DOI: 10.1590/1413-81232023286.16022022

Screening for Obstructive Sleep Apnea in truck drivers

Rastreio de Síndrome de Apneia Obstrutiva do Sono em motoristas

Mariana Argel (https://orcid.org/0000-0003-3834-1655) [1]
Ângela Cunha (https://orcid.org/0000-0002-0220-8273) [1]
Mariana Conceição (https://orcid.org/0000-0001-8392-488X) [1]
Tito Abrantes (https://orcid.org/0000-0002-0942-4323) [1]
António Simões Torres (https://orcid.org/0000-0002-0148-8138) [1]

Abstract *Professional drivers show a higher prevalence of obstructive sleep apnea (OSA) compared with the general population. OSA has been widely associated with an increased risk of traffic accidents. This article aims to investigate the presence of risk factors for OSA, its prevalence and the value of screening tools in a truck drivers' cohort. Descriptive and analytical prospective study. Demographic, anthropometric, Epworth Sleepiness Scale, STOP-Bang and Berlin Questionnaire were used to select subjects with suspicion of OSA. Polysomnography (PSG) was performed in individuals with positive screening. Mean age was 44.6±7 years, mean body mass index was 28.7±4 kg/m². Of the 281 truck drivers screened, 88 were positive for potential OSA. Of these, 63 completed PSG study and the diagnosis was confirmed in 85.7% (prevalence of 19.2%). The following variables showed a positive correlation with the apnea-hypopnea index: neck circumference and STOP-Bang. The combination of a predominantly male population, obesity, age distribution and lifestyle could account for the high prevalence of OSA in this specific population. Questionnaires proved to be a valuable screening tool. Screening, treatment, and management of OSA should be a priority as a public safety policy.*

Key words *Obstructive Sleep Apnea, Surveys and Questionnaires, Traffic Accidents*

Resumo *A prevalência de Síndrome de Apneia Obstrutiva do Sono (SAOS) em motoristas profissionais é superior à da população geral e esta tem sido amplamente associada ao risco aumentado de acidentes rodoviários. Este artigo tem por objetivos investigar fatores de risco de SAOS, estimar a sua prevalência e o valor de instrumentos de rastreio numa amostra de motoristas de pesados. Estudo prospetivo descritivo e analítico. Rastreio realizado com recurso a dados demográficos, antropométricos, Escala de Sonolência de Epworth, STOP-Bang e Questionário de Berlim. Nos indivíduos com rastreio positivo foi realizada polissonografia (PSG). A idade média era de 44,6±7 anos, índice de massa corporal 28,7±4 kg/m². Dos 281 motoristas incluídos, 88 apresentavam risco elevado de SAOS. Destes, 63 realizaram PSG, com confirmação diagnóstica em 85,7% (prevalência de 19,2%). O perímetro cervical e STOP-Bang apresentaram correlação positiva com o índice de apneia-hipopneia. A combinação de género predominantemente masculino, obesidade, distribuição de idade e estilo de vida pode justificar a elevada prevalência de SAOS nesta população. O uso de questionários é uma medida eficaz de rastreio. Nos motoristas, o rastreio e tratamento de SAOS deveria ser uma medida de saúde pública prioritária.*

Palavras-chave *Acidentes Rodoviários, Apneia Obstrutiva do Sono, Inquéritos e Questionários*

[1] Departamento de Pneumologia, Centro Hospitalar Tondela-Viseu, E.P.E. Avenida Rei D. Duarte, 3504-509. Viseu Portugal. mariana.argel.93@gmail.com

Introduction

Professional drivers are an understudied and medically underserved population, with high rates of obesity and related comorbidities[1]. Research has shown that drivers with multiple comorbidities, such as cardiovascular and cerebrovascular diseases, psychiatric conditions, diabetes, medication use, uncorrected visual defects and obesity seem to be at increased risk of being involved in a crash[2]. Sleep disturbances and sleepiness are also recognized to be associated with increased accident risk, exceeding the risk associated with many other medical disorders[3,4].

The most common type of sleep-disordered breathing (SDB) is obstructive sleep apnea (OSA). OSA is a clinical entity characterized by recurrent episodes of apnea and/or hypopnea during sleep, it occurs due to the total or partial collapse of the upper airway tract[5,6]. OSA is associated with an increase in morbidity and mortality related to cardiovascular, cerebrovascular and metabolic disorders and neurocognitive functions[7,8]. Due to the constant sleep disruptions, OSA decreases both sleep quality and quantity and, subsequently, may be associated with daytime sleepiness and impaired psychomotor vigilance. Therefore, it is not surprising that untreated OSA increases the risk of crashes by four to five-fold in comparison with subjects without OSA among commercial drivers[9]. Furthermore, there is additional evidence supporting that adequate treatment of OSA reduces the risk of motor vehicle crashes to control levels[9,10].

This condition has a high prevalence, and it is thought to be underdiagnosed. A systematic review carried out in 2016 by Senaratna *et al.*[6] shows a prevalence in the general population of 9% to 38%. Professional drivers show a higher prevalence of OSA, between 28% and 78%[11], probably because they tend to be obese, male and middle-aged, the most common risk factors for OSA[12]. Despite this risk, OSA remains underdiagnosed and untreated in this work category, mainly due to lack of appropriate screening and sleep study referrals[13,14].

The American Academy of Sleep Medicine (AASM) has issued a comprehensive and detailed document on screening, and diagnostic and therapeutic approaches for commercial drivers[11]. However, in Portugal and many other countries, there is still no consensus in the OSA screening approach, and a standardized model is needed.

Screening tools such as the Epworth sleepiness scale (ESS), the Berlin questionnaire (BQ) and STOP-Bang questionnaire (SBQ) have been widely used for detecting OSA. The ESS is one of the most used tools to measure sleepiness[15] and requires patients to rate their likeliness of falling asleep in eight different situations; the higher the score, the higher the person's level of daytime sleepiness[16]. The ESS appears to be a convenient, standardized, and cost-effective way to measure sleepiness in patients who suffer from sleep disorders. The BQ categorizes patients as either high or low risk for OSA based on self-reports of snoring, daytime sleepiness, hypertension and obesity[17]. It has modest-high sensitivity and low specificity to detect clinically relevant OSA[18]. The STOP-Bang questionnaire, due to its ease of use, efficiency, and high sensitivity, has been widely adopted and validated in various populations[19]. The questionnaire includes four dichotomous (yes/no) items (STOP: snoring, tiredness, observed apnea and high blood pressure) and four demographic questions [BANG: body mass index (BMI), age, neck circumference and gender][20]. Patients can be classified for OSA risk based on their respective scores[19].

Identifying and treating commercial drivers with OSA should decrease crash-related injuries and fatalities and improve drivers' safety and health. Occupational medicine examinations present a unique opportunity for detecting OSA as part of drivers' fitness for their job. This study aimed to investigate the presence of risk factors and symptoms for OSA and its prevalence and the value of screening tools in a truck drivers' cohort.

Material and methods

Type of study

Prospective, descriptive, and analytical.

Participants and study design

This study was conducted between January 2016 and December 2021 on a sample of truck drivers employed by a Portuguese road freight company. All truck drivers were invited to participate in the study. The participants were informed about the study procedures prior to signing informed consent. The drivers' work schedule was variable, they worked during the day and night, for long hours, with no set times for sleeping or meals.

The truck drivers were invited to complete anthropometric assessments (weight, height, and neck circumference (NC) measurements), per-

formed by a health professional, to determine their body mass index (BMI) using the criteria established by the World Health Organization[21].

Subsequently, participants completed a questionnaire evaluating sociodemographic characteristics, work, and sleep habits. In addition, it included questions concerning personal habits like smoking, consumption of alcohol and use of hypnotic-sedative drugs. Drivers' past medical history was also assessed, with a special attention given to cardiovascular and respiratory disorders. Participants were also asked about the presence of common symptoms of OSA (including night-time and daytime symptoms, presented in Table 1). The presence of hypersomnolence was measured by the Epworth Sleepiness Scale (ESS), a validated eight-item self-rating scale with a maximum of 24 points[16]. A total score ≥11 was considered indicative of excessive daytime sleepiness (EDS). The presence of insomnia was evaluated by SleepMed Insomnia Index Questionnaire (SMIIQ), which is a clinical measure of the characteristics and severity of the insomnia[22]. A total score ≥15 was considered indicative of insomnia.

The Berlin Questionnaire (BQ), which has been validated into the Portuguese language[23], was also included in this investigation. It is a subjective screening tool for OSA consisting of 10 questions divided into three categories including snoring, sleepiness and fatigue, hypertension, and obesity (defined as a BMI≥30 kg/m²). Drivers who fell into at least two of these categories were classified as being at high risk for having OSA. Furthermore, all the participants were asked to complete the STOP-Bang questionnaire which has been validated into the Portuguese language[24], and information concerning BMI, age, neck circumference, and gender was collected by a research assistant. The risk score was calculated using the sum of the "yes" answers (8 parameters), with each answer "yes" being equal to 1 point, totalling a minimum score of 0 and maximum of 8; high risk for having OSA was considered when the risk score was ≥3.

A positive screening for OSA was considered when: ESS ≥11 or high risk BQ or STOP-Bang questionnaire. Drivers with suspected OSA were submitted to an overnight portable polysomnog-

Table 1. Summary of the statistics of the sample studied and the comparison between groups of drivers with negative and positive screening for obstructive sleep apnea (OSA).

	All drivers n=281	Screened (-) for OSA n=193 (68.7%)	Screened (+) for OSA n=88 (31.3%)	p value
Age, mean ± SD (years)	44.63±7.30	43.84±6.97	46.35±7.74	0.007
BMI, mean ± SD (kg/m²)	28.72±4.05	27.12±3.05	32.25±3.73	<0.001
Obesity (BMI≥30 kg/m²), n (%)	88 (31.3)	28 (14.5)	60 (68.2)	<0.001
NC, mean ± SD (cm)	41.13±3.23	39.98±2.52	43.52±3.25	<0.001
Smoke, n (%)	169 (60.1)	121 (62.7)	48 (54.5)	0.196
Hypnotic-sedative drugs, n (%)	12 (4.27)	2 (1.04)	10 (11.4)	<0.001
Arterial hypertension, n (%)	40 (14.2)	11 (5.7)	29 (32.9)	<0.001
Night-time symptoms				
Snoring, n (%)	197 (70.1)	110 (62.1)	87 (98.9)	<0.001
Habitual snoring, n (%)	72 (25.6)	18 (9.3)	54 (61.4)	<0.001
Gasping or choking, n (%)	25 (8.9)	8 (4.1)	17 (19.3)	<0.001
Witnessed apneas, n (%)	21 (7.5)	2 (1.04)	19 (21.5)	<0.001
Restless sleep, n (%)	72 (25.6)	40 (20.7)	32 (36.4)	0.005
Dry mouth, n (%)	85 (30.2)	45 (23.3)	40 (45.5)	<0.001
Daytime symptoms				
Daytime sleepiness, n (%)	31 (11)	6 (3.1)	25 (28.4)	<0.001
Non-restorative sleep, n (%)	65 (23.1)	26 (13.5)	39 (44.3)	<0.001
Cognitive impairment, n (%)	29 (10.3)	9 (4.7)	20 (22.7)	<0.001
Morning headaches, n (%)	23 (8.2)	5 (2.6)	18 (20.5)	<0.001
ESS, mean ± SD	2±3	2.4±1.89	5.1±4.05	<0.001
SMIIQ, mean ± SD	4±6	4.48±4.38	8.5±6.66	<0.001

SD: standard deviation; OSA: obstructive sleep apnea; BMI: body mass index; NC: neck circumference; ESS: Epworth Sleepiness Scale; SMIIQ: SleepMed Insomnia Index Questionnaire.

Source: Authors.

raphy (PSG) with a level III equipment to confirm the diagnosis. PSG recordings were carried out in the patients' homes. Recordings included nasal airflow, thoracic and abdominal respiratory effort, pulse oximeter and body position sensor. The patients were instructed, by a trained PSG technician, on how to connect and remove the device. The overnight home recordings were unattended. A sleep technician manually scored the recordings according to the recommendation of AASM, and a physician informed the patient of the results. The apnea-hypopnea index (AHI) was defined as the total number of apneas and hypopneas per hour of sleep. The AHI and the lowest recorded oxygen saturation were extracted from PSG reports. The diagnosis and severity of OSA were classified based on the AHI values: ≥5-15/h as mild, ≥15-30/h as moderate, and ≥30/h as severe[5].

All subjects who underwent PSG received a report to deliver to their primary care physician to be referred for sleep consultation whether to discuss treatment options or to perform laboratory PSG, to confirm or exclude the diagnosis.

Statistical analysis

A descriptive and inferential analysis was performed using the SPPSS® 22.0 software (Statistical Package for the Social Sciences). Categorical variables are presented as absolute frequencies and percentages, and continuous variables as means and standard deviations (SD), or medians and interquartile ranges for variables with skewed distributions. Normal distribution was checked using Shapiro-Wilk or skewness and kurtosis.

Categorical variables were compared with the use of Fisher's exact test or the Chi-squared test, as appropriate. Continuous variables were expressed as means ±SD and compare with use of Student's t-test. Pearson's correlation coefficient was used to assess the correlation between NC and AHI and between STOP-Bang questionnaire and AHI. All reported P values are two-tailed, with a P value of 0.05 indicating statistical significance.

For subjects who underwent confirmatory diagnostic testing, the positive predictive value (PPV) of the screening criteria was estimated as: (Subjects with confirmed OSA diagnosis/Subjects with a positive OSA screen) x 100%.

Results

Over the 6-years study period, a total of 281 male truck drivers of a Portuguese transportation company were enrolled. The average age of participants was 44.63±7.30 years (minimum age 35 years; maximum age 65 years) and NC was 41.13±3.2 cm. Most of the drivers (50.2%) were overweight (mean BMI of 28.72±4.05 kg/m^2) and eighty-eight (31.3%) were obese. Their past medical history included arterial hypertension (14.2%), dyslipidemia (9.6%) and diabetes mellitus (5%). One hundred and sixty-nine (60.1%) had smoking habits.

Of the 281 truck drivers screened, 72 (25.6%) reported usual snoring (defined as snoring three or more nights per week), 25 (8.9%) gasping or chocking, 21 (7.5%) witnessed apneas, 72 (25.6%) restless sleep, 85 (30.2%) dry mouth, 31 (11%) reported daytime sleepiness, 65 (23.1%) non-restorative sleep, 29 (10.3%) cognitive impairment and 23 (8.2%) morning headaches. However, only 3.9% presented excessive daytime sleepiness when evaluated through ESS (ESS≥11). The prevalence of insomnia (SMIIQ ≥15) was 8.5%.

According to the BQ and STOP-Bang questionnaires, 79 (28.1%) and 80 (28.5%) patients were at high risk for OSA, respectively. Therefore, a total of 88 (31.3%) subjects screened positive for OSA. Table 1 summarizes the study population and compares drivers with positive and negative OSA screens. Drivers meeting the criteria for high-risk for OSA were significantly older, and with higher averages BMI and NC. Moreover, the percentage of drivers with obesity, arterial hypertension and use of hypnotic-sedative drugs was significantly higher in this group. They also reported significantly more daytime and night-time symptoms typical of OSA, considering the percentage results.

Figure 1 illustrates the clinical yields of screening.

From the 88 subjects with suspected OSA, 10 (11.4%) refused to perform PSG, and 15 did not perform PSG because they lost follow-up. A total of 63 (71.6%) drivers completed PSG study and the diagnosis was confirmed in 54, yielding an estimated positive predictive value of 85.7% for the screening criteria. Of these 18 (33.3%) were diagnosed with mild OSA, 24 (44.4%) with moderate OSA, and 12 (22.2%) with severe OSA. This accounts for a prevalence of at least 19.2%.

The following variables showed a positive correlation with AHI: NC (r=0.42; p=0.001) and STOP-Bang (r=0.37; p=0.006).

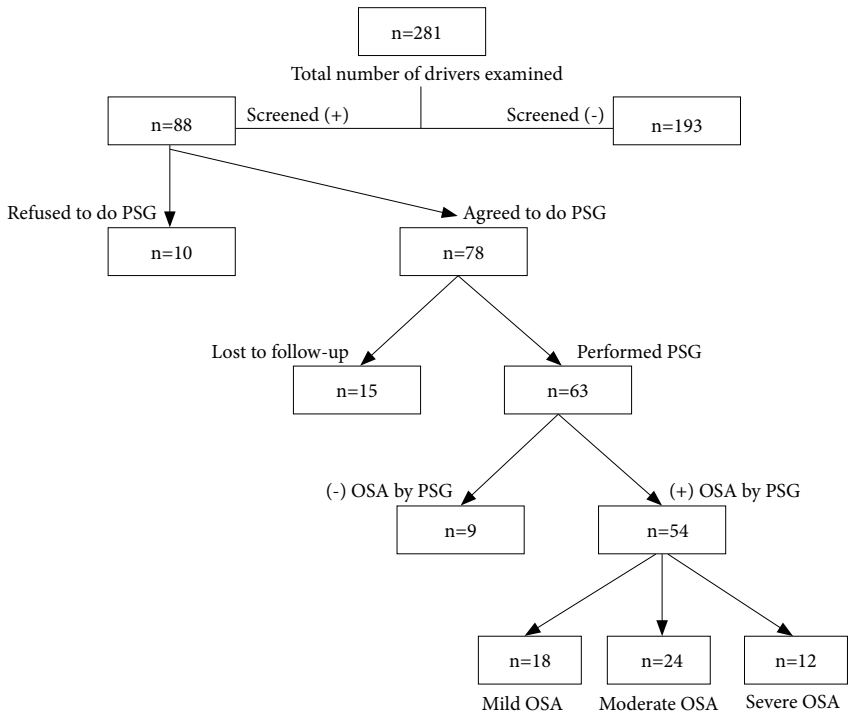

Figure 1. Obstructive sleep apnea (OSA) screening flow chart.

PSG: polysomnography.

Source: Authors.

Discussion

Our results are consistent with previous findings regarding the assessed risk factors for OSA. Obesity is well recognized as one the most important risk factors for OSA[25]. In our study, 31.3% and 50.2% of subjects were obese and overweight, respectively. Additionally, we found that the average BMI and NC of drivers with high risk for OSA was significantly higher than negative OSA screening drivers ($p<0.001$) and that there was a positive correlation between NC and AHI ($r=0.42$; $p=0.001$). These findings are in line with some authors who stated that the neck circumference correlates well with obesity and an increased NC is associated with a higher risk of OSA[26,27]. The reasons for the high incidence of obesity in professional drivers is speculated to be related to their sedentary life style, with prolonged working hours, inappropriate dietary habits, physical inactivity and occupational stress[10,28,29]. The percentage of drivers with arterial hypertension was also higher in the group with positive screen for OSA. Untreated OSA is associated with an elevated risk of hypertension and cardiovascular disease[30]. Observational studies have reported a prevalence of OSA over 30% among hypertensive patients and nearly 80% among resistant hypertensive patients[31,32]. Several pathophysiologic factors contribute to the relationship between OSA and cardiovascular risk, including endothelial dysfunction, neurohormonal dysregulation and inflammation[30]. Patients in that group were also older, reinforcing the data from current literature confirming the high prevalence of OSA in older individuals[33]. Patients who screened positive for OSA reported significantly more daytime and night-time symptoms typical of OSA presented in Table 1, which is consistent with the current literature[34,35]. Although 11% reported daytime sleepiness, only 3.9% presented excessive daytime sleepiness when evaluated through ESS (ESS≥11), which can be explained by the fact that in some patients the ESS may not be a meaningful measure of EDS[35]. ESS only measures the tendency to fall asleep in specific situations which might differ

in different groups of individuals and, therefore, may affect their answer regardless of how sleepy they are, for example depending on gender and age[36,37]. Given that ESS and self-reported EDS appear to measure distinct aspects of sleepiness, many subjects with EDS will go undiagnosed. We found a prevalence of insomnia of 8.5%. OSA and insomnia are highly prevalent in the general population and can often coexist. They share some clinical features and may aggravate each other[38]. Insomnia may reduce compliance to the treatment of OSA with positive airway pressure therapy, and OSA can make insomnia more refractory to cognitive-behavioural therapy[39,40]. Therefore, it is highly recommended for clinicians to investigate the potential co-occurrence of these disorders[38]. The COVID-19 pandemic could have also contributed to this result because many individuals reported sleep disturbances, including insomnia during this period[41]. A larger number of patients in the group who screened positive for OSA were under hypnotic-sedative drugs. Given their central nervous system depressant properties and potential myorelaxant effects, early studies found that these agents can prolong respiratory events and worsen overnight hypoxemia in OSA[42]. However, according to more recent studies, there is no evidence that hypnotics impair pharyngeal muscle activity during sleep and standard doses of common hypnotics do not systematically worsen OSA severity as measured via the AHI[43]. This difference between groups can be explained by the possible coexistence of insomnia and thus, be exposed to hypnotic use[44]. Also, patients undiagnosed for OSA are usually under hypnotic medication due to complains of sleep disruption. In our study, 60.1% of patients had smoking habits, however, we did not find a higher prevalence of smokers in the group who screened positive for OSA. Many authors have studied the potential association between smoking and OSA and it is reported that its impact on OSA is due to various mechanisms including changes of sleep architecture, of upper airway neuromuscular function, of arousal mechanisms and of enhanced upper airway inflammation[45]. It has also been found that untreated OSA is related to smoking addiction[46]. Nevertheless, data remain controversial and it is still unclear whether smoking represents a risk factor for OSA. Our findings are in line with other studies that failed to conclusively establish a significant association between cigarette smoking and OSA[46-48].

Regarding the screening tools we used in our study, the Epworth sleepiness scale (ESS), the Berlin questionnaire (BQ) and the STOP-Bang questionnaire (SBQ) are widely used for OSA[49]. Three different studies[49-51] observed that the sensitivity and diagnostic odds ratio (DOR) of the SBQ were higher than those of the BQ and ESS for detecting mild, moderate, and severe OSA. By contrast, compared with the ESS, the SBQ had limited value in screening out patients without OSA. In order to enhance our screening accuracy, we used three validated and widely used questionnaires. In fact, sleep quality should be evaluated using a combination of the different tools, in order to obtain a complete picture of both sleep and daytime impairments[15]. We found a positive correlation between STOP-Bang and AHI ($r=0.37$; $p=0.006$), which suggests that the STOP-Bang test is useful for predicting OSA severity. These results are corroborated by Farney *et al.*[52] and Chung *et al.*[53], who also demonstrated that as the STOP-Bang score increased, the probability of having more severe OSA also increased.

In this sample of Portuguese truck drivers, we found 88 (31.3%) cases that screened positive for OSA. These results are comparable with another sample of 714 Portuguese truck drivers in which 29% were at high risk for having OSA[54]. Of the 63 drivers who underwent PSG, 54 had confirmation of the diagnosis of OSA, yielding an estimated PPV of 85.7%. Previous studies that used screening criteria similar to this study found PPV that varied between and 78.5 and 100%[12,14,55,56]. In our study, the prevalence of OSA obtained by a combination of questionnaires and PSG was at least 19.2%. This is higher than the prevalence observed in a similar study[14] but lower than the estimated in previous studies which identified sleep-disordered breathing in between 25 and 78% of commercial drivers[11].

Nonetheless, our study does have a number of limitations and the true prevalence of OSA may be underestimated for several reasons. First, the subjective nature of some items of the questionnaires that were used, may have been subject to under-reporting by the drivers. Regarding the study design, there is lack of PSG data on subjects with negative OSA screens, precluding precise estimates of disease prevalence. In addition, 28.4% of drivers who had positive screening did not undergo PSG because they refused or lost follow-up; this rate is consistent with observations from previous publications[55]. Furthermore, OSA was defined using a home unattended level III PSG. Although portable monitors have been proposed as a cheaper and more accessible technology for OSA detection in specific population,

such as individuals with high pre-test suspicion and without complicated comorbidities, the gold standard test remains in-laboratory, technician-monitored PSG. In fact, portable monitors tend to underestimate the severity of OSA, and an important proportion of professional drivers who tested negative will likely require a follow-up with in-laboratory PSG due to invalid results, the relatively low sensitivity and specificity of this method, or potential barriers from human factors[57]. However, overnight PSG performed in accredited sleep units is inappropriate for systematic screening because it is expensive, labour-intensive, not feasible in all subjects and time consuming for professional drivers who are regularly on the road. Therefore, simple, and inexpensive selection of patients with the potentially highest risk of OSA is needed. Another possible limitation would be that the night of the study did not represent a typical night for the patient, for example, due to the "first-night effect", in which there is an alteration of sleep architecture on the first night of PSG studies. This effect can often be observed in studies conducted in sleep laboratories, because of the new environment, discomfort caused by electrodes, being kept under watch by experimenters, or reactions to a novel or stressful situation[58]. To overcome this possible limitation, our studies were carried out at the patient's home, in a familiar environment, and if patients reported difficulties in falling asleep or any other changes in their usual sleep pattern during the night of the study, which could underestimate the result obtained, the study was repeated. Also, a report was sent to all subjects to deliver to their primary care physician to be referred for sleep consultation whether to discuss treatment options or to perform laboratory PSG, to confirm or exclude the diagnosis. It is also important to mention that our study was conducted in a 6-years period and comprised the COVID-19 (disease caused by SARS-CoV-2) pandemic. The pandemic has had a negative impact on the general population, with many individuals reporting sleep disturbances, including difficulties in sleep initiation or maintenance, poor sleep quality, and other sleep impairments[41,59], which could have affected the individuals reports on the applied questionnaires**.** The explanation for these changes is likely multifactorial, including social restrictions, fear of infection and financial loss[41]. Regarding the association between OSA and COVID-19, many of the risk factors for OSA are associated with poor COVID-19 outcomes[60]. Patients with OSA often have upregulation of the angiotensin-converter enzyme 2 (ACE2) receptors, which facilitates SARS-CoV-2 virus entry into cells[61]. Also, chronic inflammation status in OSA patients, contributes to the worsening of the cytokine storm in patients with severe forms of COVID-19[62]. Additionally, patients who suffered from COVID-19, particularly severe cases, may be under risk for OSA due to pulmonary fibrosis[60]. Another limitation of our study is that, although our sample was obtained from one of the largest Portuguese road freight companies, the number of participants might not be sufficient to generalize the results. Other studies with a larger cohort are required.

Despite several limitations, our study has important strengths. We used a combination of 3 validated questionnaires, that demonstrated a high PPV, proving to be valuable and simple tools for OSA screening. Our study raises awareness for the significant prevalence of OSA in truck drivers, reinforcing that this pathology should not be neglected, given the associated health and economic burden[11]. Therefore, measures should be taken in order to implement screening tools as part of health policies related to these workers.

Conclusion

The combination of a predominantly male population, obesity, age distribution, and lifestyle could account for the high prevalence of sleep-disordered breathing in truck drivers. Screening, treatment, and management of OSA should be a priority as a public safety policy, along with the benefits for the driver itself. The present study found a significant relationship between indicators of high risk of OSA, obtained by clinical examination, underlining neck circumference evaluation, and questionnaires on OSA symptoms. Most of parameters were obtained after clinical evaluation, which could be performed by occupational medicine. The diagnosis can be confirmed by PSG in workers with high suspicion of OSA. The use of questionnaires proved to be a valuable and simple tool for OSA screening, and in our opinion, this screening should be implemented as an occupational requirement for professional drivers.

Collaborations

M Argel worked on the conceptualization, research, methodology and writing. Â Cunha worked on the methodology and formal analysis. M Conceição worked on the research and data curation. T Abrantes worked on the design and final editing. AS Torres on the conceptualization, supervision and final editing.

Acknowledgements

The authors would like to thank the Sleep Unit of Pulmonology Department - Centro Hospitalar Tondela-Viseu, Linde Healthcare, Patinter, and all the drivers who participated in the present study.

References

1. Ng MK, Yousuf B, Bigelow PL, Van Eerd D. Effectiveness of health promotion programmes for truck drivers: A systematic review. *Health Educ J* 2015; 74(3):270-286.
2. Thiese MS, Hanowski RJ, Kales SN, Porter RJ, Moffitt G, Hu N, Hegmann KT. Multiple Conditions Increase Preventable Crash Risks among Truck Drivers in a Cohort Study. *J Occup Environ Med* 2017; 59(2):205-211.
3. Gonçalves M, Amici R, Lucas R, Åkerstedt T, Cirignotta F, Horne J, Léger D, McNicholas WT, Partinen M, Téran-Santos J, Peigneux P, Grote L; National Representatives as Study Collaborators. Sleepiness at the wheel across Europe: A survey of 19 countries. *J Sleep Res* 2015; 24(3):242-253.
4. Rodenstein D. Driving in Europe: The need of a common policy for drivers with obstructive sleep apnoea syndrome. *J Sleep Res* 2008; 17(3):281-284.
5. American Academy of Sleep Medicine (AASM). *International Classification of Sleep Disorders*. 3ª ed. Darien: AASM; 2014.
6. Senaratna CV, Perret JL, Lodge CJ, Lowe AJ, Campbell BE, Matheson MC, Hamilton GS, Dharmage SC. Prevalence of obstructive sleep apnea in the general population: A systematic review. *Sleep Med Rev* 2017; 34:70-81.
7. Jordan AS, McSharry DG, Malhotra A. Adult obstructive sleep apnoea. *Lancet* 2014; 383(9918):736-747.
8. Heinzer R, Vat S, Marques-Vidal P, Marti-Soler H, Andries D, Tobback N, Mooser V, Preisig M, Malhotra A, Waeber G, Vollenweider P, Tafti M, Haba-Rubio J. Prevalence of sleep-disordered breathing in the general population: THE HypnoLaus study. *Lancet Respir Med* 2015; 3(4):310-318.
9. Burks SV, Anderson JE, Bombyk M, Haider R, Ganzhorn D, Jiao X, Lewis C, Lexvold A, Liu H, Ning J, Toll A, Hickman JS, Mabry E, Berger M, Malhotra A, Czeisler CA, Kales SN. Sleep disordered breathing Nonadherence with Employer-Mandated Sleep Apnea Treatment and Increased Risk of Serious Truck Crashes. *Sleep* 2016; 39(5):967-975.
10. Tregear S, Reston J, Schoelles K, Phillips B. Obstructive sleep apnea and risk of motor vehicle crash: Systematic review and meta-analysis. *J Clin Sleep Med* 2009; 5(6):573-581.
11. Gurubhagavatula I, Sullivan S, Meoli A, Patil S, Olson R, Berneking M, Watson NF. Management of obstructive sleep apnea in commercial motor vehicle operators: Recommendations of the AASM sleep and transportation safety awareness task force. *J Clin Sleep Med* 2017; 13(5):745-758.
12. Xie W, Chakrabarty S, Levine R, Johnson R, Talmage JB. Factors associated with obstructive sleep apnea among commercial motor vehicle drivers. *J Occup Environ Med* 2011; 53(2):169-173.
13. Gurubhagavatula I, Maislin G, Nkwuo JE, Pack AI, Gurubha-Gavatula I. Occupational Screening for Obstructive Sleep Apnea in Commercial Drivers. *Am J Respir Crit Care Med* 2004; 170:371-376.
14. Parks PD, Durand G, Tsismenakis AJ, Vela-Bueno A, Kales SN. Screening for Obstructive Sleep Apnea During Commercial Driver Medical Examinations. *J Occup Environ Med* 2009; 51(3):275-282.

15. Fabbri M, Beracci A, Martoni M, Meneo D, Tonetti L, Natale V. Measuring Subjective Sleep Quality: A Review. *Int J Environ Res Public Health* 2021; 18(3):1082.
16. Johns MW. A new method for measuring daytime sleepiness: The Epworth sleepiness scale. *Sleep*. 1991; 14(6):540-545.
17. Ng SS, Tam W, Chan TO, To KW, Ngai J, Chan KKP, Yip WH, Lo RL, Yiu K, Ko FW, Hui DS. Use of Berlin questionnaire in comparison to polysomnography and home sleep study in patients with obstructive sleep apnea. *Respir Res* 2019; 20(1):40.
18. Senaratna CV, Perret JL, Matheson MC, Lodge CJ, Lowe AJ, Cassim R, Russell MA, Burgess JA, Hamilton GS, Dharmage SC. Validity of the Berlin questionnaire in detecting obstructive sleep apnea: A systematic review and meta-analysis. *Sleep Med Rev* 2017; 36:116-124.
19. Chung F, Abdullah HR, Liao P. STOP-Bang Questionnaire: A Practical Approach to Screen for Obstructive Sleep Apnea. *Chest* 2016; 149(3):631-638.
20. Hwang M, Zhang K, Nagappa M, Saripella A, Englesakis M, Chung F. Validation of the STOP-Bang questionnaire as screening tool for obstructive sleep apnoea in patients with cardiovascular risk factors: a systematic review and meta-analysis. *BMJ Open Resp Res* 2021; 8:e000848.
21. World Health Organization (WHO). *Global Database on Body Mass Index. An interactive surveillance tool for monitoring nutrition transition* [Internet]. 2011 [cited 2021 jan 20]. Available from: https://www.who.int/data/gho/data/themes/topics/topic-details/GHO/body-mass-index.
22. Bogan RK, Turner JA. New assessment tools that measure sleep vital signs: The SleepMed Insomnia Index and the Sleep Matrix. *Neuropsychiatr Dis Treat* 2007; 3(4):501-510.
23. Vaz AP, Drummond M, Mota PC, Severo M, Almeida J, Winck JC. Tradução do Questionário de Berlim para língua Portuguesa e sua aplicação na identificação da SAOS numa consulta de patologia respiratória do sono. *Rev Port Pneumol* 2011; 17(2):59-65.
24. Reis R, Teixeira F, Martins V, Sousa L, Batata L, Santos C, Moutinho J. Validation of a Portuguese version of the STOP-Bang questionnaire as a screening tool for obstructive sleep apnea: Analysis in a sleep clinic. *Rev Port Pneumol* 2015; 21(2):61-68.
25. Young T, Skatrud J, Peppard PE. Risk Factors for Obstructive Sleep Apnea in Adults. *JAMA* 2004; 291(16):2013-2016.
26. Stradling JR, Crosby JH. Predictors and prevalence of obstructive sleep apnoea and snoring in 1001 middle aged men. *Thorax* 1991; 46(2):85-90.
27. Caffo B, Diener-West M, Punjabi NM, Samet J. A novel approach to prediction of mild obstructive sleep disordered breathing in a population-based sample: the Sleep Heart Health Study. *Sleep* 2010; 33(12):1641-1648.
28. Saberi HR, Moravveji AR, Fakharian E, Kashani MM, Dehdashti AR. Prevalence of metabolic syndrome in bus and truck drivers in Kashan, Iran. *Diabetol Metab Syndr* 2011; 3(1):8.
29. Guglielmi O, Magnavita N, Garbarino S. Sleep quality, obstructive sleep apnea, and psychological distress in truck drivers: a cross-sectional study. *Soc Psychiatry Psychiatr Epidemiol* 2018; 53:531-536.
30. Salman LA, Shulman R, Cohen JB. Obstructive Sleep Apnea, Hypertension, and Cardiovascular Risk: Epidemiology, Pathophysiology, and Management. *Curr Cardiol Rep* 2020;22(2):6.
31. Hou H, Zhao Y, Yu W, Dong H, Xue X, Ding J, Xing W, Wang W. Association of obstructive sleep apnea with hypertension: A systematic review and meta-analysis. *J Glob Health* 2018; 8(1):010405.
32. Muxfeldt ES, Margallo V, Costa LM, Guimarães G, Cavalcante AH, Azevedo JC, Souza F, Cardoso CR, Salles GF. Effects of continuous positive airway pressure treatment on clinic and ambulatory blood pressures in patients with obstructive sleep apnea and resistant hypertension: a randomized controlled trial. *Hypertension* 2015; 65(4):736-742.
33. Punjabi NM. The epidemiology of adult obstructive sleep apnea. *Proc Am Thorac Soc* 2008; 5(2):136-143.
34. Abbasi A, Gupta SS, Sabharwal N, Meghrajani V, Sharma S, Kamholz S, Kupfer Y. A comprehensive review of obstructive sleep apnea. *Sleep Sci* 2021; 14(2):142-154.
35. Stansbury RC, Strollo PJ. Clinical manifestations of sleep apnea. *J Thorac Dis* 2015; 7(9):E298-310.
36. Baldwin CM, Kapur VK, Holberg CJ, Rosen C, Nieto FJ; Sleep Heart Health Study Group. Associations between gender and measures of daytime somnolence in the Sleep Heart Health Study. *Sleep* 2004; 27(2):305-311.
37. Ulander M, Arestedt K, Svanborg E, Johansson P, Broström A. The fairness of the Epworth Sleepiness Scale: two approaches to differential item functioning. *Sleep Breath* 2013; 17(1):157-165.
38. Ragnoli B, Pochetti P, Raie A, Malerba M. Comorbid Insomnia and Obstructive Sleep Apnea (COMISA): Current Concepts of Patient Management. *Int J Environ Res Public Health* 2021; 18(17):9248.
39. Nguyên XL, Chaskalovic J, Rakotonanahary D, Fleury B. Insomnia symptoms and CPAP compliance in OSAS patients: A descriptive study using Data Mining methods. *Sleep Med* 2010; 11(8):777-784.
40. Williams J, Roth A, Vatthauer K, McCrae CS. Cognitive behavioral treatment of insomnia. *Chest* 2013; 143(2):554-565.
41. Hossain MM, Sultana A, Purohit N. Mental health outcomes of quarantine and isolation for infection prevention: a systematic umbrella review of the global evidence. *Epidemiol Health* 2020; 42:e2020038.
42. Guilleminault C. Benzodiazepines, breathing, and sleep. *Am J Med* 1990; 88(3A):25S-28S.
43. Carter SG, Eckert DJ. Effects of hypnotics on obstructive sleep apnea endotypes and severity: Novel insights into pathophysiology and treatment. *Sleep Med Rev* 2021; 58:101492.
44. Benetó A, Gomez-Siurana E, Rubio-Sanchez P. Comorbidity between sleep apnea and insomnia. *Sleep Med Rev* 2009; 13(4):287-293.

45. Krishnan V, Dixon-Williams S, Thornton JD. Where there is smoke…there is sleep apnea: exploring the relationship between smoking and sleep apnea. *Chest* 2014; 146(6):1673-1680.
46. Ioannidou D, Kalamaras G, Kotoulas SC, Pataka A. Smoking and Obstructive Sleep Apnea: Is There An Association between These Cardiometabolic Risk Factors?-Gender Analysis. *Medicina (Kaunas)* 2021; 57(11):1137.
47. Hsu WY, Chiu NY, Chang CC, Chang TG, Lane HY. The association between cigarette smoking and obstructive sleep apnea. *Tob Induc Dis* 2019; 17:27.
48. Casasola GG, Alvarez-Sala JL, Marques JA, Sánchez-Alarcos JM, Tashkin DP, Espinós D. Cigarette smoking behavior and respiratory alterations during sleep in a healthy population. *Sleep Breath* 2002; 6(1):19-24.
49. Chiu HY, Chen PY, Chuang LP, Chen NH, Tu YK, Hsieh YJ, Wang YC, Guilleminault C. Diagnostic accuracy of the Berlin questionnaire, STOP-BANG, STOP, and Epworth sleepiness scale in detecting obstructive sleep apnea: A bivariate meta-analysis. *Sleep Med Rev* 2017; 36:57-70.
50. Luo J, Huang R, Zhong X, Xiao Y, Zhou J. STOP-Bang questionnaire is superior to Epworth sleepiness scales, Berlin questionnaire, and STOP questionnaire in screening obstructive sleep apnea hypopnea syndrome patients. *Chin Med J (Engl)* 2014; 127(17):3065-3070.
51. Pataka A, Daskalopoulou E, Kalamaras G, Fekete Passa K, Argyropoulou P. Evaluation of five different questionnaires for assessing sleep apnea syndrome in a sleep clinic. *Sleep Med* 2014; 15:776-781.
52. Farney RJ, Walker BS, Farney RM, Snow GL, Walker JM. The STOP-Bang equivalent model and prediction of severity of obstructive sleep apnea: relation to polysomnographic measurements of the apnea/hypopnea index. *J Clin Sleep Med* 2011; 7(5):459-65B.
53. Chung F, Subramanyam R, Liao P, Sasaki E, Shapiro C, Sun Y. High STOP-Bang score indicates a high probability of obstructive sleep apnoea. *Br J Anaesth* 2012; 108(5):768-775.
54. Catarino R, Spratley J, Catarino I, Lunet N, Pais-Clemente M. Sleepiness and sleep-disordered breathing in truck drivers: Risk analysis of road accidents. *Sleep Breath* 2014; 18(1):59-68.
55. Talmage JB, Hudson TB, Hegmann KT, Thiese MS. Consensus Criteria for Screening Commercial Drivers for Obstructive Sleep Apnea: Evidence of Efficacy. *J Occup Environ Med* 2008; 50(3):324-329.
56. Garbarino S, Guglielmi O, Campus C, Mascialino B, Pizzorni D, Nobili L, Mancardi GL, Ferini-Strambi L. Screening, diagnosis, and management of obstructive sleep apnea in dangerous-goods truck drivers: to be aware or not? *Sleep Med* 2016; 25:98-104.
57. Zhang C, Berger M, Malhotra A, Kales SN. Portable diagnostic devices for identifying obstructive sleep apnea among commercial motor vehicle drivers: considerations and unanswered questions. *Sleep* 2012; 35(11):1481-1489.
58. Tamaki M, Nittono H, Hayashi M, Hori T. Examination of the first-night effect during the sleep-onset period. *Sleep* 2005; 28(2):195-202.
59. Deng J, Zhou F, Hou W, Silver Z, Wong CY, Chang O, Huang E, Zuo QK. The prevalence of depression, anxiety, and sleep disturbances in COVID-19 patients: a meta-analysis. *Ann N Y Acad Sci* 2021; 1486(1):90-111.
60. Miller MA, Cappuccio FP. A systematic review of COVID-19 and obstructive sleep apnoea. *Sleep Med Rev* 2021; 55:101382.
61. Cappuccio FP, Siani A. Covid-19 and cardiovascular risk: susceptibility to infection to SARS-CoV-2, severity and prognosis of Covid-19 and blockade of the renin-angiotensin-aldosterone system. An evidence -based viewpoint. *Nutr Metab Cardiovasc Dis* 2020; 30(8):1227e35.
62. Jose RJ, Manuel A. COVID-19 cytokine storm: the interplay between inflammation and coagulation. *Lancet Respir Med* 2020; 8(6):e46-e47.

Article submitted 03/07/2022
Approved 15/11/2022
Final version submitted 17/11/2022

Chief editors: Romeu Gomes, Antônio Augusto Moura da Silva