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Association of presence and severity of Obstructive sleep apnea syndrome with accident risk in city bus drivers

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Abstract

Objective: To determine the relationship between frequency of traffic accidents and presence and severity of the disease in bus drivers who are at risk of having obstructive sleep apnea syndrome (OSAS).

Method: In the present study, polysomnography (PSG) was applied on 162 city bus drivers directed to the sleep laboratory from a total of 1450 drivers after being determined as risky with regard to OSAS symptoms according to the questionnaire results. Their demographic characteristics, health status and accidents were compiled. Statistical analyses were made for those diagnosed with OSAS according to the PSG result and those with a traffic accident after which comparisons were made.

Results: Obstructive sleep apnea syndrome was detected in 127 out of the 162 drivers determined to be risky with regard to OSAS based on the Berlin questionnaire result. While 35% of the drivers were normal according to the polysomnography (PSG) results in the study, 39 (24.1%) were determined as light OSAS, 35 (21.6%) as moderate OSAS and 53 (32.7%) as severe OSAS. While 105 (64.8%) of the cases had no accident, 37 (22.8%) were almost involved in an accident due to sleepiness and 20 (12.3%) were actually involved

in an accident. A statistically significant relationship was determined between accident rates and OSAS severity (p:0.009; p<0.05).

Conclusion: It was concluded that presence and increased severity of OSAS is an important risk factor for being almost or directly involved in an accident among city bus drivers, even though they were not driving for long distances.

Keywords: Obstructive Sleep Apnea Syndrome (OSAS), Bus Drivers, Traffic Accident

Introduction

Sleep is temporary, partial and periodic loss of communication of organism with environment in a reversible manner due to stimulants at varying intensities. This is the period for preparing for a new day during which the body rests, cell repair and renewal takes place in addition to the completion of learning by way of arranging memory functions. A normal sleep is an indispensable factor for a healthy life (1,2).

Obstructive Sleep Apnea Syndrome (OSAS) is characterized by repeated collapse of upper respiratory tract during sleep, nocturnal hypoxemia and interrupted sleep (1). It is one of the most frequent among sleep disorders. OSAS prevalence has been determined as 3-7% for males and 2-5% for females as revealed from a systematic review (2).

The most common night symptom of OSAS is snoring, while the day symptom is excessive sleepiness (3-5). The most important risk factors of OSAS are indicated as male gender, advanced age, neck circumference and obesity (6,7).

Various questionnaires are used for identifying risky groups and Berlin questionnaire is one of these arranged for community screenings. There are a total of 10 questions in 3 categories. Positive results in 2 or more categories indicate that the participant is high risk.

Polysomnography (PSG) is the golden standard in OSAS diagnosis and treatment selection (4). OSAS has been classified into 3 different classes as light

OSAS (AHI = 5-15), moderate OSAS (AHI = 15-30) and severe OSAS (AHI > 30) according to apnea hypopnea index (AHI) in accordance with the American Sleep Disorders Association (4). Continuous positive air pressure (CPAP) is the standard treatment for OSAS (8,9).

Even though the nighttime symptoms of OSAS are generally ignored by the patient, its daytime symptoms are generally quite striking. Daytime excessive sleepiness may be so severe that it affects work performance and prevents driving a vehicle in traffic thereby increasing traffic accident risks (3).

In this study, we aimed to determine the relationship between frequency of traffic accidents and severity of the disease in bus drivers who are at risk of having OSAS. By this way, if there is an association, we wanted to emphasize that the risks of death, loss of manpower and financial loss related with the traffic accidents may be reduced for individuals diagnosed with OSAS since it is a treatable disease.

Subjects and Methods

The minimum sample numbers required for the test to be 0.80 (80%) with an estimated OSAS prevalence of 5% in normal population, were calculated with "G Power(3.1 version)" program. Regarding these results, the minimum number of samples required for the test was calculated and the highest value was determined as 159. Based on this, the number of samples in the study was determined to be 162.

The study was approved by the local ethics committee and informed consent was obtained from the study participants.

The present study was planned as a retrospective study at the Eşrefpaşa State Hospital with approval from Metropolitan Municipality. A total of 162 drivers were included in the study who have been directed to the sleep laboratory of our hospital after being identified as risky with regard to obstructive sleep apnea syndrome (OSAS) symptoms according to the Berlin questionnaire results.

Signed consent forms were obtained from all participants. Berlin questionnaire comprised of a total of 10 questions and 3 categories was applied on all participants for evaluating the level of excessive daytime sleepiness, those who responded as "yes" to two or more of the three categories were evaluated to have high OSAS risk. All bus drivers considered as having high risk for OSAS; who underwent a polysomnographic evaluation and who agreed to participate in the study were included in the study. Bus drivers who regret to participate in the study, who regret to undergo polysomnographic evaluation and bus-drivers with missing data were excluded in the study.

All drivers examined in our hospital during February 2015 and June 2017, were male. Demographic characteristics of each participant were recorded such as age, weight, height, body mass index, neck circumference, waist to hip ratio, alcohol and cigarette use and medical history. In addition, the traffic accidents they have been involved in were also recorded based on the official municipality records.

All patients included in our study were monitored all night by a trained sleep technician via polysomnography (PSG) device at our sleep center. At least 6 hours of PSG recordings were acquired. PSG was carried out in accordance with the American Academy of Sleep Medicine Classification criteria (1).

G Power (3.1 version) software was used in order to determine enough sample of sizes for statistical testing (10,11). IBM SPSS Statistics 22 (IBM SPSS, Turkey) software was used for statistical analyses when evaluating the findings of the study. Shapiro Wilks test was used for evaluating the accordance of parameters with normal distribution. In addition to descriptive statistical methods (Mean, Standard deviation, frequency), One-way Anova test was used for the comparison of quantitative data as well as Tukey HDS test and Tamhane's T2 test for the intergroup comparison of parameters with normal distribution and determination of the group that causes the difference when evaluating the study data. Kruskal Wallis test was used for carrying out

intergroup comparisons of parameters without normal distribution. Whereas Chi Square test and Fisher Freeman Halton test were used for comparing qualitative data. Level of significance was evaluated as $p<0.05$.

Results

The study was carried out during February 2015 and June 2017 on a total of 162 male drivers with ages varying between 32 and 55 years. The average age of the drivers was 42.07±5.54 years. Obstructive sleep apnea syndrome was detected in 127 (78.4%) out of 162 drivers who were defined as having high risk, based on the Berlin questionnaire result. While 35% of the drivers were having normal PSG results in the study, 39 (24.1%) were determined as having mild OSAS, 35 (21.6%) as having moderate OSAS and 53 (32.7%) were having severe OSAS. While 105 (64.8%) of the cases were not involved in any accident, 37 (22.8%) were almost involved in an accident due to sleepiness and 20 (12.3%) have been involved in an accident.

Demographic features and Epworth scores among OSAS classification groups and among patients with different accidents are summarized in tables 1 and 2, respectively.

There was not any statistically significant difference observed between the OSAS classifications with regard to age and Epworth values ($p>0.05$) (Table 1). The BMI values of those without OSAS were determined to be lower at a statistically significant level in comparison with BMI values of those with moderate and severe OSAS (p_1:0.032; p_2:0.0001, respectively). The BMI values of those with severe OSAS were determined to be higher at a statistically significant level in comparison with BMI values of those with mild and moderate OSAS (p_1:0.004; p_2:0.017, respectively). No statistically significant difference was observed between other OSAS classifications with regards to BMI values ($p>0.05$).The neck circumference values of those without OSAS were determined to be lower at a statistically significant level in comparison

with that of the study participants with moderate and severe OSAS(p_1:0.019; p_2:0.0001, respectively). Neck circumference values of those with severe OSAS were determined to be higher at a statistically significant level in comparison with neck circumference values of those with mild OSAS ($p<0.0001$). No statistically significant difference was observed between other OSAS classifications with regards to neck circumference values ($p>0.05$). Waist/hip ratio of individuals with mild OSAS was determined to be lower at a statistically significant level in comparison with waist/hip ratio of individuals with moderate and severe OSAS (p_1:0.046; p_2:0.004). No statistically significant difference was observed between other OSAS classifications with regards to waist/hip ratios ($p>0.05$). No statistically significant difference was observed between OSAS classifications with regards to alcohol and cigarette use ($p>0.05$).

There was no statistically significant difference observed between the patients with different accidents with regards to age, BMI, waist/hip ratio and Epworth values ($p>0.05$) (Table 2). A statistically significant difference was observed between accidents with regards to neck circumference values (p:0.004). The neck circumference values of those who were not involved in an accident were observed to be lower at a statistically significant level in comparison with neck circumference values of those who have been involved in an accident (p:0.003). There was no statistically significant difference observed between accident statuses with regards to alcohol and cigarette usage habits ($p>0.05$).

Regarding PSG findings, snoring+apnea prevalence for those without OSAS (17.1%) was determined to be lower at a statistically significant level in comparison with mild (53.8%), moderate (45.7%) and severe (58.5%) OSAS cases (p_1:0.002; p_2:0.020; p_3:0.000, respectively). There were no statistically significant differences between different OSAS classes with regards to snoring+apnea prevalence ($p>0.05$). There was also no statistically significant difference between different OSAS classes with regards to snoring, EDS,

snoring+EDS, apnea+EDS and snoring+apnea+EDS prevalence ($p>0.05$).

Regarding PSG findings among patients with different accidents; apnea prevalence in those who have not been involved in any accident (38.1%) was observed to be lower at a statistically significant level in comparison to those who were almost involved in an accident due to sleepiness (62.2%) and those who were involved in an accident (65%) (p_1:0.019; p_2:0.047, respectively). No statistically significant difference with regard to apnea prevalence was observed between those who were almost involved in an accident due to sleepiness and those who have been involved in an accident ($p>0.05$). The snoring+apnea prevalence in those who have not been involved in any accident (36.2%) was observed to be lower at a statistically significant level in comparison to those who were almost involved in an accident (62.2%) and those who have been involved in an accident (65%) (p_1:0.011; p_2:0.031, respectively). There was no statistically significant difference regarding snoring+apnea prevalence between those who have almost been involved in an accident due to sleepiness and those who have been involved in an accident ($p>0.05$).

There was a statistically significant difference between the OSAS classifications with regards to accident status ($p<0.0001$) (Table 3). The ratio of being almost involved in an accident due to sleepiness 0 (0%) for drivers without OSAS was determined to be lower at a statistically significant level in comparison to drivers with mild 6(15.4%), moderate 10 (28.6%) and severe 21 (39.6%) OSAS (p_1:0.026; p_2:0.0001; p_3:0.0001, respectively). The ratio of being involved in an accident for drivers with severe OSAS 18 (34%) was determined to be higher at a statistically significant level in comparison to those of drivers with mild 0(0%) and moderate 2 (5.7%) OSAS (p:0.0001). No statistically significant difference was determined between the drivers with mild and moderate OSAS with regards to distribution ratios for being involved in an accident ($p>0.05$) (Table 3).

Discussion

In this study, we determined that in bus drivers with a high risk for OSAS, there was a significant increase in ratios of being almost involved or directly involved in an accident due to sleepiness with presence and increased severity of OSAS.

Traffic accidents and loss of lives and property due to traffic accidents are among the most important issues for our country and they occur most frequently due to daytime sleepiness resulting from sleepless driving (12). Wariness, distraction and cognitive inadequacies due to short and low quality sleep increases the risk of being involved in an accident and hence patients with OSAS are more frequently involved in accidents in comparison to normal population. Studies on this subject have generally been carried out on long distance drivers subject to less stimulants and uniform driving conditions, whereas the number of studies carried out with participation of city bus drivers is quite limited. Majority of these studies have focused on questionnaires with questionnaire results based on subjective data (13, 14). It has been put forth as a result of various studies on long distance drivers that there is a positive correlation between daytime excessive sleepiness and accidents (15-18). We assumed in our study that loss of concentration and sleepiness might not be as effective on city bus drivers as they are on long distance drivers due to city traffic with high amount of stimulants, turns and stops. However, we also determined an increased prevalence of accidents in patients with OSAS and with an increase in severity of OSAS.

The drivers determined to have high OSAS risk according to the Berlin questionnaire results in our study were evaluated via PSG test results carried out in our sleep laboratory. The present study is among those carried out with the largest sample group in our country with the participation of professional drivers and the largest in our country for evaluating the relationship between sleep apnea syndrome and traffic accidents by PSG results. Even though it is a fact that working with objective data would yield more accurate results, the

difficulties related with carrying out a PSG study for each participant might be a distinctive reason for continuing with questionnaires. Subjective responses could be acquired since cases such as snoring and apnea examined with regards to OSAS are among symptoms that individuals cannot detect by themselves. On the other hand, there were also cases when the participants do not state the realities due to concerns related with work and financial issues. Results based on questions might also be misleading during work applications or health controls because of similar concerns. Hence, OSAS symptom questionnaires might not be sufficient and the unidentified OSAS cases might in turn be reflected to the society as delay in diagnosis and treatment, as well as, accidents and related outcomes of these accidents. Based on this reality, some European Union countries do not give driving licenses to OSAS patients on grounds that they are not healthy drivers (19). In this regard, various arrangements related with sleep disorders have been made in our country in 2006 for driver candidates and those who apply for a professional driver's license; however, it is necessary to apply and support them (20, 21).

Epworth sleepiness test is a questionnaire used for determining daytime sleepiness. The Epworth score for majority of the participants in our study including those who defined excessive daytime sleepiness (EDS) was below 10 which led us to think that the Epworth sleepiness test might be insufficient for identifying EDS. On the other hand, work and financial concerns of our patients might lead to misleading results. It was observed in studies carried out on drivers with OSAS that their risk of being involved in an accident is about seven times greater in comparison with normal healthy individuals (22). Young et al. carried out a study in which it was determined that the accident risk increased with increasing Apnea Hypopnea Index (AHI) (23). Similarly, a statistically significant relationship was determined between accident risk and the presence of the disease in another study carried out by Teran-Santos et al. (24). Parallel to the findings of our study, it was also reported in the same study that when

evaluations were carried out on drivers with OSAS subject to disease severity, accident risk is much greater for those with severe OSAS and that accident risk increases with increasing disease severity. The accident rates in our study were; 73.6% for severe OSAS, 34.3% for moderate OSAS and 15.4% for mild OSAS. These ratios indicated a statistically significant and positive correlation between OSAS severity and accident frequency. On the other hand, no accident was observed in healthy drivers who were not identified with OSAS based on the PSG result, but who were determined to be in the high risk group according to the Berlin Questionnaire result.

With regards to demographic data in our study; a statistically significant relationship was observed between body mass index (BMI), neck circumference, waist/hip ratio and OSAS presence as well as between neck circumference and accident frequency. Similarly, Amra et al. carried out a study on accident risk factors and apnea symptoms as a result of which the neck circumference was determined as a demographic factor that increases accident risk. A statistically significant difference was observed in the same study between accident status and ratios for apnea and accompanying snoring (25). Snoring alone, as well as snoring accompanied by apnea, were both determined to be statistically significant with regards to accident risk in our study.

There are some limitations of this study that should be mentioned. First is the retrospective design of the study. Secondly, we included only bus drivers with high risk for OSAS; since the study was based on PSG findings and performing PSG in patients with low risk might not be acceptable. Due to the retrospective design and low number of patients, the generalisability of the study results was not high. However, obtained PSG results were the main power of the study and we believe that, this study will shed light for future studies.

Conclusion

We concluded that presence and increased severity of OSAS is an important risk

factor for being almost or directly involved in an accident on city bus drivers, even though they are not driving for long distances. When the morbidities and mortalities related with traffic accidents are taken into consideration along with the financial losses that incur as a result of such accidents, it is a necessity to question the OSAS symptoms of professional drivers such as public city bus drivers during and after the certification stage in addition to apply PSG on drivers determined to be highly risky. It could thus be concluded that routine PSG might be required for occupation groups such as professional drivers who carry the responsibility of many lives throughout the day while it could also be concluded that it might be necessary to increase the number of sleep centers.

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Table 1: Evaluation of demographic features and Epworth score among OSAS classification groups

	OSAS classification				P
	Normal (n:35)	Mild (n:39)	Moderate (n:35)	Severe (n:53)	
	Mean ±SD	Mean ±SD	Mean ±SD	Mean ±SD	
Age (years)	42.26±5.9	41.41±5.64	42.26±6.05	42.32±4.98	[1]**0.866**
BMI (kg/m^2)	29.81±2.8	31.01±4.57	31.89±3.23	33.98±2.92	[1]**0.0001***
Neck circumference (cm)	40.86±2.1	41.54±3.14	42.57±2.42	43.74±2	[1]**0.0001***
Waist/Hip Ratio	0.97±0.05	0.95±0.05	0.98±0.03	0.99±0.05	[1]**0.002***
Epworth Score *(median)*	3.89±2.6 (3)	4.33±3.81 (3)	4.97±4.63 (3)	4.28±3.98 (3)	[2]**0.952**
Smoking status *n(%)*					
Never smoked	12 (34.3%)	10 (25.6%)	9 (25.7%)	19 (35.8%)	[3]**0.798**
Quit	8 (22.9%)	8 (20.5%)	7 (20%)	7 (13.2%)	
Currently a smoker	15 (42.9%)	21 (53.8%)	19 (54.3%)	27 (50.9%)	
Alcohol *n(%)*					
Not drinking	24 (68.6%)	31 (79.5%)	25 (71.4%)	39 (73.6%)	[3]**0.746**
Drinking	11 (31.4%)	8 (20.5%)	10 (28.6%)	14 (26.4%)	

*[1]Oneway Anova Test [2]Kruskal Wallis Test [3]Chi-square Test *p<0.05*

Table 2: Evaluation of demographic features and Epworth score among patients with different accident stories

	Accident status			P
	Not involved in an accident (n:105)	Almost involved in an accident due to sleepiness (n:37)	Involved in an accident (n:20)	
	Mean ±SD	Mean ±SD	Mean ±SD	
Age (years)	42.33±5.92	41.03±4.41	42.65±5.38	[1]**0.416**
BMI (kg/m^2)	31.57±3.74	32.05±3.98	33.46±3.09	[1]**0.114**
Neck circumference (cm)	41.91±2.5	42.62±2.89	44±2.43	[1]**0.004***
Waist/Hip Ratio	0.97±0.05	0.97±0.04	1±0.03	[1]**0.109**
Epworth Score *(median)*	4±3.11 (3)	5.41±5 (3)	4.3±4.54 (3)	[2]**0.598**
Smoking *n(%)*				
Never smoked	34 (32.4%)	11 (29.7%)	5 (255)	[3]**0.693**
Quit	22 (21%)	5 (13.5%)	3 (15%)	
Currently a smoker	49 (46.7%)	21 (56.8%)	12 (60%)	
Alcohol *n(%)*				
Not drinking	77 (73.3%)	30 (81.1%)	12 (60%)	[3]**0.227**
Drinking	28 (26.7%)	7 (18.9%)	8 (40%)	

*[1]Oneway Anova Test [2]Kruskal Wallis Test [3]Chi-square Test *p<0.05*

Table 3: Distribution of OSAS classifications regarding accident status

	Accident status			
	Not involved in an accident (n:105)	**Almost involved in an accident due to sleepiness (n:37)**	**Involved in an accident (n:20)**	**p**
No OSAS (n: 35)	35	0	0	0.0001
Mild OSAS (n: 39)	33	6	0	
Moderate OSAS (n:35)	23	10	2	
Severe OSAS (n:53)	14	21	18	