*Original Research*

# Assessment of Elements of STOP-BANG Questionnaire in Screening Obstructive Sleep Apnea (OSA) in Iranian Commercial Drivers

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## Abstract

**Background and Objective:** Sleepiness is one of the important factors in motor vehicle accidents, especially in commercial drivers (CDs). Obstructive sleep apnea (OSA) has an important role in developing sleepiness. The STOP-BANG questionnaire is used in medical examinations of commercial drivers in Iran by law. This study aimed to investigate the judgment that drivers prefer not to report their symptoms honestly leading to underestimation of their STOP-BANG scores.

**Materials and Methods:** In a cross-sectional study, two groups of commercial drivers were compared; A: 52 drivers referred from Occupational Medicine Clinic to Baharloo Sleep Clinic, Tehran, Iran, because of detecting high scores in the STOP-BANG questionnaire with confirmed obstructive sleep apnea in the polysomnography, B: 87 volunteer commercial drivers referred to Baharloo Sleep Clinic because of sleep related complaints and obstructive sleep apnea was confirmed via polysomnography. The score of Epworth Sleepiness Scale (ESS) and the subjective items including snoring, tiredness, and observed apnea (STO) and objective items including blood pressure, body mass index (BMI), neck circumference, age, and gender (P-BANG) were compared between the groups and the correlations with Apnea/Hypopnea Index (AHI) were assessed.

**Results:** Statistical analysis showed that STO scores were different between the two groups ($P < 0.0001$). Mean STO score was 0.80 for Group A and 1.75 for Group B. The STO of group A showed a negative correlation with Apnea/Hypopnea Index (Correlation Coefficient = -0.1240). On the contrary, the STO score for group B was correlated with Apnea/Hypopnea Index (Correlation Coefficient = 0.4432).

**Conclusion:** Subjective items of STOP-BANG questionnaire in commercial drivers requesting health license require re-evaluation. New cut-off criterion or combination with more objective methods is recommended to be considered for screening of obstructive sleep apnea in commercial drivers.



**Keywords:** Commercial drivers; Motor vehicle accident; Obstructive sleep apnea (OSA); Polysomnography; STOP-BANG questionnaire

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## Introduction

Motor vehicle accidents (MVAs) are the eight cause of mortality globally, and the leading cause of death for young people aged 15-29 years (1, 2). Based on Iranian legal Medicine Organization report, 17,994 persons were died because of MVAs in the last Iranian calendar year. In the same period, 315,719 persons were also injured in this regard (3). Based on World Health Organization (WHO) 2015 "Global Status Report on Road Safety", Iran had the 8th place in estimated road traffic death rate per 100,000 of population among 180 countries (1).

There is a consensus among the Police De-

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partment of Iran that drowsy driving is one of the main reasons of fatal MVAs. This is the case more concerning commercial drivers (CDs), whose crashes have more fatalities (4, 5).

Obstructive sleep apnea (OSA) is the most important medical cause of excessive daytime sleepiness (EDS), which is an important public safety issue for any safety-sensitive task especially for CDs (6). OSA results are decreased quality of sleep, fragmentation of sleep, and therefore daytime sleepiness and decreased vigilance. In some observational studies, people with OSA had 2 to 11 fold increases in MVA in comparison with controls (7, 8). Because of correlation between OSA and MVAs, CDs should not have OSA (4).

Besides, some studies show that continuous positive airway pressure (CPAP) treatment results in decreased crash risk (9, 10) up to general population (11).

OSA is estimated the medical problem of up to 26% of general population in some reports (12) and according to an study in the North America, this number is 17-28% for drivers (6).

The standard test for diagnosis of OSA is an overnight polysomnography (PSG). Since this test is costly, time-consuming, and unavailable in many areas of Iran, the STOP-BANG questionnaire is used for screening CDs. this questionnaire consists of eight questions including presence of (1) Snoring, (2) Tiredness, 3) Observed stop breathing, (4) Blood pressure (known as stop) and 5) Body mass index (BMI), (6) Age, (7) Neck circumference, and (8) Gender (known as BANG) (12). The questionnaire is validated in Persian by Sadeghniiat-Haghighi et al. (13). People with high STOP-BANG scores are at increased risk of OSA (12).

In Iran, professional drivers have to be evaluated for their general health and they should hold an Occupational Health License. Because of the importance of drowsy diving and large number of crashes referred to it, OSA is also assessed for the Occupational Health License of CDs. The STO part is scored based on the driver's statements and the P-BANG part is measured by the physician or trained technician. If the driver gets high score of STOP-BANG, he/she will not obtain the health license and will be referred to sleep clinics for more evaluation.

This study is designed based on the assumption that, in the process of Occupational Health License of CDs, most of the drivers may not answer the subjective part of the questionnaire correctly. Because of additive tests they must do and the delay in obtaining their health license in case of high STOP-BANG score, they do not report their symptoms honestly. Therefore, their STOP-BANG scores will not reflect their real risk of OSA. The aim of current study was to investigate the judgment that drivers prefer not to report their symptoms honestly which leads to underestimation of their STOP-BANG scores.

## Materials and Methods

This was a cross-sectional and retrospective study based on the data collected from 2010-2014 in Baharloo Hospital, Tehran, Iran. The study was approved in the committee of ethics of the Department of Occupational Medicine, Tehran University of Medical Sciences.

Two groups of participants were investigated in this study both consisted of CDs. The first group consisted of CDs seeking for Occupational Health License referred to Sleep Clinic of Baharloo hospital for the diagnosis of OSA (Group A). The second group was CDs suffering from sleep disorders coming voluntarily to Sleep Clinic of Baharloo hospital (Group B).

The following individuals were excluded from the study: those treated for OSA previously, used sedative drugs, or had disabling underlying diseases (such as cardiovascular, cardiopulmonary, etc.)

For both groups, STOP-BANG questionnaire was used for screening OSA as an acceptable method. The reliability and validity of STOP-BANG questionnaire was investigated and approved by Sadeghniiat-Haghighi et al. in Iran (13). The drivers in both groups also had to fill the ESS (Epworth Sleepiness Scale) questionnaire. This questionnaire includes eight questions about the sleepiness in different situations. For both groups, an overnight PSG was performed after completing STOP-BANG questionnaire for diagnosis of OSA.

STOP-BANG questionnaire consists of eight questions. Four of them are subjective yes/no questions which are: 1) Do you snore loudly? 2) Do you often feel tired, fatigued, or sleepy during the daytime (such as falling asleep during driving? 3) Has anyone observed you stop breathing or choking/gasping during your sleep? 4) Do you have or are being treated for high blood pressure?

These questions, known also as STOP, rely upon the truthfulness of drivers. Thus, there is always risk of false declaration in cases that the responder's interest is against the right answer. Therefore, besides the self-declaration for high blood pressure by driver, it was measured in the Occupational Health Center, too. In this study, we considered

blood pressure as an objective variable.

In addition to blood pressure, the remaining four answers are objective too and were measured in the clinic: 5) Is body mass index (BMI), more than 35 kg/m$^2$? 6) Is age, more than 50 years? 7) Is neck circumference, more than 40 cm? and 8) Is gender, male?

The answer yes to each question, accounts for 1 score.

According to this questionnaire, a score from 0 to 8 was assigned to each driver. Those who obtained high STOP-BANG score were considered at increased risk of OSA (12). They were recommended to undergo an overnight PSG in Sleep Clinic.

PSGs were performed by the experienced technicians and the interpretation of all PSGs was performed by an experienced sleep physician based on the standards of the American Academy of Sleep Medicine (AASM) (14).

The driver had to stay one night in the Sleep Clinic for performing the PSG. Different sensors and electrodes were connected to the driver to assess the electroencephalography (EEG), tone of chin muscle, eye movements, heart rate, chest muscle tone, leg movements, respiratory air flow and snoring. Oxygen saturation ($SaO_2$) was also measured via pulse oximetery.

For diagnosis of OSA by PSG, the Apnea/Hypopnea Index (AHI) was used. The AHI index is the number of apnea and hypopnea events per hour of sleep. The apneas (pauses in breathing) must last for at least 10 seconds and are associated with a decrease in blood oxygenation. The driver was considered to have no OSA, if the AHI was less than 5. If $5 \leq AHI < 15$, the driver was considered to have mild OSA. The drivers with $15 \leq AHI < 30$ were considered as having moderate OSA and if the $AHI \geq 30$, the driver was considered to have severe OSA (15).

Finally, the data collected from the STOP-BANG questionnaire and PSG were analyzed using SDATA software. T-test was used for comparison of data between the two groups and Pearson's correlation coefficient was used for identifying correlation between similar elements of groups A and B.

## Results

After preliminary refinements, 52 of 162 drivers were included in group A and 87 drivers among 1326 persons evaluated in the Sleep Lab were included in group B (Figure 1). Mean age of group A and B were 52.57 and 48.42 years, respectively (P = 0.004). All the drivers were male. Figure 1 shows the flowchart of how study participants were enrolled.

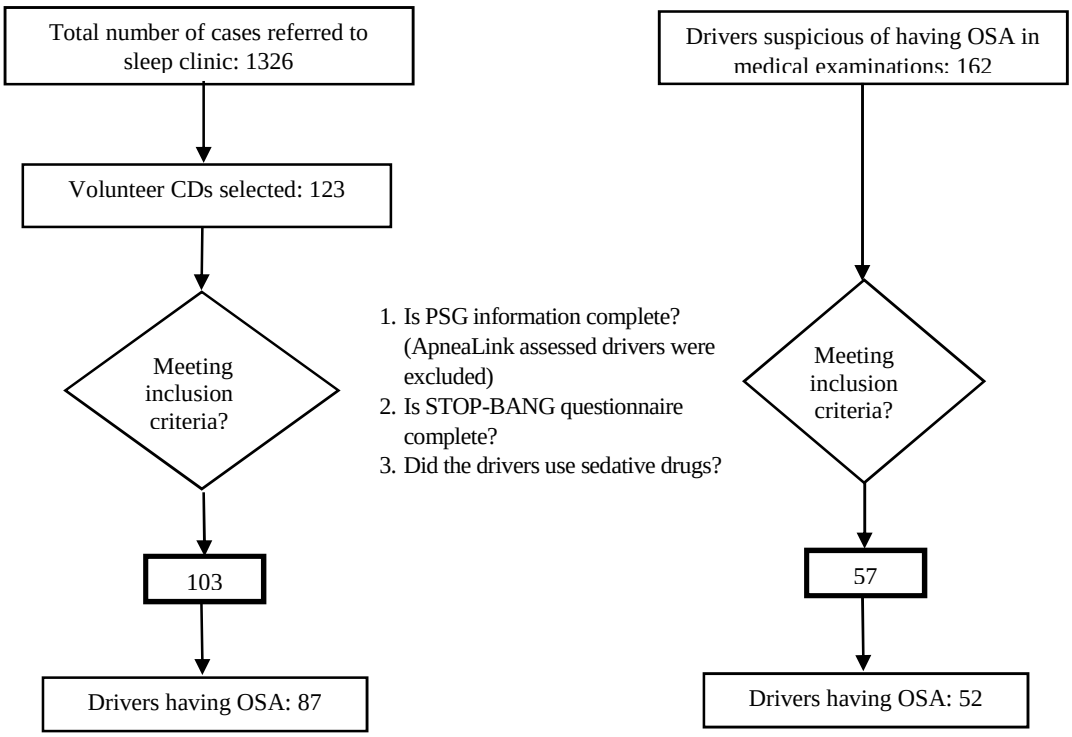


**Figure 1.** Screening flowchart
OSA: Obstructive sleep apnea; CDs: Commercial drivers; PSG: Polysomnography

**Table 1.** Mean STOP-BANG Score

| | STO (Mean) | P-BANG (Mean) | STOP (Mean) | BANG (Mean) | STOP-BANG (Mean) | ESS (Mean) |
|---|---|---|---|---|---|---|
| Group A | 0.80 | 3.46 | 1.21 | 3.06 | 4.36 | 5.54 |
| Group B | 1.75 | 3.37 | 2.17 | 2.84 | 4.76 | 8.36 |
| Difference | 0.95 | 0.09 | 0.96 | 0.22 | 0.4 | 3.14 |
| (95% confidence interval) | (0.73-1.15) | (0.01-0.17) | (0.85-1.07) | (0.16-0.30) | (0.31-0.49) | (3.01-3.30) |
| P value | < 0.0001 | 0.5628 | < 0.0001 | 0.0878 | 0.0025 | 0.0190 |

Group A: Drivers seeking for Occupational Health License referred to Sleep Clinic for the diagnosis of OSA; Group B: Drivers suffering from sleep disorders coming voluntarily to Sleep Clinic; STO: Snoring, Tiredness, Observed apnea; P-BANG: Blood Pressure, Body Mass Index, Neck circumference, Gender; ESS: Epworth Sleepiness Scale

90% of CDs in group A, and 85% of CDs in group B screened by STOP-BANG questionnaire had OSA. The mean scores of STOP, STOP-BANG, BANG as well as STO are presented in table 1.

The mean score of STOP in group A was significantly less than group B. The mean score of BANG in group A was higher, but this difference was not statistically significant. STOP-BANG in group A was significantly less than group B.

For the sake of comparison between subjective parameters of STOP-BANG questionnaire, the mean STO scores were compared. The mean STO score of group A drivers was significantly lower than group B drivers.

On the other hand, the objective part of the questionnaire, i.e. P-BANG, did not show any significant difference between the two groups.

Current findings showed that there was no correlation between STOP score and AHI in group A (correlation coefficient =-0.1240). On the contrary, STOP score and AHI in group B were correlated (correlation coefficient is 0.4442).

The comparison between STOP parameters separately showed that each subjective parameter such as snoring, tiredness and observed apnea had significant difference between two groups, but the blood pressure evaluated objectively in this study, was not different between groups A and B.

Comparison between ESS scores in two groups showed that ESS was significantly lower in group A.

Table 2 shows the difference between AHI in the population of CDs who answered the subjective parameters (snoring, tiredness, observed apnea) as “Yes” and the population of drivers who answered these subjective parameters (STO) as “No” and compares these items between two groups of CDs.

For the snoring and tiredness in group A, drivers who answered No had higher AHI surprisingly, but in the group B in every three items, drivers who answered Yes to these subjective parameters (STO) had significantly higher AHI.

## Discussion

STOP-BANG questionnaire is a useful tool for screening OSA in the general population. Its parameters are separately used in different combinations for screening OSA in different countries (5, 15-20). OSA is a known risk factor for automobile crashes and in many countries like USA, UK, and Australia, there are laws for preventing CDs with untreated OSA from driving (5, 21, 22).

**Table 2.** STO Parameters

| | Group | Absolute Frequency of Negative Responders (Mean AHI) | Absolute Frequency of Positive Responders (Mean AHI) | P value |
|---|---|---|---|---|
| Snoring | A | 35 (22.72) | 17 (19.35) | 0.5025 |
| | B | 32 (23.41) | 50 (39.28) | 0.0132 |
| Tiredness | A | 33 (23.58 | 19 (18.23) | 0.2714 |
| | B | 33 (21.80) | 49 (40.70) | 0.0020 |
| Observed Apnea | A | 46 (21.61) | 6 (21.66) | 0.9944 |
| | B | 47 (22.76) | 35 (46.96) | 0.0001 |

Group A: Drivers seeking for Occupational Health License referred to Sleep Clinic for the diagnosis of OSA; Group B: Drivers suffering from sleep disorders coming voluntarily to Sleep Clinic; STO: Snoring, Tiredness, Observed apnea; AHI: Apnea Hypopnea Index

However, there is not an international consensus about the evaluating parameters for screening OSA in commercial drivers. It can be concluded roughly that in the process of health licensing of CDs, most factors mentioned in recent studies are considered (5, 6, 23).

Although most of the drivers in the group A declared that they are symptom-free, 90% of this population had OSA while in the volunteer drivers (group B), 85% had OSA. This shows the possibility of hiding symptoms in drivers of group A. We judge this, through the number of subjective parameters they announced. Besides, as shown in Table 2, the drivers in group A, who reported negative history in the items of snoring during night and tiredness through the day, had higher AHIs in comparison with the rest of drivers in the same group who reported these symptoms. But in the group with volunteer drivers, participants with positive answer to these items and the item of observed apnea had significantly higher AHIs. The subjective parameters, like snoring, tiredness, and observed apnea were significantly lower in the CDs who are seeking health license. Moreover, the correlation between these items and AHI was negative. These results consistent with other studies (6, 24-26) show that CDs who are seeking health license because of many reasons such as delay in obtaining health license process and other reasons which are out of this article scope, are not willing to report their symptoms. Therefore, it seems that using STOP-BANG questionnaire in CDs' examination underestimates the STOP-BANG score; so, many of OSA cases will be missed. For objective parameters (blood pressure, BMI, neck circumference, age, and gender), it seems that a better correlation between this score and AHI exists. Therefore, using objective parameters like blood pressure, BMI, age, gender, (P-BANG factors) may be a more precise method to predict probability of having OSA in a CD (who wants to obtain health license) in order to prevent underestimation of real risk of OSA (6, 27).

One of the strengths of this study was performing all the operations in one center, which eliminates the errors causing by use of different kinds of equipment and different interpretations. So, there is a good consistency for all of the items of STOP-BANG questionnaire between different drivers. Besides, this was the case for PSG and its interpretation.

Using two groups of CDs (one as volunteers and the other obliged for routine commercial drivers checkups) is the unique design of this study which shows the role of self-motivation on the honesty.

The main limitation of this study was that we compared the questionnaire items with the results obtained from the PSG, and the comparison with functional outcome and real function of the drivers during driving was not performed.

## Conclusion

Using subjective items of STOP-BANG questionnaire in CDs requesting Health License require re-evaluation, new cut-off criterion or combination with more objective methods is recommended to screen OSA.

## Conflict of Interests

Authors have no conflict of interests.

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