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## *Research Article*

# Obstructive Sleep Apnea and Associated Risk Factors among Managerial and Senior Executive Level Workers in the Western Province of Sri Lanka

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**Abstract**

Introduction: Obstructive sleep apnea (OSA) is a highly prevalent, yet underdiagnosed potentially serious sleep disorder identified worldwide. The present study aimed to assess the risk factors associated with OSA among the managerial and senior executive level workers, who work in demanding work environments. Methods: A web based, cross-sectional study was conducted using data of 390 study participants, comprising managers, senior officials, and legislators selected through cluster sampling in the Western Province, Sri Lanka. Berlin Questionnaire (BQ) was used to assess the OSA risk and demographic and associated factors of participants were surveyed in another section of the semi-structured questionnaire. Associations between risk factors and OSA were evaluated using logistic regression analysis by SPSS 26.0. $P<0.05$ was considered significant. Results: BQ identified 20.8% of participants as being at high-risk of OSA, whereas 79.2% were classified under low-risk. Males were more likely than females to develop high-risk OSA (26.6%vs11.3%, P=0.001), and those in the high-risk category were predominantly middle-aged (41-60 years) men (48.1%). Further, BMI (p=0.001), neck circumference (p=0.044) and alcoholism (p=0.009) had a positive correlation with high-risk OSA which was statistically significant. However, there was no significant association between smoking status and high-risk OSA (p=0.155). There was a significant relationship between the comorbidities, diabetes (p=0.007), stroke (p=0.006), hypertension (p=0.001) and OSA risk except for heart disease (p=0.412). Conclusion: Among category one occupants in the Western Province of Sri Lanka, 20.8% were at high-risk for OSA. Male gender, middle age, obesity, increased neck circumference, alcohol use, and comorbidities like diabetes, stroke, and hypertension were significantly associated with OSA.

**Keywords:** Sleep Disorders, Obstructive Sleep Apnea, Risk factors, Berlin Questionnaire

## Introduction

Obstructive sleep apnea (OSA), defined as repetitive collapse of the upper respiratory tract during sleep, leading to oxygen desaturation and frequent arousals from sleep, is the most common sleep-related breathing disorder. The cardinal features of OSA include repetitive episodes of upper airway obstruction, loud snoring, progressive tiredness, excessive day-time sleepiness and restless sleep [1]. The symptoms are caused by the frequency and severity of breathing obstructions. The severity of OSA is measured through Apnea Hypopnea Index (AHI) which is given by the number of breathing obstructions per hour [2]. OSA is dependent upon a combination of risk factors including obesity,

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age, male sex, obese neck circumference, excess alcohol intake, and smoking. It is also associated with comorbidities such as diabetes, hypertension, and cardiovascular diseases. Moreover, evidence suggests that OSA plays a crucial role in occupational accidents and also has a negative impact on work processes, work performance, and business in the workplace [2, 3]. The proportion of individuals having OSA has been increasing rapidly ever since the disorder was initially reported fifty years back. The worldwide obesity epidemic and the ageing population are the likely factors that could have contributed to the rising prevalence of OSA [4]. According to the reported data, OSA represents a crucial health problem as it strongly correlates with high prevalence, increased levels of morbidity and mortality, and increased risk of general health [4, 5].

Polysomnography, the 'gold standard' of OSA diagnosis is a labor intense, time consuming and costly diagnostic method [6]. Therefore, questionnaires employing a simple strategy to evaluate the at-risk population of OSA through the surveillance of symptoms and associated risk factors have been proposed [7] As a result, Berlin Questionnaire (BQ), a validated screening tool designed to assess the risk of developing OSA, emerged in 1996. Research findings show that subjects who are classified as high-risk based on the BQ score can be prioritized to undergo further testing to confirm the presence of OSA due to its good sensitivity and negative prediction value [8].

The International Standard Classification of Occupations (ISCO) classifies managers, senior officials and legislators as the major group 1 category of occupations [9]. We considered managers, senior officials and legislators as "managerial and senior executive level workers" in the present study. Adverse health impacts may strongly be related to these employees due to the occupational stress resulting from extensive responsibility, workload, job demand, challenging situations, long working hours and lack of sleep [10]. The current competitive lifestyle has created a work conscious generation, increasing the health impacts they face due to the possible negligence of the risk factors. Obesity, alcohol use, smoking and lack of physical activity, which may eventually lead to OSA could be other contributory factors. Although there is evidence with regard to this matter none of the studies conducted in Sri Lanka specifically examined the association of risk factors of OSA in managerial and senior executive level workers.

With the highest population density among all provinces, the Western Province has a diverse socioeconomic composition due to rapid urbanization and industrialization occurring in Sri Lanka. Additionally, according to the latest labor force report of Sri Lanka, approximately 40% of the employees are centralized in the western province [9]. Moreover, the majority of the country's company head offices operate within this Province. Therefore, Western Province was chosen for this study to recruit the required sample size from the study population.

Worldwide research studies have emphasized the need for screening OSA among different groups of the labor force to identify the high-risk population of OSA [3,11]. The recent studies have worked to emphasize the high OSA prevalence, its health consequences and the importance of screening for OSA. However, evidence suggests that adequate attention is not given to screening OSA and identifying its risk factors. This prioritizes the urgent need to implement proper OSA screening in an effort to reduce the health burden of this disorder. The primary objective of this study was to assess the prevalence of risk for obstructive sleep apnea among managers, senior officials, and legislators working in selected industries of the Western Province of Sri Lanka and to identify associated risk factors and comorbidities.

## Methods

### *Study Design and Population*

A quantitative, cross-sectional study was conducted from June to August 2021 among category 1 occupants: managers, senior officials and legislators of selected industry groups in Western Province, Sri Lanka. Both male and female managers, senior officials and legislators from the industry groups of manufacturing, transportation and storage, information and communication, financial and insurance activities and human health and social work activities, aged 20 or above and employed for at least a period of one year or more in their current or similar post, were eligible to participate in the study.

The sample size was calculated based on the number of currently employed persons by occupation group by province according to the labor force report of Sri Lanka, 2019. The minimum sample size was calculated as 384 using the standard sample size calculation formula, $S = x^2 np(1-p)/ d^2 (n-1) +x^2 p(1-p)$ and 390 participants were recruited as the final sample size. A multistage cluster sampling method was used. First stage of sampling involved a proportional sample allocation across the Districts of the Western Province. This was determined based on the total number of category one occupants - managers, senior officials and legislators in each District of Western Province. This resulted in sample sizes of 165 for Colombo, 155 for Gampaha, and 70 for Kalutara. Subsequently, within each District, the sample was equally divided among the five selected industry groups.

### *Questionnaire*

A self-administered questionnaire was piloted among the managerial and senior executive level workers of selected industries through online resources. The questionnaire comprised two sections. The first section surveyed the information regarding demographics, anthropometric and lifestyle characteristics, and the second section was the Berlin Questionnaire; a standard questionnaire designed to screen risk of OSA. The questionnaire was available in all three languages: Sinhala, Tamil and English to facilitate all ethnicities participating in the survey.

The Berlin questionnaire had 11 questions under three categories. The first category comprised of five questions concerning snoring, witnessed apneas, and the frequency of such events. The second category comprised of four questions, and they are addressed to daytime sleepiness, with a sub-question about drowsy driving. The third category comprised of two questions related to the history of high blood pressure (>140/90 mmHg) and a Body Mass Index (BMI) of >30 $kgm^{-2}$. Categories 1 and 2 were considered positive if there were two positive responses to each category, while category 3 was considered positive with a self-report of hypertension and/or a BMI of >30 $kgm^{-2}$. Study participants were scored as being at ‘‘high-risk’’ of having OSA if scores were positive for two or more of the three categories. Those participants who scored positively on less than two categories were identified as being at ‘‘low-risk’’ of having OSA [8]. The questionnaire was validated through a pilot study before conducting the research survey to confirm the feasibility of the questionnaire.

### *Ethical Considerations*

Ethical clearance for the study was obtained from the Ethics Review Committee of CINEC Campus, Malabe, Sri Lanka under the reference number ERC/CINEC/2021/007. Informed consent was obtained from all the respondents prior to the study.

### *Data Analysis*

Initially, the data were tabulated in Excel and checked for errors. The BMI categories were defined according to the World Health Organization (WHO) recommended cutoff points as; underweight: <18.5 $kgm^{-2}$; normal: 18.5–24.9 $kgm^{-2}$; overweight: 25.0–29.9 $kgm^{-2}$; and obese:

**Table 1**: Demographic and other associated characteristics of study participants

| **Characteristic** | **N (%)/mean** |
|---|---|
| Gender | |
| • Male | 240 (61.5) |
| • Female | 150 (38.5) |
| Age | 39.185 |
| • 20 – 40 | 229 (58.7) |
| • 41 – 60 | 149 (38.2) |
| • > 60 | 12 (3.1) |
| Occupation | |
| • Manager | 245 (62.8) |
| • Senior Official | 130 (33.3) |
| • Legislator | 15 (3.8) |
| BMI | 24.326 |
| • < 18.5 | 12 (3.1) |
| • 18.5 – 24.9 | 227 (58.2) |
| • 25 – 29.9 | 126 (32.3) |
| • > 30 | 25 (6.4) |
| Neck Circumference | |
| • > 17 | 111 (28.5) |
| • <17 | 279 (71.5) |
| Alcohol Consumption | |
| • Frequent | 21 (5.4) |
| • Occasional | 178 (45.6) |
| • Never | 191 (49.0) |
| Smoking | |
| • Frequent | 10 (2.6) |
| • Occasional | 55 (14.1) |
| • Never | 325 (83.3) |
| Presence of chronic medical conditions | |
| • Diabetes | 57 (14.6) |
| • Stoke | 20 (5.1) |
| • Heart Disease | 30 (7.7) |
| • Hypertension | 97 (24.9) |

Data are presented as total number (percentage) or mean; BMI- body mass index

≥30.0 $kgm^{-2}$. The software, IBM Statistical Package of Social Sciences program, version 26.0 (SPSS) was used in analyzing the collected data. Descriptive statistics was performed to summarize the demographics and information based on the Berlin questionnaire as total numbers, means and percentages for categorical variables. The study population was grouped into two groups, high-risk and low-risk, according to the scoring criteria of the Berlin questionnaire. Further, the correlation

between the high-risk population and the baseline data was analyzed using logistic regression analysis. A P value less than 0.05 was considered statistically significant.

## Results

### *Description of Study Sample*

The 390 participants enrolled in the study were aged between 21 - 68 years. The mean age was 39.185 ± 10.72 and the majority of the participants (58.8%) were in the 20-40 age category. The proportion of males (61.5%) was higher than that of females (38.5%) giving a male-female ratio of 8:5. The mean BMI was 24.33 $kgm^{-2}$. The majority of the respondents had a normal healthy BMI (18.5–24.9 $kgm^{-2}$), 32.3% were identified as overweight (25-29.9 $kgm^{-2}$) while 6.4% of the participants were obese with a BMI of 30 or above. Table 1 shows the characteristics of the study sample.

### *Classification of High-risk and Low-risk*

A total of 81 (20.8%) participants had a high-risk score for OSA based on the scoring criteria of BQ, while 309 (79.2%) had a low-risk score. A total of 122 (31.3%) had a positive score for category 1 of the BQ, which evaluates snoring. The second category, which determines the presence of daytime sleepiness, was positive with 63 (16.2%) and category 3 which assesses the presence of hypertension or obesity (>30 $kgm^{-2}$) reported having 113 (29%) positive responses.

### *Correlation Between the High-risk Study Population and Risk Factors*

The association between risk factors and being considered at a high-risk for OSA is shown in Table 2. In this study, a significant difference in OSA risk was found between male and female participants ($p<0.001$). Males showed an approximately threefold higher prevalence towards developing high-risk OSA than that of females (26.6% vs 11.3%, OR=2.845, 95% CI =1.592-5.082). The overall mean age of respondents with a high-risk of OSA was 43.16 ± 10.54 years and the prevalence of high-risk for OSA increased with age, although those were slight increments. However, when age and gender were cross tabulated, it was found that middle-aged men were the most affected, accounting for a proportion of 48.1% (39/81) from the total high-risk sample. Also, the odds of developing a high-risk of OSA increased as BMI increased, with 25.4% and 56.0% of those classified as overweight (OR=3.745, 95% CI = 0.465-30.156) and obese (OR=14.0, 95% CI = 1.560-125.613) respectively, being at high-risk for OSA. Similarly, participants with >17-inches neck circumference displayed a higher trend towards the risk of OSA compared to those who were with <17-inch neck circumference (OR=2.67, 95% CI =1.605-4.444). With regard to alcohol consumption, occasional (OR=4.075, 95% CI = 2.277-7.294) and frequent alcohol consumers (OR=8.74, 95% CI = 3.265-23.382) showed a higher prevalence towards high-risk OSA, compared to those who have never consumed alcohol. Similarly, compared to those never smoked, occasional (OR=3.607, 95% CI =0.082-1.095) and frequent (OR=3.35, 95% CI =0.273-4.259) smoking were more likely to have a high-risk for OSA. However, the association of smoking with high-risk of OSA was not statistically significant unlike other analyzed risk factors.

Further, an association between high-risk for OSA and certain comorbidities was assessed. Figure 1 depicts the proportion of certain diseases in low-risk and high-risk study participants. When compared to those who were at low-risk of OSA, the high-risk study population was more likely to be associated with the comorbidities, diabetes (OR = 2.549, p = 0.007, 95% CI = 1.289-5.055), stroke (OR= 4.743, p = 0.006, 95% CI = 1.569-14.340), heart disease (OR = 1.468, p = 0.412, 95% CI = 0.587-3.672) and hypertension (OR = 7.547, p = 0.001, 95% CI = 4.164-13.680).

**Table 2**: Risk factor analysis of high-risk Obstructive Sleep Apnia

| Variable | All (N=390) | High-risk (N=81) | OR (95% CI) | P Value |
|---|---|---|---|---|
| Gender | | | | 0.001 |
| • Female | 150 (38.5) | 17 (21.0) | 1 | |
| • Male | 240 (61.5) | 64 (79.0) | 2.845 (1.592-5.082) | |
| Age | | | | 0.001 |
| • 20 – 40 | 229 (58.7) | 29 (35.80) | 1 | |
| • 41 – 60 | 149 (38.2) | 48 (59.25) | 3.278 (1.950-5.509) | |
| • > 60 | 12 (3.1) | 4 (9.87) | 3.448 (0.976-12.179) | |
| BMI | | | | 0.001 |
| • < 18.5 | 12 (3.1) | 01 (1.23) | 1 | |
| • 18.5 – 24.9 | 227 (58.2) | 34 (41.98) | 1.938 (0.242-15.501) | |
| • 25 – 29.9 | 126 (32.3) | 32 (39.5) | 3.745 (0.465-30.156) | |
| • > 30 | 25 (6.4) | 14 (17.28) | 14.000 (1.560-125.613) | |
| Neck Circumference | | | | 0.044 |
| • < 17 | 279 (71.5) | 44 (54.3) | 1 | |
| • >17 | 111 (28.5) | 37 (45.7) | 2.670 (1.605-4.444) | |
| Alcohol Consumption | | | | 0.009 |
| • Never | 191 (49.0) | 18 (22.2) | 1 | |
| • Occasional | 178 (45.6) | 53 (65.4) | 4.075 (2.277-7.294) | |
| • Frequent | 21 (5.4) | 10 (12.3) | 8.737 (3.265-23.382) | |
| Smoking | | | | 0.155 |
| • Frequent | 10 (2.6) | 4 (4.9) | 1 | |
| • Occasional | 55 (14.1) | 23 (28.4) | 3.607 (0.082-1.095) | |
| • Never | 325 (83.3) | 54 (66.7) | 3.346 (0.273-4.259) | |

Data are presented as total number (percentage)
OSA-Obstructive sleep apnea; OR-odds ratio; CI-confidence interval; BMI-body mass index
p>0.05 was considered statistically significant by logistic regression analysis

**Discussion**

Our study is the first study in Sri Lanka to assess the risk factors of OSA associated with category 1 occupational group comprising managers, senior officials and legislators to the best of our knowledge. The results from the survey of selected industries in western province, Sri Lanka supported the results of the study. In the target group of 390 managerial and senior executive level workers OSA was identified using the standard Berlin Questionnaire and 20.8% of the participants had a high-risk for OSA. This finding is approximately twice that of a comparable study in the country among bus drivers in Jaffna, Sri Lanka which reported a high-risk prevalence of 11.6% [13].

It is reported that males have a higher susceptibility to OSA than females [2, 14]. The Wisconsin Sleep Cohort Study showed a prevalence of 9% in female and of 24% in male with AHI ≥5/hour in a population of male and

female workers within the age category 30-60 years [14]. Our study supported this with males showing a threefold higher prevalence for high-risk OSA compared to female participants. However, contradictory findings with no difference in the risk of developing OSA between males and females have also been reported [15, 16].

Our study showed a slight increase in the prevalence of high-risk OSA with age, as assessed by the Berlin Questionnaire. While previous studies based on clinical diagnosis report a consistent increase in OSA prevalence with age that plateaus after 60 years [2,17], these findings are not directly comparable due to differences in assessment methods. Moreover, the limited number of participants over 60 years old (only 4 out of 81 in the high-risk group) restricts our ability to draw definitive conclusions. In spite of that, middle aged (40-60 year) men were found to be more prone to OSA agreeing with Tennakoon et al., [2] a study done by the National Hospital of Sri Lanka which states that the majority of the OSA patients in Sri Lanka are middle aged, obese males.

In concordance with other studies [13, 15, 19], BMI showed a significant association with OSA risk. The obesity epidemic has been identified as a major risk factor which affects OSA. Obesity is associated with anatomical alterations, leading to a narrowing of the throat, eventually resulting in an increased risk of upper airway obstruction during sleep [20]. Ahbab et. al. [21] states that neck circumference is a more effective factor for predicting OSA and that higher neck circumference (>40 cm) to be an independent risk factor for OSA. Not surprisingly, our results were also similar, showing significant association with higher neck circumference (>17 inches).

Alcohol consumption has been found to increase upper airway collapsibility, increasing the OSA risk. Further, alcohol intake can also contribute to higher BMI, which itself is a risk factor for OSA [22]. Both frequent and occasional consumption of alcohol showed higher odds towards high-risk OSA supporting the findings of Franklin et. al. Smoking has also been found to increase the risk of OSA, which could be related to airway inflammation predisposing to upper airway

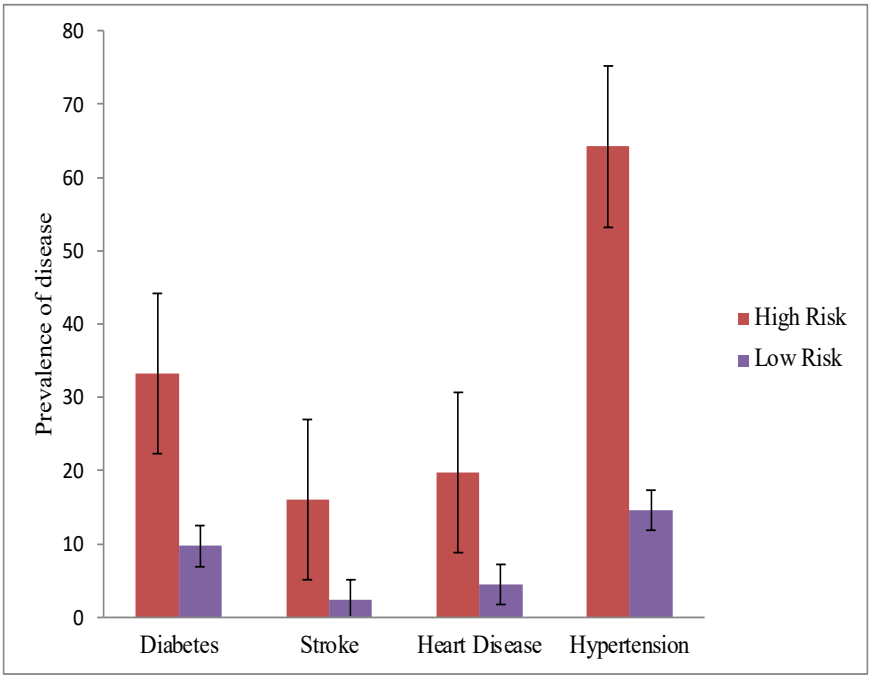


**Figure 1:** Disease prevalence of high-risk and low-risk study populations (Prevalence of the diseases are expressed in percentages)

collapse [23]. On the contrary, our study results did not show an association between smoking status and OSA risk. This perhaps is due to the limited number of smokers in our study.

Other risk factors for the development of metabolic abnormalities include diabetes [24], hypertension [25, 26], heart disease [27] and stroke [28, 29]. The results of our study reiterated the significant relationship between these disorders and OSA risk (Figure 1) except for heart disease. Our study did not support the fact that OSA has an impact on heart diseases. A prominent association was found between hypertension and high-risk of OSA, displaying a considerably higher disease prevalence compared to low-risk study population (64.2% vs 9.3%). OSA has been associated with a number of cardiovascular complications [30]. Besides, evidence suggests that cardiovascular abnormalities can exacerbate OSA, implying that this relationship is bidirectional [31].

The high prevalence of OSA can be decreased with the improvements in knowledge and awareness of OSA, early diagnosis, and appropriate treatment. Further, modification and reduction of risk factors like obesity, smoking and alcoholism could reduce the impacts of OSA. The consistent association of OSA with the risk of developing cardiovascular disease makes it important to develop strategies to lower such consequences. Thus, community awareness of the importance of lifestyle modifications is required.

While the study provides valuable insights, it is important to address certain limitations. First, the high-risk participants did not undergo polysomnography examinations. Therefore, the exact prevalence of OSA among the category 1 participants cannot be defined. However, we were able to clearly define the percentage of these participants at risk of OSA utilizing the standardized Berlin Questionnaire which has a high reliability and accuracy. Also, the use of quantitative, cross sectional study design makes it difficult to determine the causality of the risk factors. Therefore, we would recommend further long-term longitudinal studies to examine the association of OSA with different occupational categories.

## Conclusion

This study shows that 20.8% of managers, senior officials, and legislators (category one occupants) working in selected industries in the Western Province of Sri Lanka are at high-risk of developing obstructive sleep apnea (OSA) assessed by the Berlin Questionnaire. Male gender, middle age (41–60 years), BMI, larger neck circumference, and alcohol consumption were significantly associated with high-risk OSA. Additionally, comorbidities such as diabetes, stroke, and hypertension were significantly linked with high-risk OSA. These findings emphasize the importance of early screening of OSA and its associated risk factors among high-risk occupational groups.

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