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ORIGINAL ARTICLE

PREVALENCE OF OBSTRUCTIVE SLEEP APNEA RISK FACTORS AMONG ACTIVE DRIVERS AND THEIR ASSOCIATION WITH TRAFFIC ACCIDENTS: A CROSS-SECTIONAL STUDY

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ABSTRACT

Aim: This cross-sectional observational study aimed to investigate the prevalence of risk factors for obstructive sleep apnea (OSA) within the active driving population and to assess the association between these risk factors and traffic accidents.

Methods: Conducted with ethical approval, the study took place between March 15, 2022, and May 15, 2022, at Prof. Dr. Cemil Tascioglu City Hospital Family Medicine Polyclinic. Participants who met the inclusion criteria and provided voluntary informed consent were selected from those seeking care. A structured questionnaire, including the Berlin Risk Scale, sociodemographic inquiries, and questions related to driving and licensure, was administered through face-to-face interviews.

Results: 250 participants, with a mean age of 37.86±13.42 years, were included in the study. Obesity was present in 17.6% of participants, and 51.2% had more than 10 years of driving experience. Ten participants experienced accidents due to falling asleep while driving, with two encountering this situation multiple times. According to the Berlin Risk questionnaire, 19.2% of participants were identified as at high risk for OSA. In a multivariable logistic regression model, the odds of having a sleep-related traffic accident were found to be 12.82 times higher in people at high risk of OSA and 6.33 times higher in smokers. However, in the other regression model, obesity increased the risk of OSA 33.28 times.

Conclusions: This study identified that 19.2% of licensed drivers were at risk for OSA based on the Berlin questionnaire. The results underscore the importance of addressing OSA risk factors, particularly obesity, age, and BMI, among active drivers to enhance road safety and reduce the likelihood of accidents associated with sleep apnea.

Keywords: sleep apnea syndrome, traffic accidents, risk factors

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INTRODUCTION

Obstructive Sleep Apnea (OSA) is a prevalent sleep disorder characterized by recurrent breathing interruptions during sleep. These interruptions stem from the upper airway obstruction, attributed to insufficient motor tone in the tongue and/or airway dilator muscles [1]. As the most prevalent sleep-related breathing disorder, OSA poses significant health concerns [2].

In OSA, the upper airway can experience repeated complete or partial obstructions during sleep, leading to apnea or hypopnea, respectively. The compromised airflow and ensuing disruptions in sleep patterns contribute to a cascade of physiological consequences, impacting nocturnal rest and daytime wakefulness. Consequently, frequent nocturnal awakenings contribute to excessive daytime sleepiness in affected patients [3].

The prevalence of OSA in the general population is reported to be %9-38 [4]. Risk factors for OSA include obesity, male sex, age, specific craniofacial features, and ethnicity. The prevalence of OSA is rising due to increasing obesity rates [5].

Obesity is emerging as a global epidemic, resulting in worldwide adverse health consequences. It is currently second only to smoking, concerning leading causes of preventable death in the United States. The WHO has recognized the increased worldwide prevalence of obesity and the global implications caused by this trend. Obesity and overweight are among the top 10 leading causes of global mortality and burden of disease [6]. The majority of countries in North, Central, and South America, Europe, and the Middle East report a prevalence of overweight and obesity at 40% or greater of the population ages 45–59 years (based on standard BMI categorization) [7].

In obese patients, the upper airway narrows with the increase of adipose tissue around the neck, especially the pharynx. The decrease in vital capacity with central obesity significantly increases the closure of the pharynx by decreasing the downward expanding force on the pharynx [8]. The presence of obesity not only increases the likelihood of OSA but also exacerbates the severity of symptoms in individuals with both conditions [2]. Consequently, evaluating obese individuals for the presence of OSA becomes critically important.

In the Republic of Turkish legislation on Driver's License and Obstructive Sleep Apnea Syndrome:

a) Individuals with severe apnea [Apnea-hypopnea index (AHI) >30/hour] or moderate apnea (15<AHI<30) along with daytime drowsiness cannot obtain a driver's license without undergoing treatment.

b) A driver's license may be granted to those in whom sleep apnea is controlled or treated, as determined by a tripartite committee comprising at least one sleep-certified doctor (pulmonologist, psychiatry, neurology, ENT

specialist) and an ENT specialist. The report specifies whether the individual can obtain a second group driver's license and whether they are eligible to operate an ambulance, official, or commercial vehicle, considering factors such as disease severity, treatment response, and patient compliance with positive airway pressure (PAP) treatment.

c) Individuals with a body mass index (BMI) of 33 and above are required to undergo polysomnography testing for the entire night, regardless of complaints.

d) Persons with witnessed apnea and daytime drowsiness are recommended to undergo an all-night polysomnography test, irrespective of their BMI [9].

According to the 2022 Turkish Statistical Institute (TÜİK) data, there were 197 261 fatal traffic accidents in Turkey. Among the factors contributing to these accidents, 86.8% were attributed to driver faults, 9.5% to pedestrians, 2.1% to vehicles, 1.2% to passengers, and 0.4% to road-related issues (TÜİK) [10]. Globally, efforts are being made to reduce the fatality rate in traffic accidents through measures such as increasing seatbelt usage, implementing speed limits, and preventing alcohol-impaired driving.

In addition to these factors, conditions like fatigue, tiredness, and sleepiness can also lead to traffic accidents [11]. A review examining the impact of sleep disorders on driving found an increased risk of traffic accidents during conditions such as daytime sleepiness and fatigue, irrespective of whether they are related to a primary sleep disorder [12].

This study aims to investigate the prevelance of sleep apnea syndrome risk factors in the active driving population and examine the relationship between these risk factors and traffic accidents.

METHODS

Ethical Approval: Prof. Dr. Cemil Tascioglu City Hospital Clinical Research Ethics Committee At its meeting of 28.02.2022, Resolution No. 46 Ethical permission was obtained accordingly.

The present study, designed as a cross-sectional observational investigation, commenced after obtaining ethical approval. Between March 15, 2022, and May 15, 2022, participants were selected from those who had sought care at Prof. Dr. Cemil Tascioglu City Hospital Family Medicine Polyclinic, meeting the inclusion criteria and willingly agreeing to participate. Voluntary informed consent forms were filled out, and face-to-face interviews were conducted using a structured questionnaire.

The questionnaire delved into participants' demographics, including age, gender, height, weight, known medical conditions, duration of holding a driver's license, duration of active driving, sleep duration, and the use of medication to facilitate sleep to assess the risk of OSA. This questionnaire comprises a total of 10 questions

across three categories. If two or more categories within any group yielded positive results, participants were considered to have a high OSA risk [13]. The questions covered various aspects, including snoring, the occurrence of apnea during sleep, post-sleep fatigue, daytime tiredness, dozing off while driving, and a history of traffic accidents.

Inclusion Criteria: Participants must be 18 years or older, express a willingness to participate in the study, and have engaged in active vehicle driving within the past year.

Exclusion Criteria: Individuals under 18, those who decline participation in the study, and individuals who have not actively driven a vehicle in the last year are excluded from this study.

Sample Size: The sample size was calculated as 232 individuals based on the total number of people who applied to family medicine outpatient clinic in the last two months, which was 7 235, assuming a risk of OSAS based on literature at 20% in the general population, with a margin of error set at 5%, and a 95% confidence interval. A design effect of 1 was applied. Our study was conducted with a total of 250 participants.

Statistical Analysis: The SPSS (IBM Corp. 2011. IBM SPSS Statistics for Windows version 25.0. Armonk, NY: IBM Corp.) was used for statistical analysis. The suitability of continuous variables to normal distribution was examined with the Kolmogorov test. Descriptive statistics are expressed as numbers and percentages for categorical variables that fit the normal distribution, the mean and standard deviation for variables that do not fit the normal distribution, and median, minimum and maximum values for variables that do not fit the normal distribution, reported as. Since the numerical variables did not meet the normal distribution condition, two independent group analyses were performed with the Mann-Whitney U test. The comparison of proportions in independent groups was performed using the chi-square test. Logistic regression analysis determined the parameters affecting the study group's high-risk status for OSA and sleep-related traffic accidents. $p<0.05$ was considered statistically significant.

RESULTS

A total of 250 people participated in our study. The mean age of the participants was 37.86±13.42 years. Obesity was present in 17.6% of the participants. The proportion of smokers was 39.2%. 26.8% of the participants had chronic diseases; the most common chronic diseases were hypertension and diabetes (%15.6, n=39, %10.8, n=27; respectively). 51.2% of the participants had been driving for more than 10 years, 10 participants had experienced traffic accidents due to falling asleep while driving once, and 2 participants had experienced more than once. According to the Berlin risk questionnaire, 19.2% of the participants were at high risk for OSA (Table1).

Table1. General characteristics of the participants and Berlin questionnaire risk status

		Mean ± SD	**Median (Min-Max)**
Age (year)		37.86±13.42	36(18-78)
Body Mass Index (kg/m^2)		25.98±5.52	24.98(17.21-47.75)
		n	%
Gender	Female	111	44.4
	Male	139	55.6
Obesity Status	BMI<30	206	82.6
	BMI≥30	44	17.6
Smoking Status	Smoker	98	39.2
	Non-smoker	152	60.8
Chronic Disease Status	No chronic disease	183	73.2
	One or more chronic disease	67	26.8
Snoring at night	Yes	97	38.8
	No	153	61.2
Excessive day-time sleepiness	Yes	87	34.8
	No	163	65.2
Witnessed Apnea at night	Yes	13	5.2
	No	10	94.8
Daily sleep duration	Less than 3 hours	8	3.2
	3-4 hours	91	36.4
	5-6 hours	126	50.4
	7-8 hours	19	7.6
	9-10 hours	6	2.4
OSAS risk status according to the Berlin risk questionnaire	Low-risk	202	80.8
	High-risk	48	19.2

The risk status in terms of OSA was compared with the participants' gender, presence of obesity, smoking status, presence of chronic diseases, duration of driving a car and presence of sleep-related road traffic accidents. There was a significant relationship between age, presence of obesity, BMI and OSA risk (respectively p=0.001, p<0.001, p<0.001) (Table2).

Table2. General characteristics and OSA risk status of participants

		OSA risk status according to the Berlin risk questionnaire		**p-value**
		Low-risk n (%)	High-risk n (%)	
Gender	Female	94(%84.7)	17(%15.3)	0,163*
	Male	108 (%77.7)	31 (%22.3)	
Obesity Status	BMI<30	190 (%92.2)	16 (%7.8)	**<0.001***
	BMI≥30	12 (%27.3)	32 (%72.7)	
Smoking Status	Smoker	80 (%81.6)	18(%18.4)	0.788*
	Non-smoker	122 (%80.3)	30 (%19.7)	
Chronic Disease Status	No chronic disease	53 (%79.1)	14 (%20.9)	
	One or more chronic disease	149 (%81.4)	34 (%18.6)	0.680*
Driving licence holding period	0-1 year	21(%87.5)	3(%12.5)	
	1-5 years	40 (%93)	3 (%7)	
	5-10 years	31 (%75.6)	10(%24.4)	0.087*
	More than 10 years	110 (%77.5)	32 (%22.5)	
Duration of driving a car	0-1 year	36 (%85.7)	6 (%14.3)	
	1-5 years	45 (%81.8)	10 (%18.2)	0.695*
	5-10 years	21 (%84)	4 (%16)	
	More than 10 years	100 (%78.1)	28 (%21.9)	
Sleep-related road traffic accidents	None	199 (%83.6)	39 (%16.4)	**<0.001***
	Yes	3 (%25)	9 (%75)	
		Median (Min-Max)	Median (Min-Max)	
Age		33(18-78)	44(18-74)	**0.001****
Body Mass Index		23.90 (17.21-45.49)	32.16 (19.57-47.75)	**<0.001****

*: Pearson chi-square Test; **: Mann-Whitnney U Test

According to the results of the univariate analysis on OSA risk, factors such as age, presence of obesity, and gender, with a p-value <0.20-0.25, were considered for inclusion in the multivariate logistic regression model [14]. Following the establishment of the multivariate logistic regression analysis model, it was determined that being obese increased the risk of OSA by 33.28 times (Table3).

Table 3. Potential Risk Factors Associated with high risk for OSAS in Multivariate Logistic Regression Model

Variables	**OR (95% CI)**	**p**
Gender (ref: male)	1.71 (0.69-4.24)	0.246
Age	1.01 (0.98-1.05)	0.211
Obesity Status	33.28 (12.95-85.51)	**<0.001**
Hosmer and Lemeshow test: 0.66, Omnibus test: <0.001, Nagelkerke R^2= 0.45, -2 log likelihood= 161.22		

According to the results of the univariate analysis on the occurrence of sleep-related traffic accidents, it was decided to include the variables of OSA risk status, age, presence of obesity, and smoking status in the multivariate logistic regression model (p=0.001, p=0.026, p=0.001, p=0.018). The multivariate logistic regression analysis model revealed that the likelihood of experiencing sleep-related traffic accidents increased by 12.82 times with a high OSA risk and 6.33 times with smoking (Table4).

Table 4. Potential Risk Factors Associated with Sleep-Related Road Traffic Accidents in Multivariate Logistic Regression Model

Variables	**OR(95% CI)**	**p**
OSA risk status (ref: low-risk)	12.82 (2.42-67.72)	**0.003**
Age	1.01 (0.97-1.06)	0.409
Obesity status (ref: no obesity)	1.46 (0.31-6.89)	0.630
Smoking status (ref: no smoker)	6.33 (1.51-26.40)	**0.011**
Hosmer and Lemeshow test: 0.84, Omnibus test: <0.001, Nagelkerke R^2= 0.32, -2 log likelihood= 68.47		

DISCUSSION

In our study, it was determined that 17.6% of participants were obese (BMI > 30 kg/m2). Being obese was found to increase the likelihood of OSA by 33.2 times. This association is frequently emphasized in the literature, with numerous studies highlighting the increased risk of OSA associated with obesity [15-17]. Obesity, as a risk factor for OSA, can lead individuals to a higher risk of OSA over time if left untreated, and obese individuals often experience more severe effects from the condition. A population-based study conducted in the United Kingdom observed that each increase in BMI raised the risk of developing OSA [18]. There exists a complex relationship between obesity and OSA. Studies suggest that the increased storage of fat in specific areas due to obesity may worsen the condition of OSA, and fat deposits in the respiratory tract can expose patients to apnea [2]. Additionally, studies propose that reduced nighttime sleep may influence hormones in the hunger and appetite centers, leading to excessive food intake [19, 20].

Consistent with many studies in the literature, our study found a higher prevalence of OSA in obese individuals. Therefore, we believe that evaluating individuals with a driver's license who are obese for OSA is always important.

In the present study, the prevalence of high risk for OSA, according to the Berlin questionnaire among participants who actively drive vehicles, was found to be 19.2%. A study conducted among truck drivers in Brazil, as documented in the literature, applied the Berlin questionnaire to drivers with a history of active vehicle use, revealing a risk prevalence of 26% [21]. In a study conducted among public transportation drivers in Western Iran, the Berlin questionnaire was administered to 170 drivers, and 29.5% were found to be at risk for obstructive sleep apnea [22]. In a study focused on bus drivers in Turkey, 1400 male bus drivers were included, and the Berlin questionnaire was applied, identifying 12.6% of drivers at risk for obstructive sleep apnea [23]. Both in our study and in studies conducted worldwide, the proportion of drivers at risk for OSA is considerable. We believe that increasing health screenings in this regard and regularly monitoring drivers at intervals are crucial.

In the literature, in a study conducted by Fidan et al. on truck drivers in Turkey, sleep apnoea syndrome findings were investigated in active long-distance drivers, and it was found that 52.8% of the participants snored, 25.6% had excessive daytime sleepiness and 9.8% had diagnosed apnoea [24]. In another study in which sleep apnoea syndrome findings were investigated in city bus drivers in Turkey, it was found that snoring was observed in 65.7%, excessive daytime sleepiness in 48% and witnessed apnoea in 48% of active drivers [25]. In our study, snoring was found in 38.8% of the participants, daytime sleepiness was found in 34.8%, and apnoea was witnessed in 5.2%.

In the present study, according to the Berlin Questionnaire results, in the group at risk

for OSA, the rate of traffic accidents due to drowsiness significantly increased in the group at risk for OSA. In the literature, in a study conducted by Fidan et al. on truck drivers in Turkey, 29.7% of the drivers stated that they had a traffic accident before, and 20.2% of those who had a traffic accident stated that they had an accident as a result of falling asleep while driving [24]. Another study investigating sleep apnoea syndrome findings in IETT drivers in our country found that 65.7% snoring, 48% excessive daytime sleepiness and 48% diagnosed apnoea were observed in active drivers [25]. A significant relationship was found between daytime sleepiness and traffic accidents. In a study conducted on bus drivers in our country, 1400 male bus drivers were included, and the study and Berlin questionnaire were applied. 12.6% of the drivers were found to be at risk for obstructive sleep apnoea, and the rate of traffic accidents was found to be higher in the high-risk group [23].

In the present study, the susceptibility to OSA did not vary based on gender, smoking habits, or the presence of chronic diseases. It is well-established in the literature that male gender increases the risk of OSA [5]. The consistency in OSA risk across genders in our study may be attributed to the study's reliance on self-reporting and the relatively small sample size.

In the present study, the sample's limited representation of individuals with chronic diseases might contribute to the observed lack of impact on OSA risk. Additionally, the inquiry into smoking history only focused on current usage without considering former smokers, and factors such as pack years were not investigated. Therefore, these methodological limitations may be attributed to the absence of a relationship between smoking and OSA.

This study focused on licensed drivers who visited a single institution. Conducting broader studies with a more diverse sample could provide a more comprehensive understanding. The reliance on self-reported information from participants and the exclusive focus on determining obstructive sleep apnea (OSA) risk are limitations. Relying solely on participant statements limits the scope of information collected, focusing exclusively on identifying OSA risk.

In conclusion, in present study, 19.2% of individuals holding a driver's license were identified as at risk for obstructive sleep apnea syndrome, according to the Berlin questionnaire. As BMI and age increased, the risk also escalated. According to the Berlin questionnaire, a higher incidence of traffic accidents was observed within the group identified as at risk.

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