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Association between Obstructive Sleep Apnea and Physical Activity

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ABSTRACT

Introduction: Obstructive sleep apnea causes various psychological and physical complications, reduces productivity, and increases car accidents. The present study aimed to assess the association between obstructive sleep apnea and the level of physical activity.

Methods: In this cross-sectional study, people who were referred to a specialized occupational medicine clinic were enrolled using the simple random sampling method. After applying the inclusion criteria, participants completed a package, including demographic and occupational data, the International Physical Activity Questionnaire, the Epworth Sleepiness Scale, and the STOP-BANG (SB) questionnaire. Fasting blood glucose and lipid profiles were measured. The subjects were assigned to two groups according to the score of the SB questionnaire.

Results: A total of 126 participants with a mean age of 36.85±9.88 years were enrolled in this study. Based on the results, 65 (52%) subjects were at a high risk of obstructive sleep apnea. The group with an SB score < 3 was significantly more frequent. Glucose, triglyceride, and LDL levels were significantly higher in obstructive sleep group (P<0.05). Participants with low physical activity had a significantly higher chance of obstructive apnea (OR=9.6, 95% CI 1.1–78.8 berr). In addition, rotational shift decreased the odds of obstructive sleep apnea to 0.17, and subjects with ESS >10 had higher odds of obstructive sleep apnea.

Conclusion: There was a significant relationship between the severity of obstructive sleep apnea and physical activity. Exercise and daily activities can help prevent and improve apnea and its subsequent complications in diseased and disease-prone people.

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Introduction

Sleep is a multidimensional behavior with characteristics such as duration, timing, continuity, depth, and breathing, each being relevant to optimal health and functioning (1, 2). Recurrent upper airway obstruction during sleep indicates obstructive sleep apnea (OSA) (3). OSA impairs quality of life and increases the risk of high blood pressure, heart attack, stroke, heart failure, metabolic syndrome, and depression. It can cause daytime sleepiness and consequently increase the incidence of workplace injuries and car accidents (4-6). A sedentary lifestyle is associated with a higher risk of type 2 diabetes

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and cardiovascular disease (7); nonetheless, its role in the severity of obstructive sleep apnea is not definitive.

Exercise can be a modifiable factor in mitigating the risk of OSA. According to US and Australian guidelines, adequate exercise is defined as moderate-intensity physical activity for at least 150 min per week (8, 9). A decrease in the incidence of OSA has been observed in people who exercise regularly (10), with two cross-sectional studies demonstrating a lower risk of moderate to severe OSA in people with high levels of exercise (11, 12). Low-activity occupations are becoming increasingly common, as 50% of US workers were engaged in the least moderate physical activity in 1960, and by 2006, that number dropped to 20% (13).

Continuous positive airway pressure (CPAP) and nasal or full-face masks have been recognized as the most common and effective treatment for sleep-disordered breathing (SDB). Unfortunately, long-term compliance with CPAP therapy is not optimal (14). Consequently, sometimes alternative treatments are the only available solution. Physical activity, along with a healthy diet, is usually advised for obese patients with SDB or those who are just obese (15). Moreover, there is a dearth of information regarding the behavioral or lifestyle factors that can protect middle-aged people against sleep disorders. Physical activity may be one of these protective factors, although the evidence is controversial. In addition, regular exercise is considered one of the principles of sleep hygiene. Studies pinpointed that in the general population, physical activity is usually associated with better sleep (16), and exercise interventions reduce the severity of various sleep disorders (17-19).

According to epidemiological studies, higher levels of moderate to severe physical activity are associated with a reduced risk of sleep disorders and SDB (20, 21). Improvements in sleep continuity, depth, and intensity of SDB after exercise have been recorded in the meta-analysis of experimental studies (21, 22). Although some studies have not demonstrated an association between physical activity and sleep (23, 24), the findings are more consistent with the higher prevalence of sleep disturbance in people with low physical activity (25).

Due to the positive effects of physical activity, if the amount of physical activity is related to the severity and symptoms of apnea, an acceptable and uncomplicated adjunctive treatment can be provided. To the best of our knowledge, few studies have assessed the association between physical activity and OSA severity or its important symptom, sleepiness. In light of the aforementioned issues, the present study aimed to investigate the association of physical activity with OSA and increased symptoms of daytime drowsiness.

Materials and Method

Study design

This cross-sectional and analytical study was conducted in the specialized clinic of occupational medicineoccupational medicine clinic of Mashhad University of Medical Sciences from 2017 to 2018.

Population and sampling

The sample size was calculated according to the prevalence of apnea in the general population and in people with an activity level of less than 150 min per week (26,27). The size for each group was equal to 59 cases. The study population included people who were referred to a specialized occupational medicine clinic for job examinations, and participants were selected using a simple random sampling method. The inclusion criteria were 1) an age range of 18-65 years, 2) current employment for at least one year, and 3) provision of informed consent. On the other hand, the exclusion criteria entailed 1) diabetes (known patient), *Cushing's* syndrome, kidney failure, heart failure, and secondary blood pressure, 2) head and face abnormalities (including micro-genesis, small mandible, and tonsillar hypertrophy, 3) any restrictions on physical activity due to the disease (nervous, muscular, skeletal, chronic disease complications, such as rheumatoid arthritis), and 4) taking medications that affect or exacerbate the symptoms of obstructive sleep apnea (such as benzodiazepines).

Data collection

After applying the inclusion and exclusion criteria which were reviewed in the interview and initial examination, participants received four questionnaires, including demographic and occupational information, the International Physical Activity Questionnaire (IPAQ), the Epworth Sleepiness Scale (*ESS*), and the STOP-BANG questionnaire. The participants were assigned to two groups based on the score of the STOP-BANG questionnaire (≥ 3 or < 3). The results of examinations, including height and weight measurements, neck circumference, arterial blood pressure (after 15 min of rest and non-exposure to cigarette smoke and acute stress measured in the last 2 hours), were registered in the research checklist. In addition, some biochemical tests, such as fasting blood sugar and blood lipid profile, were administered.

Portable breath testing during sleep was performed in the group with a STOP-BANG score ≥ 3. The portable sleep monitoring device was used as an alternative for polysomnography and detection of obstructive sleep apnea syndrome. The portable device is of great help in resolving the problems of time and place, patient's lack of cooperation to attend the clinic, and diagnosing with appropriate approximation (28). Finally, the relationship between the results of portable sleep testing, scores of questionnaires, and demographic variables was measured by people's physical activity.

The ESS questionnaire is a self-assessment tool that determines the degree of individuals' daytime drowsiness in eight different scenarios, with a minimum score of 0 indicating "would never doze" and a maximum score of 3 indicating a "high chance of dozing." The overall score ranges from 0-24, and a score above 10 indicates a person with abnormal daily drowsiness (29). This questionnaire was translated into Persian and validated for Iranian people (30). The STOP-BANG questionnaire was also employed to assess the risk of obstructive sleep apnea. (31) We used the validated Persian version of the questionnaire (32). If the patient scores three or more positive questions on three or more questions and parameters, they are considered at high risk for obstructive sleep apnea (33).

The third questionnaire was the IPAQ, which was developed as a tool for physical activity on an international scale. In 2000, 14 centers from 12 countries that collected IPAQ reliability and validity data confirmed the repeatability of the test. This questionnaire is a suitable tool for the level of physical activity in people aged 15-69, considering different examples. This instrument assesses individual activity in four areas: work, recreational and sports activities, homework and traffic to the workplace, and time spent sitting (hours per day) during a typical work week (34). IPAQ has been translated into Persian, and its validity and reliability were confirmed (35). According to this IPAQ questionnaire, people are assigned to three levels of activity: low, medium, and severe.

Intense physical activities require a lot of physical strength and breathing much faster than normal. These activities include:

- Have intense physical activity at least three days a week
- Have a combination of walking with moderate to severe physical activity seven days a week.

Moderate activities: These are activities that require moderate physical strength and cause the person to breathe a little faster than normal. Examples of these activities are as follows:

- People who exercise or walk for 30 min three days or more a week.
- People who have moderate physical activity for five days or more for 30 min a day; the total is about 600 meters/min.

Other people are in the low-activity group (34).

2.4 Statistical analysis

All data were entered in SPSS software (version 11.5). Categorical variables were demonstrated as frequency, and quantitative variables were displayed as mean and standard deviation. The chi-square test was used to compare categorical variables between the two study groups. The man-Whitney-U test or Student T-test was used to assess quantitative variables in two groups based on the Kolmogorov–Smirnov test results. Logistic regression analysis was performed in order to assess the independent effect of different variables on obstructive sleep apnea. All variables that had a statistically significant relationship with obstructive sleep apnea in univariate analysis were entered in the logistic regression model. In all analyses, a p-value less than 0.05 was considered statistically significant.

Ethical approval

After explaining the objectives of the study, oral consent was obtained, and patients' information was kept confidential. All stages of the study were explained before entering the study, and it was possible for patients to withdraw from the study at any stage of the study. In addition, the doctor's visit and subsequent examinations were free for the participants. This study was approved by the Organizational Ethics Committee of the Faculty/Regional University of Mashhad (proposal No: 960496 and ethical No: IR.MUMS.fm.REC.1396.403)

Results

In total, 103 (82.4%) subjects were male and 23 (17.45%) cases were female. The mean age of participants was 36.85±9.88 years. The main demographic characteristics and examination of all participants are presented in Table 1. A number of 65 participants were at a high risk of obstructive sleep apnea, and 61 participants had SB<3. Gender, marital status, smoking habits, sleeping, alcohol usage, cholesterol, and diastolic blood pressure were not different between patients suspected of obstructive sleep apnea and controls. Morning shift work was more frequent in the obstructive sleep apnea group

Table1. Demographic and biological characteristics of participants

Variables		Suspected obstructive sleep apnea	Healthy participants	P-value
		n=65	n= 61	
Sex, % (n)	Men	81.5 (53)	82.0 (50)	0.54
	Female	17.5 (12)	18 (11)	
Age (Mean ± SD)		42.4 ±13.8	32.4 ±7.6	<0.001
BMI (Mean ± SD)		29.0 ± 4.5	25.7 ±4.5	0.005
Marital status, %(n)	Single	13.8 (9)	23.0 (14)	0.06
	Married	86.2 (56)	77.0 (47)	
smokers, % (n)		9.2 (6)	6.6 (4)	0.39
Alcohol consumption, % (n)		1.5 (1)	1.6 (1)	0.74
Sleep (Hours)		7.1 ±1.1	6.8 ±1.2	0.39
Exercise, % (n)		32.0 (21)	68.0 (42)	0.035
Shift work, % (n)	Morning	47.7 (31)	24.6 (15)	<0.001
	Rotate	9.2 (6)	47.5 (29)	
	Morning and evening	38.5 (24)	27.9 (17)	
ESS , % (n)	<10	70.8 (46)	98.4 (60)	<0.001
	≥10	29.2 (19)	1.6 (1)	
Glucose (mg/dL)		100.0 ±15.1	93.3 ± 10.4	0.025
Total cholesterol (mg/dL)		188.5 ±38.1	178.8 ±32.2	0.169
Triglycerides (mg/dL)		155.7 ±19.5	124.1 ±66.4	0.020
HDL-C (mg/dL)		44.5 ±9.6	43.8 ±7.5	0.017
LDL-C (mg/dL)		119.8±36.2	106.3 ±33.2	0.016
Systolic BP (mm Hg)		116.2 ±11.8	105.9 ±13.7	<0.001
Diastolic BP (mm Hg)		74.9 ±7.8	70.0 ±8.6	0.070

than in controls (P<0.001). Moreover, glucose, triglycerides, HDL, LDL, and systolic BP were higher in patients suspected of obstructive sleep apnea than in controls. In terms of laboratory findings, glucose, triglyceride, and LDL levels were significantly higher in obstructive sleep apnea than in the non-apnea group; nonetheless, there was no significant difference in cholesterol levels between the two groups, and body mass index was higher in patients than in healthy subjects.

Physical activity levels were compared between the two groups. As illustrated in Figure 1, the majority of participants (63%) with an SB score ≥ 3 had low physical activity. On the contrary, 49.25 cases with SB scores < 3 had medium physical activity. The participants' apnea-hypopnea index (AHI) is depicted in Figure 2. Patients with AHI scores of <5, 5-15, 15-30, and >30 were considered normal, mild, moderate, and severe sleep apnea, respectively. By comparison, 50% of subjects in the obstructive sleep apnea group had a normal level of oxygen desaturation index. Table 2 illustrates the odds of OSA among

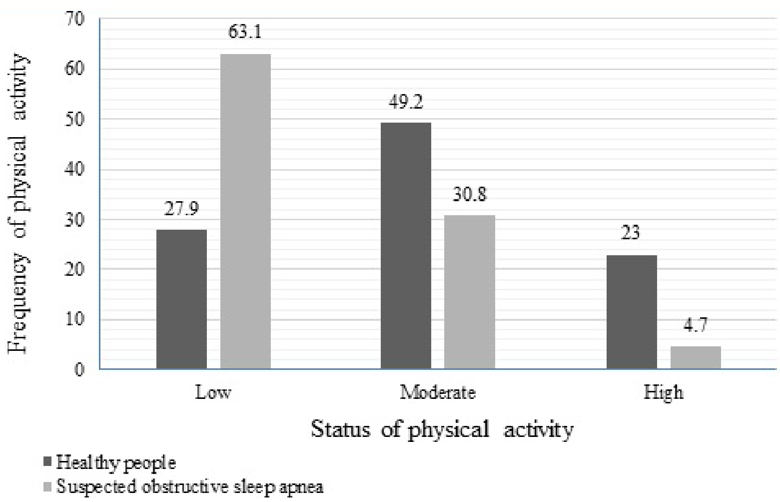

Figure 1. Frequency of physical activity in among suspected obstructive sleep apnea in comparison to healthy people

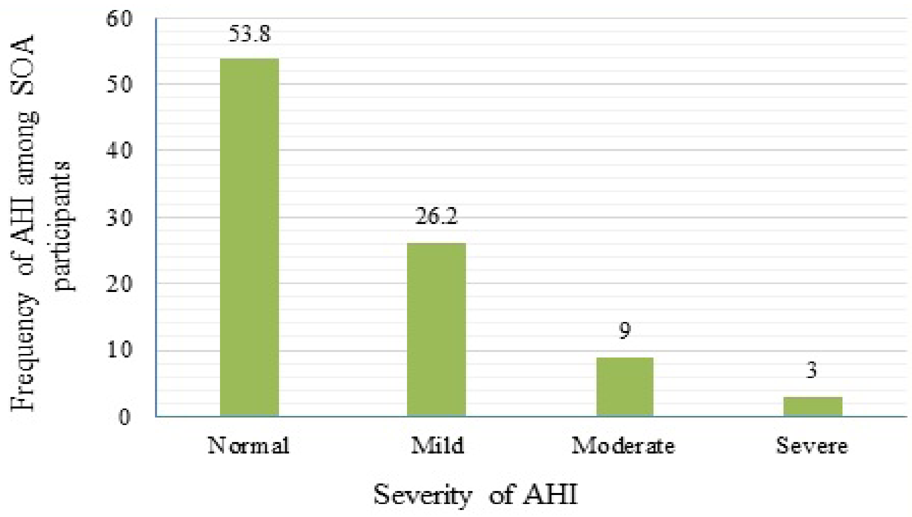

Figure 2. Frequency of AHI intensity in people with a score of 3 and above, according to STOP-BANG

different exercise categories. The logistic regression test pinpointed that subjects with low physical activity had a significantly higher chance of obstructive apnea in comparison with those with severe activity (OR = 9.6, 95% CI 1.1–78.8). In addition, rotational shift decreases the odds of obstructive sleep apnea to 0.17. participants with ESS >10 carried higher odds of OSA. There was a clear relationship between age and odds of OSA.

Discussion

The present study assessed the association between obstructive sleep apnea and physical activity in 126 participants. Based on the STOP-BANG inventory, 65 cases were at high risk for obstructive sleep apnea (SB score >3), while 61 employees ran a low risk of OSA. Regarding physical activity, healthy subjects had higher regular daily exercise, while the sleepiness score was reported higher in the OSA group. The bio-profile findings revealed higher levels of blood

Table 2. The results of logistic regression to investigate factors related to possibility of OSA

		OR (95% CI)*	P-value
Age		1.15 (1.07-1.23)	0.001
Shift work	Morning	1.00 (Reference)	
	Rotate	0.17 (0.32-0.95)	0.04
	Morning and evening	0.52-6.09))1.79	0.34
Physical activity	Low	9.69 (1.19- 78.8)	0.03
	Moderate	2.84 (0.32- 1.25)	0.34
	Severe	1.00 (Reference)	
ESS , % (n)	<10	1.00 (Reference)	0.007
	≥10	30.9 (2.60-367.8)	

* OR, odds ratio; CI, Confidence Interval

sugar, triglycerides, low-density lipoprotein, and BMI in the OSA group compared to healthy participants. Furthermore, employees with low physical activity and fixed day shifts had a higher chance of obstructive apnea than those with vigorous physical activity and rotational shifts.

In agreement with the present study, Simpson et al. investigated the association between physical activity and moderate to severe OSA in 1769 patients (571 women and 1198 men) with suspected OSA and 1931 subjects (1097 women and 834 men) as the control group. Physical and occupational activities were assessed by self-report questionnaire based on the Active Australia Survey (total time spent walking and moderate or vigorous activity in a week) and occupational categories (sedentary, light, medium, and heavy). The two groups were significantly different in demographic variables, such as gender, alcohol, smoking, and BMI. At the same time, our study demonstrated significant differences between the controls and OSA groups in terms of age and BMI. In the current study, men comprised the majority of cases in both the control and OSA groups (50% and 53%, respectively). The findings related to occupational activity in the study by Simpson et al. indicated that 24.7% and 35.9% of the OSA group had jobs with sedentary and low activity, respectively. These values were obtained at 20.8% and 30.5% in the control group (P<0.01) compared to the findings of our study (63% of OSA cases and 27.9% of controls had low physical activity). However, the measurement tool of physical activity was different in these two studies. The odds ratio for moderate to severe OSA indicated that high, low, and nil exercise could increase the risk of having OSA by 0.6, 1.6, and 2.7. In contrast, in our study, low physical activity can result in a 9-time increased risk of OSA. The significant differences in gender distribution (men are more at risk for OSA, especially those younger than 50) and age (mean age 42.37 years in the OSA group vs. 32.1 years in controls) in these two studies explained this finding. In addition, Simpson et al. concluded that heavy occupational activity could decrease the risk of OSA; however, the shift time of the job was not considered. Moreover, the results of the study by Simpson et al. suggested that regular exercise in the OSA group was associated with decreased blood pressure, depression, and fatigue (27).

In this regard, Da Silva et al. assessed the impacts of exercise on sleep symptoms among 1,395 patients with severe OSA (apnea-hypopnea index> 30 events in an hour). Consistent with our study, most patients were male (81%) with a mean age of 49±14 years. The participants were assigned to two groups: exercisers (n=488) and non-exercisers (n=907). The findings indicated that exercise is associated with lower symptom frequency and scores in poor sleep quality, tiredness, and negative mood on awakening and un-refreshing sleep. In addition, the exercisers had a lower rate of ESS score >10. These findings support our results, which suggest that 90% of cases with ESS score >10 had low to moderate physical activity. The occupational factors and cases without OSA were not assessed in the study by Da Silva et al. (36).

Furthermore, the results of a review article published in 2019 by Van Offenwert indicated that low physical activity was associated with an increased risk of OSA. This article suggested that regular physical activity could reduce the severity of OSA among patients, even without weight loss (37). In agreement with the results of the current study, the mentioned research emphasizes the effect of physical activity on OSA severity. In contrast to the present study, Itoh et al. (2017) assessed 200 Japanese male workers who had occupational driving. The stated study, which was conducted on men with BMI<30, assessed sleep apnea and physical activity by portable instrument and IPAQ. The results did not exhibit any significant relationship between sleep apnea and physical activity. This finding can be explained by the fact that for non-obese people, physical activity through weight change does not further improve or prevent SDB. Further possible mechanisms might be the effect of race and age (38).

The results of the study pointed out that the group with apnea had higher mean triglyceride, fasting blood sugar, and systolic blood pressure. Both aerobic and resistant physical activity lead to better blood sugar control by increasing tissue sensitivity to insulin. Physical activity, regardless of the effect of weight loss, leads to a decrease in lipid profile, and these positive effects apply even if the body weight is low. Blood fat reduction depends on the intensity and duration of physical activity (39,40).

Another finding of the research was the higher frequency of apnea in day workers compared to shift workers. This issue is not consistent with the current evidence on shift work suggested by other studies. According to the study conducted in the occupational medicine clinic, it is possible that this relationship is due to the effect of a healthy worker; that is to say, the people who are healthier than others were recruited for shift jobs. This result is similar to another study on sleepiness among shift workers, demonstrating no association between shiftwork and sleepiness among the younger working population. (41) Overall, the findings of different studies indicated the positive impact of physical activity on obstructive sleep apnea, which was related to improving occupational function sleep quality, decreasing daily sleepiness, and consequently reducing occupational injuries.

Among the notable limitations of this study are the use of portable instruments to diagnose sleep apnea, the small sample size, and the use of questionnaires, which can lead to bias in recall and lack of measurable values. Another limitation of the present study was that the drowsiness was only examined mentally. Objective assessment of drowsiness using the multiple sleep latency test can help to examine this relationship more closely. The present study had some strengths, such as novelty in Iranian employees, good quality of apnea tests, duration of sleep evaluation of more than five hours, and unique laboratory tests that increase the accuracy of results.

Conclusion

In conclusion, in the present study, there was a significant relationship between obstructive sleep apnea severity and physical activity. This confirmed the role of physical activity in preventing and treating sleep apnea since obstructive sleep apnea can reduce patients' activity and worsen symptoms. Exercise and daily activities in people who are prone to disease and patients with a disease can help prevent and improve apnea and its subsequent complications.

The results of this research can be of great help in managing patients with obstructive sleep apnea and preventing its complications. Undoubtedly, planning for preventing and treating obstructive sleep apnea patients will improve their daily work performance and increase their quality of life. By reducing the severity of the disease, physical activity can affect the set pressure of the CPAP device, or in cases of non-acceptance of first-line treatment, it can help in alternative treatment.

Authors' contributions

Lahya Afshari Saleh designed the study. Data collection was performed by Kheradmand. Statistical analyses were conducted by Shabnam Niroumand. All authors contributed to the interpretation of the results. Pegah kheradmand and Hossein Zakeri contributed to the drafting of the manuscript. All authors also contributed to the critical revision of the manuscript for important intellectual content, approved the final version, and are accountable for the integrity of its content.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of the Mashhad University of Medical Science. (Ethical No: IR.MUMS.fm.REC.1396.403) (IRCT138711021162N9). The researchers obtained informed consent from patients.

Consent for publication

"Not applicable."

Conflicts of interest

The authors declare that they have no conflict of interest regarding this study.

Availability of data and materials

The study data can be obtained from the corresponding author.

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