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Cross-sectional Study

Risk of obstructive sleep apnea and traffic accidents among male bus drivers in Ecuador: Is there a significant relationship?

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ABSTRACT

Background: Obstructive sleep apnea (OSA) represents an important occupational health concern in the transportation industry, affecting a substantial percentage of transportation operators. Our study aims to determine the frequency of individuals at high risk of obstructive sleep apnea, and excessive daytime sleepiness, as well as any potential association between these conditions and traffic accidents among a sample of Ecuadorian bus drivers.

Methods: We conducted a cross-sectional study involving 340 commercial bus drivers from Ecuador. Descriptive statistics were used to determine frequency and proportions for demographic and clinical variables. A Kendall's tau-b was performed to ascertain the relationship between the STOP-Bang score towards the Epworth Sleepiness Scale (ESS) score and the number of accidents and near accidents.

Results: In general, 18.5% ($n = 63$) of participants were found to be at high-risk for OSA. There was a weak positive correlation between STOP-Bang score and ESS score ($\tau^b = 0.244$, $p = .000$). We also found a statistically significant, although negligible, correlation between the STOP-Bang score and the number of accidents ($\tau^b = 0.096$, $p = .039$) and near accidents ($\tau^b = 0.120$, $p = .008$).

Conclusion: Our results suggest that a considerable proportion of Ecuadorian bus drivers were at high-risk for obstructive sleep apnea. Higher STOP-Bang scores were correlated with an increased number of accidents and near accidents. Additional studies are needed to determine whether additional interventions could increase road safety by taking care of undiagnosed and untreated OSA cases in a timely manner.

1. Introduction

Obstructive sleep apnea (OSA) is a disease characterized by partial or complete collapse of the upper airway during sleep, causing hypoxia and sleep fragmentation [1]. OSA is the most frequent type of sleep-disordered breathing among adults, with a prevalence ranging from 9% to 38% in the general population when a five-events per hour of apnea-hypopnea index is used as a cutoff value [2]. Clinical symptoms are varied, but patients mainly complain of excessive daytime sleepiness (EDS), and the presence of snoring, choking or gasping during sleep, often noticed by bed partners and/or the family [2]. Excessive daytime sleepiness may be described by patients as fatigue, tiredness, low energy, or poor focus, and represents an inability to remain fully awake or alert during the wakefulness portion of sleep-wake cycles [3]. Thus, patients are at risk of falling asleep while performing daily activities, which could pose a serious risk of injury to self and others, when activities such as driving are conducted [1].

In this regard, a systematic review and metanalysis by Tregear and

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colleagues found that untreated sleep apnea is a significant contributor to motor vehicle crashes, with a mean crash-rate ratio associated with OSA between 1.21 and 4.89 [4]. Moreover, body mass index, apnea-hypopnea index, oxygen saturation, and daytime sleepiness, have been identified as possible predictors of motor vehicle accidents [4]. Furthermore, road traffic accidents are an increasingly major problem in densely populated regions such as Asia and Latin America, in which a rising mortality and morbidity constitutes a social issue [5,6]. According to the World Health Organization, Ecuador was ranked as the 74th country with highest road traffic accident deaths in 2017, with a death rate of 21.22 per 100.000 population [7]. However, recent years have seen an increase in the number of fatal and non-fatal traffic accidents in the country, with transportation buses often involved in accidents with the highest mortality [8]. Although traffic accidents are often complex and multifactorial in etiology, there is a need to study possible contributors to these events. Considering the previously discussed evidence, our study aims to determine the frequency of individuals at high risk of obstructive sleep apnea, and excessive daytime sleepiness, as well as any potential association between these conditions and traffic accidents among a sample of Ecuadorian bus drivers.

2. Methods

We conducted a cross-sectional study from September 2020 to September 2021 among male professional bus drivers in the city of Guayaquil, Ecuador. Of the 380 individuals approached for the study, 340 accepted to participate (response rate 89.5%). To be included in the study, participants were required to be male, have an unexpired professional driver's license, as well as being currently enrolled at any local transportation company. Individuals who did not met the inclusion criteria, or who declined voluntary participation were excluded from the study. No financial incentives were given to participants in our study.

2.1. Procedures

Demographic and clinical variables included age, educational level, associated comorbidities (hypertension and diabetes), years as a professional driver, and number of accidents and near-accidents while working. Accidents were defined as a collision involving the vehicle in which the participant was the driver and another vehicle or stationary obstruction. Near-accidents were defined as unplanned events involving the driver that did not result in injury but had the potential to do so [9].

To screen for obstructive sleep apnea, we used the official Spanish version of the STOP-Bang questionnaire developed by the University of Toronto (available from http://www.stopbang.ca/). The STOP questionnaire assesses four questions related to snoring, tiredness during daytime, observed apnea, and high blood pressure (STOP), while the Bang aspect screens for a BMI ≥35, age ≥50, neck circumference >40 cm and male gender [10]. The STOP-Bang questionnaire is useful as screening tool due to its high sensitivity for all degrees of OSA severity, however, the specificity of this method can be at best moderate for severe OSA (56%, 43%, and 37% for predicting mild to severe OSA, moderate-severe OSA, and severe OSA, respectively) reproducing in some cases false-positives [10–12]. Given the fact that this study won't confirm OSA diagnosis through polysomnography, we are going to use the two-step approach proposed by Chung F. et al. to increase the STOP-Bang specificity [13]. In this model, the first step is based on the standard method which sets three risk categories which are: low risk (STOP-Bang = 0–2), intermediate risk (STOP-Bang = 3–4) and high risk (STOP-Bang = 5–8). The second step involves reclassification of patients at intermediate risk. If such patients have 2 positive items from the 4 STOP questions plus any of the following: BMI >35 kg/m2, male gender, or neck circumference >40 cm, patients are reclassified as high risk.

To assess excessive daytime sleepiness (EDS), which is defined as an "average sleep propensity", we used a Spanish validated version of the original Epworth Sleepiness Scale (ESS) [14,15]. The ESS is a self-administered questionnaire, with 8 questions in which individuals are asked to rate the likelihood of falling asleep while engaged in different activities using a 4-point scale. The final score can range from 0 to 24, with higher scores reflecting a higher average sleep propensity in daily life. According to this, patients would be categorized as having lower normal daytime (ESS = 0–5), higher normal daytime (ESS = 6–10), mild excessive daytime sleepiness (ESS = 11–12), moderate excessive daytime sleepiness (ESS = 13–15) and severe excessive daytime sleepiness (ESS = 16–24).

2.2. Ethical considerations

This study was approved by the local ethics committee "Comité de ética e Investigación en Seres Humanos" (#HCK-CEISH-18-0060). We obtained informed consent before participation in the survey. With the information recollected in the survey, personal identification was not possible as such anonymity/personal data protection was conserved. This study is registered with the ResearchRegistry and the unique identifying number is: researchregistry7561. Additionally, our work has been reported in line with the STROCSS 2021 criteria [16].

2.3. Statistical analyses

The present study applied descriptive statistics to report the demographic and clinical variables of interest. Frequencies of nominal data were reported as percentages while continuous variables were represented as mean and standard deviation.

A Kendall's tau-b was performed to ascertain the relationship between the STOP-Bang score towards the ESS score and the number of accidents and near accidents. Furthermore, a chi-square test to assess the association between the STOP-Bang and ESS categories was conducted. Same analysis to determine the association between the presence/absence of diabetes and hypertension with the STOP-Bang categories was also applied. To further determine the degree of such associations, if present, a Phi correlation's coefficient was applied. In case of assumption violation, a Fisher's exact test was used instead. A p value of less than 0.05 was set to express statistical significance. All the data was analyzed using SPSS, version 24.0 software (SPSS Inc., Chicago, IL, USA).

3. Results

We screened 340 male professional bus drivers whose mean age was 44.3 (SD, 9.4) and average years of experience of 19.38 (10.2). Of the participants, 91.5% (N = 311) were either overweight or obese, 7.6% (N = 26) had been diagnosed with hypertension and 5.9% (N = 20) with type II diabetes mellitus (Table 1). In average, participants reported that during their career they had faced 0.74 (SD, 1.1) accidents and 1.17 (SD, 1.5) near accidents.

Regarding the STOP-Bang questionnaire, the mean score was 2.97 (SD, 1.2) with 18.5% (N = 63) participants being at high-risk for OSA. Meanwhile, the average ESS score was 4.60 (SD, 3.47) with most participants reporting lower normal daytime sleepiness 67.9% (N = 231) followed by higher normal daytime sleepiness 25.0% (N = 85).

3.1. Correlations & associations

A Kendall's tau-b revealed a weak positive correlation between the STOP-Bang score and the ESS score ($\tau^b = 0.244$, $p = .000$). Same analysis showed a negligible but significant correlation between the STOP-Bang score and the number of accidents ($\tau^b = 0.096$, $p = .039$) and near accidents ($\tau^b = 0.120$, $p = .008$). However, according to this statistical method the ESS score was only correlated with the number of near accidents ($\tau^b = 0.154$, $p = .000$).

Furthermore, a chi-square test demonstrated a statistically significant association between STOP-Bang categories and ESS categories,

Table 1
General characteristics of the surveyed population (n = 340).

Characteristics	n (%)
Age, mean (SD)	44.3 (9.4)
Educational level	
Primary	96 (28.2)
Secondary	200 (58.8)
University	44 (12.9)
Hypertension	26 (7.6)
Type 2 diabetes	20 (5.9)
BMI, mean (SD)	31.8 (4.9)
Normal range	29 (8.5)
Overweight	93 (27.4)
Obese Class I	135 (39.7)
Obese Class II	68 (20.0)
Obese Class III	15 (4.4)
Years of professional career, mean (SD)	19.38 (10.2)
Accidents, mean (SD)	0.74 (1.1)
Near-accidents, mean (SD)	1.17 (1.5)
STOP-Bang score, mean (SD)	2.97 (1.2)
Non-high risk	277 (81.5)
High-risk	63 (18.5)
ESS score, mean (SD)	4.60 (3.47)
Normal sleep	231 (67.9)
Higher normal daytime sleepiness	85 (25.0)
Mild excessive daytime sleepiness	12 (3.5)
Moderate excessive daytime sleepiness	10 (2.9)
Severe excessive daytime sleepiness	2 (0.6)

Notes: BMI, body mass index; ESS, Epworth Sleepiness Scale; SD, standard deviation.

$\chi^2(4) = 13.965$, p = .004. Also, hypertension was found to be significantly associated with the STOP-Bang categories, $\chi^2(1) = 71.424$, p = .000 (Fig. 1). The nature of such association was determined to be very strong ($\varphi = 0.460$, $p = .000$). However, same analyses between diabetes and STOP-Bang categories did not achieve statistical significance, $\chi^2(1) = 0.589$, p = .389.

4. Discussion

Obstructive sleep apnea represents an important occupational health concern in the transportation industry, affecting a substantial percentage of transportation operators. According to a previous study between 17 and 18% of commercial drivers in the United States are expected to have OSA [17]. In our study we found a similar proportion, with 18.5% of participants determined to be at high risk for OSA based on initial screening, with hypertension being significantly associated with STOP-Bang risk categories. This latter finding aligns with previous reports, in which compared to the general population, commercial drivers have a higher cardiovascular risk that may be a result of stressors such as lower exercise levels, sedentary lifestyle, poor job satisfaction, and long duration working hours [18]. It also appears that the prevalence of hypertension increases substantially in patients with OSA, and that these two conditions increase the risk for additional cardiovascular comorbidities and worse outcomes [19,20].

The main consequence related to OSA is excessive daytime sleepiness (EDS), which is associated with increased risk of accidents at work or while at driving [21]. Around 25–50% of patients with OSA will experience EDS, and it can negatively affect daily functioning, cognition, mood, and other aspects of well-being [22]. Its pathophysiology involves chronic intermittent hypoxia and sleep fragmentation causing oxidative injury and changes in neurons and neurotransmitters that regulate wake-promoting regions of the brain [23]. Such is the link between EDS and OSA that in our study we found a weak positive correlation between STOP-Bang and ESS scores, and a statistically significant association between OSA risk and daytime sleepiness categories. Despite measuring different aspects, as screening tools for OSA both the STOP-Bang and ESS instruments are valid instruments that can be used in the clinical practice. However, it is worth noting that according to a previous metanalysis the STOP-Bang questionnaire is a more accurate tool for detecting mild, moderate, and severe OSA compared to the Berlin, STOP, and Epworth questionnaires, and its use is recommended in low resource settings where polysomnography might not be readily available [24].

As previously stated, excessive daytime sleepiness is one of the main consequences related to obstructive sleep apnea which may ultimately contribute to road accidents [17]. Between 10 and 30% of all vehicle crashes are estimated to have sleepy drivers as a root cause, and among drivers diagnosed with OSA there is an increased crash risk in the range of 2–11 fold [25]. Furthermore, a previous metanalysis including over 70,000 participants found that sleepiness at the wheel was associated with an increased risk of motor vehicle accidents (pooled OR 2.51 [95% CI 1.87; 3.39]) [26]. Consistent with the reported literature we found a statistically significant correlation between STOP-Bang score and the number of accidents ($\tau b = 0.096$, p = .039) and near accidents ($\tau b = 0.120$, p = .008). By itself, undiagnosed and untreated OSA represents an issue to transportation safety particularly among commercial drivers, in which higher a prevalence of OSA compared to the general population has been observed, and who are by nature, subject to higher mileage per year and hours driving than non-commercial drivers [27].

4.1. Limitations

The are some limitations to the present study. For instance, despite the high sensitivity of the STOP-Bang score as a screening tool, we did not confirm the diagnosis of OSA through polysomnography. Additionally, our sample included only males, of which 91.5% were either overweight or obese. Consequently, we may not be able to extrapolate the results observed to the general population. Lastly, the data regarding accidents and near accidents was collected retrospectively from participants, which may have possibly led to recall bias.

5. Conclusions

Our results suggest that a considerable proportion of Ecuadorian bus drivers (18.5%) were at high-risk for obstructive sleep apnea. Higher STOP-Bang scores were correlated with an increased number of accidents and near accidents, while higher daytime sleepiness scores were correlated only with the number of near accidents. Additional studies

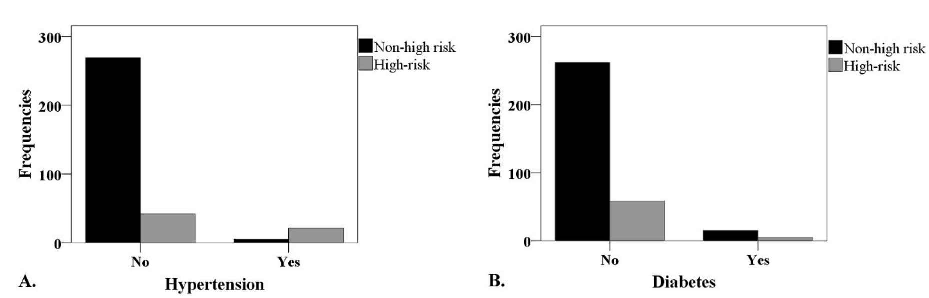

Fig. 1. Frequency of hypertension and diabetes per STOP-Bang risk category.

are needed to further investigate the observed relationship between the risk of OSA and the occurrence of motor vehicle accidents, and to determine whether additional interventions could increase road safety by taking care of undiagnosed and untreated OSA cases in a timely manner.

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Author contributions

Authors have made substantial contributions to conception and design, acquisition, analysis and interpretation of data, have been involved in drafting the manuscript or revising it critically for important intellectual content, and given final approval of the version to be published. All authors read and approved the final version.

Ethical approval

This study was approved by the local ethics committee “Comité de ética e Investigación en Seres Humanos” (#HCK-CEISH-18-0060). With the information recollected in the survey, personal identification was not possible as such anonymity/personal data protection was conserved.

Consent

We obtained informed consent before participation in the survey.

Trial registry number

1. Name of the registry: ClinicalTrials.gov
2. Unique Identifying number or registration ID: NCT05175287
3. Hyperlink to your specific registration (must be publicly accessible and will be checked): ClinicalTrials.gov PRS: Record Summary NCT05175287

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Declaration of competing interest

The authors declare no conflicts of interest related to this work.

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Abbreviations

OSA Obstructive sleep apnea
EDS excessive daytime sleepiness
ESS Epworth Sleepiness Scale

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