Instruments for Screening Obstructive Sleep Apnea in Drivers of Commercial Vehicles: A Systematic Literature Review

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Abstract

Background: Undiagnosed Obstructive sleep apnea in commercial vehicle drivers has the potential to cause traffic accidents. Polysomnography is the gold standard for diagnosing obstructive sleep apnea, but it is expensive, impractical, and not available in primary health services in the workplace.

Objective: This systematic literature review aimed to identify and evaluate the Obstructive Sleep Apnea screening instruments that have been used on commercial vehicle drivers in the past 10 years.

Method: A review was conducted to analyze the latest research related to the use of instruments for screening Obstructive Sleep Apnea in commercial vehicle drivers. Publications from December 2009 through December 2019 were identified using EBSCO, Science Direct, ProQuest, SpringerLink, and SAGE Publications. The research included was published in English and concerns the use of Obstructive Sleep Apnea screening tools among commercial vehicle drivers (i.e., truck, taxi, commercial vehicle, and public transportation drivers). The screening employed various questionnaires, the measurement of biological parameters (body mass index [BMI], neck circumference, blood pressure, Mallampati score), and polysomnography. Each article was analyzed according to these criteria, and its relevance was assessed.

Result: The initial screening inclusion criteria produced 10 relevant studies. All the studies used instruments to screen Obstructive Sleep Apnea in commercial vehicle drivers, and they all indicate that using obstructive sleep apnea screening instruments is useful for identifying Obstructive Sleep Apnea cases in commercial vehicle drivers.

Conclusion: The Obstructive Sleep Apnea screening instruments provided information through the use of a questionnaire and the examination of biological parameters. The Berlin and STOP-Bang questionnaires have good sensitivity and specificity, making them suitable tools for Obstructive Sleep Apnea screening in commercial vehicle drivers.

Keywords: *OSA, sleep disorder, snoring, professional drivers, accident, screening tools.*

Introduction

Obstructive sleep apnea (OSA) is a commonly undiagnosed condition, there being an 80%–90% possibility that those who have it are unaware of their condition. Drivers with OSA who are not being treated are at greater risk of having a traffic accident related to sleep problems[(1)], and an estimated 7% of traffic accident injuries in the male driver population are linked to OSA[(2)].

OSA is a respiratory disorder in sleep caused by the relaxation of the pharyngeal muscles and characterized by a decrease or total stoppage of airflow despite continuing attempts to breathe. Most people with OSA

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snore loudly, and they repeatedly stop breathing when the airflow is reduced or blocked during sleep. Apnea is characterized by a reduction in airflow of up to 90% for at least 10 seconds (30% for hypopnea) followed by a decrease in blood oxygen level of up to 3%–4%[3]. OSA prevalence varies greatly around the world, ranging from 9% to 38%, and is higher in the male population[4].

The severity of OSA is determined by the total amount of apnea or hypopnea that occurs during sleep. The average hourly number of incidents that occur during sleep is called the Respiratory Disturbance Index or Apnea/Hypopnea Index (AHI). An AHI of fewer than five episodes/hour is considered normal while 5–15 episodes/hour is categorized as mild sleep apnea, 15–30 episodes/hour as moderate sleep apnea, and 30 or more episodes/hour as severe sleep apnea[5].

OSA has two main pathophysiological consequences: the disruption of sleep and the desaturation of oxygen. Sleep disruption can cause excessive sleepiness[6], which reduces quality of life[7] and increases the risk of traffic accidents[8].

The gold standard for OSA diagnosis is the polysomnographic examination (PSG), but its use is limited because it is costly and time consuming[9][10], so there is an urgent need for a reliable OSA screening tool to help doctors decide which patients should be referred to a sleep clinic. Self-reported questionnaires constitute a good first step in clinical research [11], and instruments that are practical and easy to use are also needed in the workplace.

This research reviews the OSA screening instruments that have been used on commercial vehicle drivers in the past 10 years.

Material and Method

The scope of this study included a review with a five-stage methodological framework consisting of (1) identifying research questions, (2) identifying relevant studies, (3) selecting studies, (4) graphing the data, and (5) compiling, summarizing, and reporting the research results[12]. In addition, the Preferred Reporting Items for Systematic Reviews and Meta-Analysis[13] was implemented although the protocol had not been previously registered. The review's research question was: Which method have been used to track the OSA of commercial vehicle drivers over the past 10 years?

The literature was searched through online databases, and articles were deemed suitable for consideration if they were written in English and provided relevant information on sleep apnea diagnostic procedures for commercial vehicle drivers. Bibliographies were searched manually to discover other research related to the topic.

Search Strategy: The search strategy employed a combination of relevant keywords: (obstructive sleep apnea OR sleep apnea) AND fatigue AND (driver OR drivers OR commercial drivers OR truck drivers OR taxi drivers) AND (accident OR accidents) AND (measurement OR method OR instrument).

An identified article was included in the study if it met the following criteria: (a) it was published in a public health academic journal and was freely available; (b) the study identified at least two to three of the following: sleep apnea, obstructive sleep apnea, driver, drivers, commercial drivers, accident, accidents; (c) the research was conducted anywhere in the world; (d) it used either quantitative or qualitative method. Only articles published in English from December 2009 through December 2019 were included.

To reduce the potential for observer bias, the title and abstract were identified by two authors (LS and LMK), and their relevance was reviewed. The full text of the potentially relevant article was then reviewed and analyzed separately based on the eligibility criteria and discussed with the third author (RM) for final approval to be included in the review. The information taken from the study included: (1) author, (2) title, (3) year of publication, (4) location/country, (5) language, (6) population, (7) instrument, (8) obstructive sleep apnea, (9) drivers, and (10) accidents.

Results

Study Search and Selection: When searching the literature, we identified 44 studies in the identification step. After duplicates were removed, 20 studies remained. Of these, 10 articles were excluded during the next analysis because they did not provide information on the topic of interest. Finally, 10 studies qualified with the inclusion criteria and were selected for extraction of the data (Fig. 1).

General Study Characteristics: The selected studies were conducted in both developed and developing countries: two in Italy[14,15], one in South

Korea[16], one in the US[17], one in China[18], one in Turkey[19], two in Iran[20][21], and two in Serbia[22,23]. The target populations included truck drivers[14,15], commercial vehicle drivers[17,19–23], taxi drivers[18],and public transport drivers[16].

Quality Assessment: All of the studies had good reporting quality, and they all addressed questions and problems that were clear and focused, with research method suitable for answering the research questions. Several studies did not determine statistical significance or confidence intervals in the outcomes of their tests.

Use of OSA Screening Instruments: Among the 10 studies on commercial vehicle drivers, all used a combination of instruments in the form of questionnaires and examinations of biological parameters to screen for OSA with the exception of a study that used only one instrument, the Berlin questionnaire [16]. One to four distinct instruments were used in each study. Two studies used two instruments [17,20], five studies used three instruments [14,15,19,21,23], and two studies used four instruments [18,22].

The Epworth Sleepiness Scale (ESS) was the most commonly employed instrument, with nine studies using it [14,15,17–22]. The ESS is a basic test used to assess daytime sleepiness. The ESS consists of eight-item questions with scores ranging from 0 to 24, and a scores of >10 suggests excessive sleepiness[23] and indicates that OSA is the significant cause of excessive daytime sleepiness [24].

The self-completed Berlin questionnaire, which was developed to identify OSA in practitioners in primary health care, was used in five studies [14,16,19,20,23]. It comprises three parts:one on snoring, the second on drowsiness and fatigue during the day, and the third addressing medical history, anthropometric measurements, hypertension, and BMI. If two or more categories are recognized as positive, patients are considered to be highly prone to OSA [25].

The STOP-Bang questionnaire, used in four studies[15,18,21,22], consists of eight questions (yes/no) on the clinical symptoms of sleep apnea and produces a total score of 0–8. This questionnaire (which stands for **s**noring, **t**iredness, **o**bserved apnea, high blood **p**ressure, **B**MI, **a**ge, **n**eck circumference, and male **g**ender) was specifically developed to meet the need for a screening tool that is reliable, concise, and easy to use[26].

The Pittsburgh Sleep Quality Index (PSQI), a self-completed questionnaire assessing sleep quality and sleep disturbances over a one-month interval, was used in two studies [15,21]. Nineteen individual items produce seven "component"scores for subjective sleep quality, sleep latency, sleep duration, sleep efficiency habits, sleep disturbance, use of sleeping pills, and daytime dysfunction [27].

PSG, the gold standard for diagnosing OSA, was used in two studies [22,23]. Nocturnal PSG is the standard procedure for making an objective diagnosis of OSA, but it is expensive, not easily accessible, and unsuitable for screening at work [28].

One study used the Mallampati scores [14], and two studies measured biology parameters (body mass index (BMI), neck circumference, and blood pressure) [17,22].

Discussion

The results of various studies indicate that drivers with symptoms of OSA are 2–12 times more likely to experience traffic accidents than drivers without such symptoms [29]. Individuals with OSA show intermittent hypoxia [30] that reduces frontoparietal activation and leads to a failure in top-down prefrontal control and attention [31]. This condition tends to inhibit executive functioning, alertness, ongoing attention, and cognitive performance [32].

This study found that the combination of self-completed questionnaire instruments with the examination of biological parameters produced results that could be used to predict OSA's risk of causing accidents and psychological distress. The study by [15], which used the STOP-Bang, ESS, and PSQI method, found that half of the participants (51.1%) had OSA and that 19.8% reported psychological distress.A study conducted by [14], using the Berlin questionnaire, the ESS, and Mallampati ratings, found that OSA in patients substantially predicted the outcomes of motor vehicle accidents and near collisions. The results of the Berlin questionnaire in research conducted by [20] showed a high risk of a rise in accident rates for people with OSA. In the study of [22], the STOP-Bang questionnaire (Serbian version) demonstrated an adequate specification validity and standard, which merit its continued use as a screening tool to diagnose OSA in commercial drivers. With the STOP-Bang achieving 100% sensitivity at AHI>15, having the highest specificity at 53.3% (AHI ≥5), it can be used as a reliable screening tool.

Sunwoo, et all used the Berlin questionnaire to determine the prevalence of OSA and found that, in high-risk groups,the prevalence of OSA in men was 19.8% while in women it was only 11.9% [16]. Olszewski and Wolf used the ESS, and its biological parameters identified 36% of commercial drivers as being at risk of OSA[17]. Zhang, et al combined the STOP-Bang, the ESS, the Driver Behavior Questionnaire, and the Driver Skill Inventory on taxi drivers [18]. The results showed that the driving ability of those at highrisk of OSA was worse than that of drivers at low risk because OSA causes memory lapses and affects risk perception. In their research using the Berlin questionnaire, the ESS, and the Psycho Technical Assessment System. Demirdogen, et al found that cognitive-psychomotor functioning could be impaired in persons with obesity and a high risk of OSA [19]. Popevic,et al used the Berlin questionnaire and found that 35% of the subjects potentially had OSA. This was confirmed using PSG, which diagnosed 58% of the subjects with OSA. The Berlin Questionnaire has a sensitivity from 50.9% (AHI ≥5) up to 75% (AHI ≥ 30) and a specificity of 70.5% to 86% [23].

The present research found that the STOP-Bang has a higher sensitivity (100%) than the Berlin questionnaire (50.9%–75%) while the specificity of the Berlin questionnaire was higher (70.5%–86%) than that of the STOP-Bang (whose highest was 53.5%). Questionnaires and the measurement of simple biological parameters have the potential to screen commercial vehicle drivers who are at high risk of suffering from OSA. This will increase the attention and alertness of occupational health physicians, occupational safety and health teams, and related parties in the workplace to the possibility of commercial vehicle drivers suffering from OSA. It is expected that identifying drivers of commercial vehicles suffering from OSA will reduce the risk of accidents.

Conclusion

This study provides information on a variety of self-completed questionnaire instruments and measurements of biological parameters that can be used to screen OSA in commercial vehicle drivers. The commonly used questionnaire is the ESS in combination with other questionnaires, namely the Berlin questionnaire, the STOP-Bang, and the PSQI. The measurement of biological parameters consists of the Mallampati score, BMI, neck circumference, and blood pressure. The Berlin and STOP-Bang questionnaires have good sensitivity and specificity, making them suitable tools for OSA screening in commercial vehicle drivers.

This research also shows that subjects with the potential of having OSA have a higher risk of having traffic accidents, near collisions, psychological distress, worse driving ability, memory lapses, reduced risk perception, and disturbed cognitive-psychomotor functioning.

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Conflicts of Interest: The authors declare that they have no conflicts of interest in this study.

Ethical Clearance: Submit to The Ethic Review Board of The Faculty of Public Health, University of Indonesia

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