

## High-risk of obstructive sleep apnea and excessive daytime sleepiness among commercial intra-city drivers in Lagos metropolis

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### Abstract

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#### Background:

The burden of obstructive sleep apnea among commercial drivers in Nigeria is not known.

#### Aim:

To assess the prevalence of high risk of obstructive sleep apnea (OSA) and excessive daytime sleepiness (EDS) among intra-city commercial drivers.

#### Setting and Design:

A descriptive cross-sectional study in three major motor parks in Lagos metropolis.

#### Materials and Methods:

Demographic, anthropometric and historical data was obtained. The risk of OSA and EDS was assessed using the STOP BANG questionnaire and the Epworth Sleepiness Scale, respectively.

#### Statistical Analysis:

The relationship between the OSA risk, EDS risk and past road traffic accident (RTA) was explored using the Pearson's chi square. Independent determinants of OSA risk, EDS risk and past RTA, respectively, were assessed by multiple logistic regression models.

#### Result:

Five hundred male commercial drivers (mean age (years)  $\pm$ SD =  $42.36 \pm 11.17$  and mean BMI ( $\text{kg}/\text{m}^2$ )  $\pm$ SD =  $25.68 \pm 3.79$ ) were recruited. OSA risk was high in 244 (48.8%) drivers and 72 (14.4%) had EDS. There was a positive relationship between OSA risk and the risk of EDS (Pearson's  $X^2 = 28.2$ ,  $P < 0.001$ ).

Sixty-one (12.2%) drivers had a past history of RTA but there was no significant relationship between a past RTA and either OSA risk ( $X^2 = 2.05, P = 0.15$ ) or EDS risk ( $X^2 = 2.7, P = 0.1$ ), respectively. Abdominal adiposity, regular alcohol use and EDS were independent determinants of OSA risk while the use of cannabis and OSA risk were independent determinants of EDS. No independent risk factor for past RTA was identified.

### **Conclusion:**

A significant proportion of commercial drivers in Lagos metropolis are at high risk of OSA and EDS.

**Keywords:** Commercial drivers, excessive day time sleepiness, Lagos, obstructive sleep apnea

## **INTRODUCTION**

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Obstructive sleep apnea (OSA) is a form of sleep disordered breathing characterized by recurring episodes of partial or complete airway obstruction during sleep resulting in repeated arousals and lack of restful sleep.<sup>1</sup> The adverse consequences of OSA include excessive daytime sleepiness (EDS), fatigue and impaired cognitive functioning which could increase the risk of road traffic accidents (RTA) as well as other accidents. In addition, there is increased cardiovascular risk and poor quality of life.<sup>2,3,4</sup>

The cognitive effects of OSA are particularly important in persons engaged in daytime activities that require intense concentration, simultaneous visuo-spatial computations, prompt reaction time and decision making, especially in the face of threats. Controlled experiments have demonstrated that sleep loss results in episodic lapses comprising of brief unresponsiveness with extreme drowsiness and electroencephalographic slowing, which are worsened with increased duration of sleep loss, and are strongly affected by stimulus monotony, as may be experienced during driving.<sup>5</sup>

Approximately 20% of driving accidents are attributable to inadequate sleep such as occurs in persons with OSA.<sup>6</sup> In Nigeria, it is estimated that over 90% of RTA are due to driver error.<sup>7</sup> Multiple factors contributing to the risk of RTA among long distance truck drivers in Nigeria include daytime sleepiness, fatigue and stimulant use.<sup>8</sup> Studies have shown that commercial bus drivers with undiagnosed and untreated OSA are at increased risk of RTAs.<sup>9,10,11,12,13</sup> Intra-city commercial drivers with OSA are also vulnerable because of the long driving hours and economic pressure to achieve financial commitment and targets. The burden of OSA in commercial drivers in Lagos, Nigeria, has not been evaluated, but such data are undoubtedly important as a baseline to guide counselling, driver certification and education, and ultimately improve road safety.

Polysomnography is the gold standard for diagnosing OSA, but its wide applicability is hampered by limited access and cost.<sup>13</sup> Thus, OSA risk assessment typically comprises the use of validated screening instruments that evaluate multiple parameters to obtain a score that reflects the magnitude of risk of OSA.<sup>14,15,16</sup> This can then guide selection of high-risk individuals for further evaluation and treatment.

The objectives of the study were to assess the prevalence of high risk of OSA and EDS among commercial drivers as well as to determine the relationship of high risk of OSA to the past history of RTA and use of psychoactive substances.

## **MATERIALS AND METHODS**

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This is a descriptive cross-sectional study, for which prior ethical approval was obtained from the Lagos University Teaching Hospital Health Research Ethics Committee (ADM/DCST/HREC/310). The study was conducted at the three major commercial motor parks in Lagos Mainland, situated at Ojuelegba, Idi Araba and Lawanson. These parks were selected based on information obtained from local government authorities and the National Union of Road Transport Workers (NURTW) as being among the top ranking

parks in Mushin (8 parks) and Surulere (12 parks) zones in terms of membership of registered operators of commercial vehicles. A total of 610 commercial drivers were registered under the NURTW (mandatory membership required of all commercial drivers) at the three parks at the time of the study between September and December 2011. Verbal permission was obtained from the NURTW executive at each park, while individual written consent was obtained from each participating driver.

Data was collected from consecutively consenting drivers during the weekly NURTW meetings held at the park. Based on an initial pilot to test the study instrument, in which 8 out of 10 consented to participate, we estimated a total sample of 488 (80% of 610) with the intention to round this up to a final sample size of 500.

The study instrument was a questionnaire containing demographic information, anthropometric data, historical, social, occupational and medical data, the STOP-BANG questionnaire for assessment of OSA risk, and the Epworth Sleepiness Scale for assessing daytime sleepiness. The questionnaire was administered by trained interviewers.

Specific demographic information obtained were age and gender. Medical history of physician diagnosed diabetes mellitus, bronchial asthma or any lung disease was obtained. Self-declared smoking status, psychoactive substance (in local parlance), kolanut (caffeine containing nuts), caffeine and alcohol use were also obtained. Information related to driving occupation included duration and past history of RTA on the job.

The anthropometric measurements were obtained using standard procedures, and included weight (kilograms), height (metres), waist circumference (centimetres), and neck circumference (centimetres).<sup>17</sup> Abdominal adiposity was defined as waist circumference >88 cm in females and >102 centimetres in males.<sup>18</sup> Body mass index ( $\text{kg}/\text{m}^2$ ) was calculated using Quetlet's index and translated as underweight (<18.5), normal (18.5-24.9) overweight (25-29.9) or obese class 1 (30-34.9), obese class 2 (35-39.9) and extremely obese ( $\geq 40$ ).<sup>19,20</sup> Blood pressure (mmHg) was measured using an Omron<sup>®</sup> electronic sphygmomanometer and a reading of  $\geq 140/90$  considered as hypertension.<sup>21,22</sup> The presence any of the following - diabetes mellitus, hypertension, current cigarette smoking, obesity and central adiposity, were documented, with patient's having any of these categorized as high cardiovascular risk.<sup>23</sup>

Current cigarette smoking was defined as smoking at least one puff of cigarette in the preceding 30 days. Current cannabis smoking was defined as smoking at least one puff of cannabis in the preceding 30 days. Regular alcohol use was defined as taking an alcoholic beverage at least once every 7 days. Alcohol use was quantified in terms of bottles of alcoholic beverage (beers typical volume 600 mls per bottle, alcohol contents approximately 5 - 6 g per 100 mls) taken per week and those who took more than 14 bottles per week were categorised as heavy drinkers.

The risk of OSA was measured using the STOP-BANG questionnaire.<sup>14</sup> The STOP-BANG questionnaire is a simple validated 8 item instrument that asks about symptoms of Snoring, Tiredness, Observed apnea and a history of high blood Pressure.<sup>14,24</sup> It includes a section to document the body mass index, age, neck circumference in centimeters, and gender. A systematic review of the various screening tools for OSA recommends the use of the STOP-BANG questionnaire due to its higher methodological quality and easy to use features.<sup>25</sup> A total score of 3 and above is considered a high risk of OSA.<sup>14</sup>

The risk of excessive daytime sleepiness (EDS) was assessed using the Epworth Sleepiness Scale<sup>®</sup> ((ESS)<sup>®</sup> MW Johns 1990-1997 used with permission). This is a validated 8-item questionnaire that measures the ease of falling asleep in the daytime under various circumstances as a measure of daytime hypersomnolence.<sup>26</sup> In the setting of OSA, the ESS has been shown to distinguish between patients with

primary snoring (without airway obstruction) and OSA.<sup>27</sup> The interpretation is as follows: 0 - 5: Good (likely getting restful sleep quality); 6 - 9: (sleep could be improved but may not be to sleep apnea); 10 and above: Bad (likely to have excessive sleepiness (suggestive of a sleep disorder possibly OSA)).<sup>26</sup>

Data obtained was analyzed using the Statistical Software for Social Sciences (SPSS) version 20. Continuous variables with normal distribution (age, blood pressures, BMI, waist circumference, STOP-BANG and ESS scores) are expressed as means and standard deviation and compared using the Pearson's correlation. Group differences in discrete variables (e.g., BMI category, OSA risk category, ESS category (presented as frequencies)), are compared with the Pearson  $\chi^2$  test. Independent predictors of OSA risk were assessed in multivariate logistic regression analysis.

## RESULTS

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Five-hundred commercial drivers (all men) participated in the study. [Table 1](#) shows baseline characteristics of the commercial drivers. The age range was 20-73 years. Two hundred and thirteen (42.6%) were aged 15-39 years, 285 (57%) were 40-65 years and 2 (0.4%) >65 years. Median duration of working as a commercial driver was 10 years (interquartile range 4-18); 272 (54.5%) had driven for 1-10 years, 155 (31%) for 11-20 years and 73 (14.6%) for >20 years. Based on the BMI, 4 (0.8%) of the drivers were underweight, 248 (49.6%) normal, 173 (34.6%) overweight, 61 (12.2%) obese (class 1), and 14 (2.8%) obese (class 2). There were 52 (10.8%) drivers with abdominal adiposity, 211 (42.2%) with hypertension and 3 (0.6%) with diabetes. A total of 341 (68.2%) drivers had at least one risk factor for adverse cardiovascular events. None of the participants had a prior diagnosis of asthma or COPD.

### Use of psychoactive substances among commercial drivers

One-hundred and sixty (32%) were current cigarette smokers, 108 (21.6%) smoked cannabis regularly and 72 (14.4%) smoked cannabis daily. There were 362 (72.4%) who took alcohol regularly and 79 (15.8%) were heavy alcohol drinkers. Fourteen (2.8%) ate kolanuts daily and 5 (1%) took sedatives at least once weekly. No driver reported the use of cocaine, heroin, amphetamines or other psychoactive substances.

### Risk of OSA in commercial drivers

Two-hundred and forty-four (48.8%) of the drivers had a high risk of OSA based on a total STOP-BANG score of  $\geq 3$ . On the individual domains, regarding symptoms (STOP), 202 (40.4%) snored loudly, 176 (35.2%) felt tired or sleepy during the day and 211 (42.4%) had hypertension. One-hundred and forty-five (29%) had a combination of two of these symptoms present and 26 (5.2%) has a combination of three symptoms present. With regards to the domains on demography and anthropometry (BANG), 10 (2%) had BMI greater than 35, 147 (29.4%) were aged  $\geq 50$  years, and 63 (12.6%) had neck circumference greater than 40 cm (all were male). No driver admitted to having been observed to have stopped breathing during sleep.

### Risk of excessive daytime sleepiness and relationship to the OSA risk

Based on the ESS score, 351 (70.2%) of the drivers were getting restful sleep (ESS score 0-5), 77, (15.4%) could have their sleep improved (ESS score 6-9) and 72 (14.4%) had EDS, possibly due to OSA (ESS score  $\geq 10$ ). In correlation analysis, OSA score correlated positively and significantly with the ESS score (Pearson's correlation 0.29,  $P < 0.001$ ). In intra-group comparison based on risk category, 56 (23%) of those at high risk of OSA also had excessive day time sleepiness compared to 16 (6.2%) of those with low risk of OSA (Pearson's  $\chi^2 = 28.2$ ,  $P < 0.001$ ). [Figure 1](#) shows a comparison of measures of central tendency of the ESS scores across the STOP-BANG risk category.

## Determinants of high risk of OSA and excessive daytime sleepiness

Multiple logistic regression analysis was done to identify the independent determinants of OSA risk [Table 2]. After univariate regression, abdominal adiposity, alcohol intake, use of kolanut and risk of excessive day time sleepiness were included in the model. Potential determinants represented in the STOP-BANG questionnaire (snoring, tired or sleepy during the day, hypertension, obesity, age, neck circumference and male gender) were excluded from the model. Abdominal adiposity ( $P < 0.001$ ) use of alcohol ( $P = 0.004$ ) and excessive daytime sleepiness ( $P < 0.001$ ) were significant associated with OSA risk and are thus independent determinants of OSA.

To assess the independent determinants of excessive daytime sleepiness, a multiple logistic regression analysis was also conducted [Table 3]. The model included, current smoking, current cannabis use, and the OSA risk after univariate analysis. The independent determinants of excessive day time sleepiness were the OSA risk ( $P < 0.001$ ) and the use of cannabis ( $P = 0.02$ ).

## Factors associated with past-RTA

Sixty-one (12.2%) of the drivers admitted to a past history of at least one RTA. Twenty-one (34.4%) of them believed that excess alcohol intake contributed to the accident and none reported that feeling sleepy contributed to the accident. There was no difference in the prevalence of high risk of OSA in drivers with and without a past history of RTA ( $X^2 = 2.1, P = 0.2$ ). Similarly there was no statistical difference in the risk of EDS ( $ESS \geq 10$ ) in those with past history of RTA compared to those without ( $X^2 = 2.7, P = 0.1$ ). The BMI category (obese or not obese) was also not associated with a past history of RTA ( $X^2 = 1.7, P = 0.4$ ).

Use of kolanuts was a statistically significant determinant of past RTA on univariate analysis ( $P = 0.07$ ) but when imputed in a multiple logistic regression model with other potential risk factors (ESS risk, STOP-BANG risk) [Table 4], none was independently associated with risk of RTA in the past.

## DISCUSSION

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The potential impact of OSA on the performance of commercial drivers in relation to driving safety is of major public health importance. According to reports from the Federal Road Safety Commission in Nigeria, Nigeria ranks second to Eritrea in RTA rates in sub-Saharan Africa.<sup>28</sup> Current medical requirements for commercial drivers' certification in Nigeria include tests of vision and general medical examination, blood pressure, and history of epilepsy. However the risk of excessive daytime sleepiness or OSA is not addressed.<sup>29</sup> The Federal Highway Administration in the United States of America has published standards for medical examination of commercial drivers regarding OSA.<sup>30</sup>

In this study, approximately half of the drivers were found to have a high risk of OSA, and this in turn was associated with excessive daytime sleepiness in about one-quarter. The prevalence of OSA in our study affirms the figures reported from other populations. In a study conducted in Australia by Howard *et al.*, about 50% of over 3000 drivers assessed using a questionnaire had a high risk of OSA, while 45% of drivers in a Malaysian study had OSA based on an apnea/hypopnea index (AHI) greater than 5 on polysomnography.<sup>9,31</sup> The AHI index is the number of episodes of apnea or hypopnea occurring per hour of sleep during a polysomnography test. Apnea is the complete cessation of airflow or greater than 50% reduction in airflow lasting at least 10 seconds, while hypopnea is <50% reduction in airflow lasting longer than 10 seconds that is accompanied by  $\geq 4\%$  oxygen desaturation or by arousal from sleep. The prevalence of excessive daytime sleepiness in our study overall (14%) was also similar to that in Edinburgh where 20% of the drivers had excessive daytime sleepiness using the ESS.<sup>12</sup>

The occupational hazards attributable to OSA and EDS in commercial drivers are particularly significant because the risk extends, not just to the individuals themselves, but also to third parties including passengers and other road users. Pack *et al.* demonstrated that commercial drivers with OSA had marked sleepiness and impaired driving performance.<sup>10</sup> Simulated driving experiments have also demonstrated impaired steering ability in those with OSA compared to controls, with patients with OSA wandering more often from the road and having delayed response to distractions.<sup>32,33</sup> Two meta-analyses have clearly shown that there is an increased risk of RTA among patients with OSA and this risk is actually more profound in those patients with very severe OSA (AHI  $\geq 30$ ).<sup>34,35</sup> Although we did not demonstrate any direct relationship between OSA and ESS risk with past history of RTA, the potential impact of these conditions on the high rate of RTAs in our population may have been masked by the use of self-reported RTA (which is retrospective, subject to bias, under-reported and not verifiable in the absence of official records). Drivers can deliberately under-report the symptoms of excessive daytime sleepiness or sleepiness while driving to appear competent and many episodes of micro sleep may go unnoticed when they occur.<sup>36</sup> Additionally, intra-city drivers often drive shorter distances per trip compared to long distance drivers and may have the opportunity to catch short naps while waiting for passengers in the parks. Micro-sleep tends to occur on long stretches of road without traffic where the driving is monotonous in contrast to intra-city driving. The effects of OSA goes beyond increasing the risk of RTA, as the impaired neuro-cognitive functioning due to OSA also results in reduced productivity, mood disorders including depression, irritability, poor libido and overall negative impact on the quality of life.<sup>2,3</sup> There is a strong association of OSA in the etiology and adverse outcomes in several cardiovascular conditions such as hypertension, stroke, coronary artery disease, diabetes mellitus and cardiac arrhythmias.<sup>4,37,38</sup>

In evaluating risk factors for OSA in this study, the independent determinants considered included snoring, daytime sleepiness, witnessed apnea during sleep, hypertension, obesity (class 2), age, neck circumference and male gender. Documented risk factors for OSA include snoring, increasing age, male gender, obesity (both central and nuchal), altered craniofacial anatomy, decreased posterior airspace from various causes and cigarette smoking.<sup>39,40,41</sup> Use of alcohol and sedatives worsens symptoms in those with OSA.<sup>39</sup> The STOP-BANG questionnaire used in our study incorporates class 2 obesity (BMI 35-39.9) in the risk assessment; however, we demonstrated that abdominal adiposity independent of BMI was also a significant determinant of OSA risk. The high rate of psychoactive substances use among commercial drivers in this study and the demonstrated interaction with OSA risk and EDS has the potential of further impairing driving safety. This makes it imperative for the regulatory authorities to make education and enforcement of laws relating to abstinence from alcohol and cannabis during work hours a priority in improving road safety.

The implications of the finding in our study are that a significant proportion of commercial drivers in the Lagos metropolis are at increased risk of adverse cardiovascular outcome due to the high OSA risk and use of psychoactive substances and are also potentially at increased risk of RTA. This thus serves as the rationale for recommending that commercial drivers in Nigeria should be screened for OSA using validated questionnaires as part of medical assessment for initial issue and subsequent renewal of commercial vehicle licences. Further formal assessment using polysomnography can then be offered to those at high risk to make a definite diagnosis of OSA. Those confirmed to have OSA should be treated appropriately using several modalities including weight loss (improves overall cardiovascular outcome), oral appliances (that keep the airway open during sleep) and continuous positive airway pressure (CPAP). The role of CPAP treatment in improving driving skills and reducing RTA in compliant patients has been clearly demonstrated.<sup>42,43,44</sup>

## Footnotes

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**Source of Support:** Nil

**Conflict of Interest:** None declared.

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## Figures and Tables

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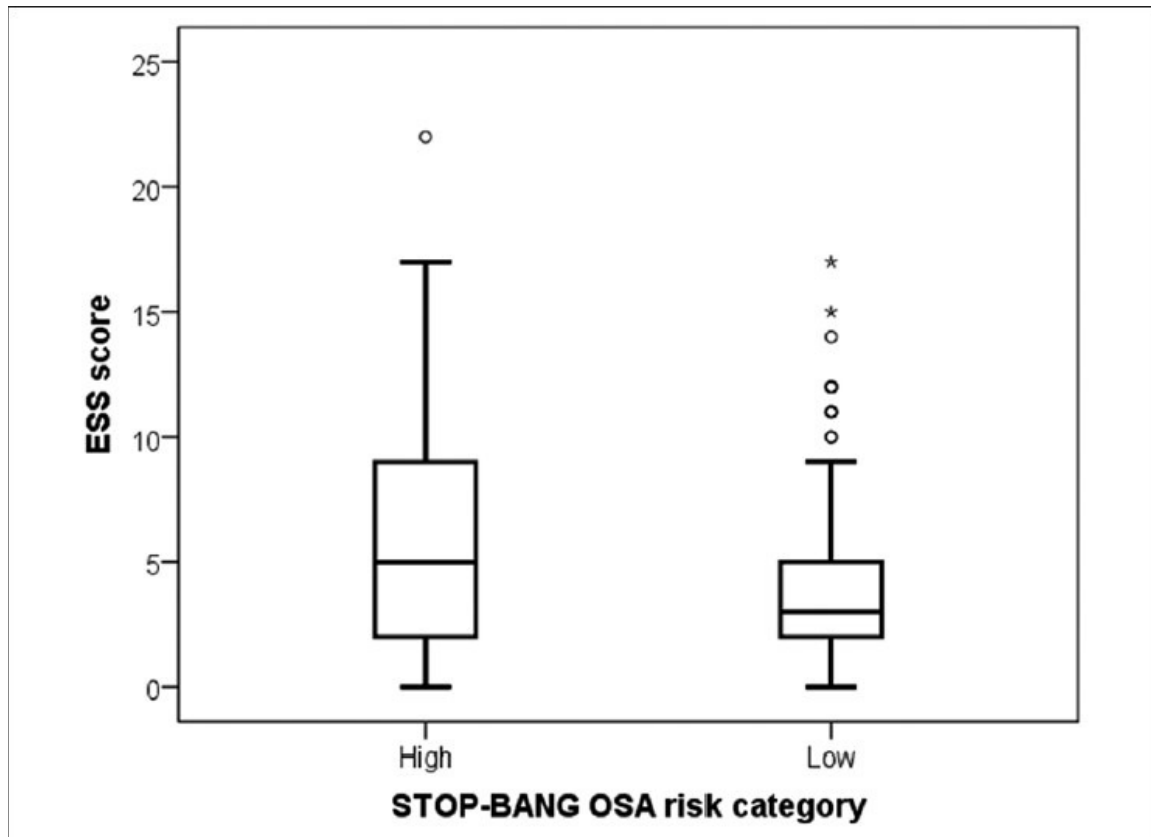
**Table 1**

Baseline characteristics of study participants

Characteristic	Description
Mean age (years)±SD	42.36±11.17
Mean BMI (kg/m <sup>2</sup> )±SD	25.68±3.79
Waist circumference (cm)	85.43±10.78
Mean systolic blood pressure (mm/hg)	133.1±19.7
Mean diastolic blood pressure (mm/hg)	84.7±11.8
Mean STOP-BANG score±SD	2.6±1.2
Median STOP-BANG score	2.0 (IQR=2-3)
Mean ESS score±SD	4.8±3.9
Median ESS score	4.0 (IQR=2-8)

SD – Standard deviation; ESS – Epworth sleepiness scale; IQR – Interquartile range; BMI – Body mass index

**Figure 1**



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Comparison of measures of central tendency of the ESS scores across the STOP BANG risk category. The median ESS score is higher for those with high risk of OSA than for those with low risk of OSA. There is greater variation in the ESS score in those at high risk of OSA but most are within the 95% confidence interval with very few outliers

**Table 2**

Multiple logistic regression analysis for the determinants of OSA risk

Variable	Odds ratio	Standard error	P value
Abdominal adiposity	0.71	0.37	<0.001
Use of alcohol	0.62	0.22	0.004
Use of kolanut	1.01	0.62	0.1
ESS risk	-1.48	0.31	<0.001

OSA – Obstructive sleep apnea; ESS – Epworth sleepiness scale

**Table 3**

Multiple logistic regression analysis for the determinants of risk of excessive day time sleepiness

Variable	Odds ratio	Standard error	P value
Current cigarette smoking	0.34	0.34	0.31
Current cannabis use	0.83	0.36	0.02
STOP BANG risk	-1.56	0.31	<0.001

**Table 4**

Multiple logistic regression analysis for determinants of history of past road traffic accident

Variable	Odds ratio	Standard error	P value
Use of kolanuts	-1.01	0.62	0.1
ESS risk	0.83	0.36	0.21
STOP BANG risk	-1.56	0.31	0.34