means the weaker sleep quality. So, poor sleep quality was associated with disorders in FBS and TG metabolism and decrease in physical activity level in present study. Our findings agree with Jennings [33] and Narang [34]. They have shown in their study that poor sleep quality is associated with increase in body fat mass and waist circumference. Poor sleep quality can disrupt secretion rhythm of melatonin, as a major mediator of balance between energy and body weight. It may lead to obesity and fat accumulation [35,36]. Some hormonal disorders may also occur due to poor sleep quality [38]. Findings of a meta-analysis showed that exercise training resulted in improvements in sleep quality in adults with sleep problems [37], although, other trials have found minimal to no improvements in sleep quality due to exercise training [38]. These controversial findings can be explained by different severity of sleep disorders and level of exercises in different studies. The association between poor sleep quality and increase in FBS and TG level in our study, is consistent with Khorasani and colleague's study. They found that serum levels of TG in people with poor sleep quality is higher than those with good sleep quality [39]. In the current study, No association was found between sleep quality and total cholesterol, HDL-C, LDL-C, or insulin. These results agreed with Zhu and colleague's' study, that found no significant associations between PSQI score and these biochemical factors [40]. Poor sleep quality may have effects on FBS and TG through some mechanisms. For example, chronic or acute sleep deprivation can increase appetite through increase in ghrelin, an orexigenic hormone, and decrease in leptin as an anorexigenic factor [20,21]. These factors may lead to weight gain that in turn, can cause increase in FBS and TG level [10,22]. Furthermore, poor sleep quality decreases glucose uptake in skeletal muscle via the hypothalamic–sympathetic nervous system axis and β-adrenergic mechanisms due to decrease in leptin level [41]. Increasing in turnover of triglycerides, inhibiting the basal and insulin-stimulated de novo lipogenesis and stimulating the oxidation of glucose and free fatty acids are of the other probable mechanisms [42]. On the other hand, obesity could increase the risk of obstructive sleep apnea, which in turn, may increase metabolic impairment, including dyslipidemia [43,44]. Some of the subscales of sleep quality was associated with higher BMI in the current study.While increase in prevalence of obesity worldwide has been reported parallel to increase in sleep disorders,, the association between sleep disorders and obesity is not fully understood [45,46]. Some researchers showed that people suffering from sleep disorders are more prone to gain weight [47]. Some studies have suggested that diet quality may have a role on sleep quality [48]. Some nutrients may act on inflammatory hormonal responses involved in hunger-satiety mechanisms and energy metabolism. However, we did not find any significant association between dietary intakes and sleep quality. Our finding is inconsistent with some evidences showing that poor sleep quality is associated with higher calorie intakes and lower intakes of fish [49,50], energy-dense foods [51] and vegetables [52-54]. These controversial findings may be for the reason of clinical characteristics of our participants. Our participants did not have any chronic diseases like diabetes, while most of the other studies have been conducted on people with diabetes or dyslipidemia. The other probable

reason may be severity of sleep disorder in our participants. The mean total score of sleep quality in our study was 6.8, while the range of score is from 0 to 21. It is possible that sleep quality in our participants may not have been sufficiently poor to affect dietary intake. Investigating all subscales of sleep quality, in addition to total score of sleep quality and focusing on quality instead of quantity of sleep may be of the other probable reasons to find some controversial results. Since there was not any association between sleep quality and dietary intake, it seems that the correlation between poor sleep quality and higher BMI, waist circumference and body fat mass is more attributable to lower physical activity than higher energy intake. Furthermore, due to the design of the current study, it is not possible to determine whether weight gain leads to sleep disorders or sleep disorders lead to obesity. We suggest conducting prospective studies to assess causality.

Conclusion

Good sleep quality plays an important role as a modulator of weight, body fat mass, neuroendocrine function for glucose and triglyceride metabolism and physical activity. The current study confirmed an association between poor sleep quality and increased risk of obesity and dysregulation of glucose and triglyceride metabolism.

Strengths and Limitations

One strength of our study was considering all subscales of sleep quality, separately, instead of considering only the total score of sleep quality. Assessment of sleep quality, instead of its quantity (sleep duration), is the other strong point of the current study. As with other observational studies, there may be unmeasured confounding factors that affected the results. In addition, biochemical analyses were limited to a subsample (n = 90), which may affect the generalizability of the findings. For example, influences of common behavioral factors for delayed sleep onset among young people, including caffeine intake, use of electronics late at night and traditional methods to manage sleep, were not considered. Furthermore, the study design did not allow causal inference.

Competing Interest

The authors declare that there is no conflict of interest.

Author Contributions

Study concept and design, analysis and interpretation of data: S.R; Acquisition of data and drafting of the manuscript: M.H and H.S; Critical revision of the manuscript: A.S.

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