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Risk of Common Mental Disorders in Relation to Symptoms of Obstructive Sleep Apnea Syndrome among Ethiopian College Students

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Abstract

Background—The Berlin and Epworth Sleepiness Scale (ESS) are simple, validated, and widely used questionnaires designed to assess symptoms of obstructive sleep apnea syndrome (OSAS) a common but often unrecognized cause of morbidity and mortality.

Methods—A cross-sectional study was conducted among 2,639 college students to examine the extent to which symptoms of OSAS are associated with the odds of common mental disorders (CMDs). The General Health Questionnaire (GHQ-12) was used to evaluate the presence of CMDs while the Berlin and ESS were used to assess high-risk for obstructive sleep apnea (OSA) and excessive daytime sleepiness, respectively. Logistic regression procedures were used to derive odds ratios (OR) and 95% confidence intervals (CI) assessing the independent and joint associations of high-risk for OSA and excessive daytime sleepiness with odds of CMDs.

Results—Approximately 19% of students had high-risk for OSA while 26.4% had excessive daytime sleepiness. Compared to students without high-risk for OSA and without excessive daytime sleepiness (referent group), students with excessive daytime sleepiness only (OR=2.01; 95%CI: 1.60-2.52) had increased odds of CMDs. The odds of CMDs for students with high-risk OSA only was 1.26 (OR=1.26; 95%CI 0.94-1.68). Students with both high-risk for OSA and excessive daytime sleepiness, compared to the referent group, had the highest odds of CMDs (OR=2.45; 95%CI: 1.69-3.56).

Conclusion—Our findings indicate that symptoms of OSAS are associated with increased risk of CMDs. These findings emphasize the comorbidity of sleep disorders and CMDs and suggest that there may be benefits to investing in educational programs that extend the knowledge of sleep disorders in young adults.

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Keywords

Sleep apnea syndrome; OSAS; College students; Common mental disorders; GHQ; Ethiopia

Introduction

Obstructive sleep apnea syndrome (OSAS) is characterized by repetitive, complete, or partial collapse of the pharyngeal airway during sleep and, generally, reduction in oxygen desaturation and arousals [1]. OSAS is a highly prevalent among both men (15–24%) and women (9–26%) of middle age [2,3]. Manifestations of OSAS include daytime sleepiness, anxiety, depression, irritability, and lack of concentration and fatigue [4]. These symptoms have a tremendous impact on an individual's ability to function and have been shown to lead to increased domestic, work and traffic accidents [5]. Behavioral characteristics such as excessive consumption of caffeinated products, consumption of Khat, and smoking are also shown to have an adverse effect on daytime sleepiness and mental health [6]. An accumulating body of literature documents that sleep disturbances such as sleep quality, sleep duration, excessive daytime sleepiness are associated with common mental disorders (CMDs) [7-10]. However, few studies have focused on the relation between OSAS with CMDs. A recent study by our team found that the prevalence of short sleep duration (6 hours) was 44% while poor sleep quality (determined using Pittsburgh Sleep Quality Index) was 53% among Ethiopian college students [11]. Given the growing problems of sleep disorders among young adults globally, we conducted the current study to examine the extent to which symptoms of OSAS are associated with CMDs among Ethiopian college students.

Materials and Methods

Study setting and sample

A cross-sectional survey was conducted at two major Universities in Ethiopia. The study procedures have been described in detail elsewhere [11]. In summary, a total of 2,817 undergraduate students were recruited through informational flyers at the universities. After attending an information session about the study, those who consented to participate were included in the study. For the study described here, after excluding subjects with incomplete questionnaires on sleep disorders, the final analyzed sample consisted of 2,639 students. Based on the information provided, students excluded from analysis had similar characteristics as those considered for analysis.

Data collection and variables

A self-administered questionnaire was used to collect information for this study. The questionnaire ascertained demographic and behavioral risk factors information including age, sex, education level, smoking, consumption of alcohol and caffeinated beverages, and consumption of Khat. Khat is an evergreen plant with amphetamine-like effects commonly used as a mild stimulant for social recreation and to improve work performance in Ethiopia [12,13]. Trained research nurses using standard protocols took participants' anthropometric and blood pressure measurements. Height and weight were measured without shoes or

outerwear. Height was measured to the nearest 0.1 cm and weight was measured to the nearest 0.1 kg. All anthropometric values consisted of the mean of three measurements. Blood pressure was digitally measured (Omron M4-I, Omron Healthcare, Inc, Bannockburn, Illinois) after participants had been resting for five minutes. Two additional blood pressure measurements were taken with three minutes elapsing between successive measurements. In accordance with WHO recommendation the mean systolic and diastolic blood pressure from the second and third measurements were considered for analyses.

Ethics statement

All completed questionnaires were anonymous, and no personal identifiers were used. Given the minimum risk of the study and use of anonymous questionnaire, waiver of documentation of written consent form was approved by the ethics committees. All study procedures were approved by the institutional review boards of Addis Continental Institute of Public Health and Gondar University, Ethiopia and the University of Washington, USA. The Harvard T. H. Chan School of Public Health Office of Human Research Administration, USA, granted approval to use the de-identified data for analysis.

The Berlin questionnaire-Obstructive Sleep Apnea (OSA)

The Berlin Questionnaire has been widely used in epidemiologic studies globally including in sub-Saharan Africa [14-16]. The questionnaire consists of 11 questions separated into three sections. Section 1 asked participants whether they snore [14-16]. Those who responded affirmatively were then asked how loud their snoring was, how often it occurred, and whether their snoring bothered other people. In the present study, participants were also asked whether anyone has ever noticed cessation of their breathing during sleep. Section 2 asked participants how often they felt tired or fatigued right after sleep; how often they felt tired, fatigued, or not up to par during wake time, and whether they ever fell asleep while driving a car. In section 3, participants were asked about their history of hypertension, as well as their height, weight, and age. A response was considered positive if there were two affirmative answers in either section 1 or 2, or one affirmative response in section 3. In section 3, high-risk for OSA was defined when there was a history of hypertension (systolic blood pressure ≥ 140 mmHg or diastolic blood pressure ≥ 90 mmHg) or obesity (body mass index ≥ 30 kg/m²). When 2 or more sections were classified as positive, the participant was deemed to be at high-risk for OSA [14-16].

Epworth Sleep Scale (ESS)

The ESS is a measure of a person's general level of daytime sleepiness [17]. It is composed of 8 questions capturing an individual's likelihood of falling asleep during regularly encountered situations. The questions fall on a scale ranging from 0 to 3. Individual scores are then summed to yield a single total score ranging from 0 to 24. In adults, an ESS score ≥ 10 is taken to indicate increased daytime sleepiness [17]. The ESS has been widely used globally among different study populations including college students in sub-Saharan Africa [18,19].

General Health Questionnaire (GHQ-12)

The 12-item version of the General Health Questionnaire (GHQ-12) was used for screening for non-pathological common mental disorders (CMDs) [20]. The GHQ-12 has been commonly used worldwide, including sub-Saharan Africa [21]. The GHQ-12 asks respondents to report how they felt recently on a range of variables including problems with sleep and appetite, subjective experiences of stress, tension, or sadness, mastering of daily problems, decision making and self-esteem. Response choices included: less than usual, no more than usual, more than usual and much more than usual. Scoring was 0 for the first two choices and 1 for the next two. The maximum possible score was 12 with higher scores suggesting higher mental distress. Presence of CMDs was defined using previously established cut points in other study populations and those who scored 5 or higher on GHQ-12 scale were considered as having CMDs [22].

Other Covariates

We defined alcohol consumption as low (<1 alcoholic beverages week), moderate (1–19 alcoholic beverages a week), and high to excessive consumption (>19 alcoholic beverages a week). Other covariates considered were: age (years), sex, cigarette smoking history (never, former, current), consumption of caffeine containing beverages during past month (no vs. yes), Khat stimulant use (no vs. yes) and participation in moderate or vigorous physical activity (no vs. yes); BMI was calculated as weight (in kilograms)/height squared (in meters squared). BMI thresholds were set according to the WHO protocol (underweight, <18.5 kg/m²; normal, 18.5–24.9 kg/m²; overweight, 25.0–29.9 kg/m²; and obese, ≥30 kg/m²).

Statistical Analysis

We first examined the frequency distributions of the socio-demographic and behavioral characteristics of the study participants using counts and percentages. We then used chi-square and Student's t-tests to determine bivariate differences in distribution of covariates according to high risk for OSA among categorical and continuous variables, respectively. Logistic regression procedures were performed to calculate odds ratios (ORs) along with 95% confidence intervals (CIs) evaluating the independent and combined associations of high-risk for OSA and excessive daytime sleepiness with the risk of CMDs. For these analyses, participants were classified as follows: (i) absence of high-risk OSA and absence excessive daytime sleepiness, (ii) presence of high-risk OSA and absence of daytime sleepiness, (iii) absence of high-risk OSA and presence of excessive daytime sleepiness, and (iv) presence of both high-risk for OSA and excessive daytime sleepiness. Participants without high-risk OSA and excessive daytime sleepiness comprised the reference group for these analyses. We included potential confounders of a priori interest (i.e., age, sex, smoking, stimulant use, body mass index, and physical activity) in multivariable adjusted logistic regression models on the bases of their hypothesized relationship between exposure (sleep disturbances) and outcome (CMDs). All analyses were performed using SPSS Statistical Software for Windows (IBM SPSS, version 22, Chicago, IL, USA). All reported p-values are two-sided and deemed statistically significant at a 0.05 level.

Results

Of our sample of 2,639 undergraduate students, 77.3% were male and 22.7% were female with a mean age of 21.7 (SD 1.7) years. Approximately 60% of the students had normal body mass index (BMI) and only 3% reported being current smokers. Snoring was reported by 18.4% of study participants while hypertension was prevalent in 14.7% of study participants. Table 1 provides further distribution of the demographic and behavioral characteristics of students' in relation to high-risk for OSA. Of students categorized as being at high-risk for OSA, 81.6% were male, whereas 76.3% of those not at high-risk for OSA were male students (p -value=0.012). Out of those at high-risk for OSA, 83.7% consumed caffeinated beverages compared to 79.5% among those who were not at risk of OSA (p -value= 0.034). There was also a statistically significant association between physical activity and high-risk of OSA with 23% of those at high-risk of OSA participating in moderate to high physical activity versus 16.5% among those not at risk of OSA (p -value=0.001). Other behavioral characteristics, such as alcohol and Khat consumption, were associated with high-risk of OSA (p -values = 0.075 and 0.083, respectively), although these associations did not reach statistical significance.

The prevalence of high-risk OSA by age and sex is presented in Figure 1. Among 20 and 21 year olds, high-risk for OSA appears more prevalent in male students (20.9%) than in female students (12.1%) (p -value=0.641). Among males, the overall pattern appears to be a steady increase in prevalence of high-risk OSA until the age of 22 then a slight decrease. Among females, there is a steady decrease in prevalence of high-risk OSA until age 22 then a sharp increase. After age 22, the prevalence of high-risk of OSA in females surpasses that of males in the same age group.

Table 2 shows the mean GHQ total score for students experiencing daytime sleepiness and/or are at high-risk of OSA. The mean GHQ total score is lowest among those who do not experience either event and is highest among students experiencing both events. For those with only one of the two events, the mean score is higher among those with only daytime sleepiness compared to those with only high-risk of OSA. This trend remains the same after adjusting for age and sex.

Table 3 shows results of the multivariate logistic regression models evaluating the associations of CMDs with high-risk for OSA and excessive daytime sleepiness. Compared to students without high-risk for OSA and without excessive daytime sleepiness (referent group), students with excessive daytime sleepiness only (OR=2.01; 95% CI 1.60-2.52) had increased odds of CMDs. The odds of CMDs for students with high-risk OSA only was 1.26 (OR=1.26; 95% CI 0.94-1.68) although statistical significance was not achieved. Those students with both high-risk for OSA and excessive daytime sleepiness had the highest odds of CMDs (OR=2.45; 95% CI 1.69-3.56) compared to the referent group.

Discussion

In the present study we found that approximately 19% of students had high-risk for OSA while 26.4% had excessive daytime sleepiness. Compared to students without high-risk for

OSA and without excessive daytime sleepiness (referent group), students with excessive daytime sleepiness only (OR=2.01; 95% CI 1.60-2.52) had increased odds of CMDs. Those students with both high-risk for OSA and excessive daytime sleepiness, compared to the referent group, had the highest odds of CMDs (OR=2.45; 95% CI 1.69-3.56).

To the best of our knowledge, this is the first study to examine the prevalence of high-risk for OSA among sub-Saharan African young adults. The prevalence of high-risk for OSA appears to be higher than what is reported in the high-income countries including the US [23] and Australia [24] in the general population. However, the overall prevalence of OSA among obese individuals can be as high as 30% [25]. The prevalence of high-risk for OSA in our study appears to be similar to one other African study [26]. Sogebi et al (2012) in their study among Nigerian outpatients found a 17.4% prevalence of high-risk for OSA using the Berlin questionnaire [26]. Future studies are needed to evaluate the personal, environmental and social risk factors of high-risk for OSA in sub-Saharan Africa.

Our observation showing increased odds of CMDs among those experiencing symptoms of OSAS (both high-risk for OSA and excessive daytime sleepiness) are in alignment with the findings of most prior studies [27,28]. Hayley et al using the National Health and Nutrition Examination Survey (NHANES) found that those with OSA were associated with more than 5-fold (OR=5.14, 95% CI 3.14-8.41) increased odds of experiencing depression (determined using the Patient Health Questionnaire-9) [28]. In a population-based study of veterans, Babson et al reported that those with sleep apnea had increased odds of receiving a mood disorder diagnosis (OR=1.85; CI 1.71-1.72) and anxiety disorder diagnosis (OR=1.82; CI 1.77-1.84) [27]. Additionally, in the present study we observed that students experiencing only excessive daytime sleepiness had a 2.01 fold increased odds of CMDs (OR=2.01; 95% CI 1.60-2.52) compared to the reference group. This finding is in agreement with findings reported by other investigators. For instance in a study of Thai college students, we found that in a multivariate adjusted model, the odds of CMDs was increased two-fold among students with daytime sleepiness as compared with those without the risk factor (OR=1.95; 95% CI 1.54-2.47) [7]. Similarly, Bixler and colleagues (2013) reported that excessive daytime sleepiness was strongly associated with depression than sleep-disordered breathing (e.g., due to sleep apnea) [29]. A study of school-aged children from the general population further corroborates with our results by demonstrating that the presence of excessive daytime sleepiness is strongly associated with anxiety and/ or depression (p-value=0.001) [30].

Plausible biological mechanisms that could explain observed associations between high-risk for OSA, excessive daytime sleepiness, and CMDs include sleep fragmentation and nocturnal hypoxemia [31] that occurs during episodes of OSA. Hypoxemia causes sympathetic vasoconstriction and decreased vascular protective mechanisms, which causes impairments in cognitive areas, and in mood and sleepiness [32]. Impairments were reported to be associated with focal reductions of gray-matter volume in the left hippocampus, left posterior parietal cortex, and right superior frontal gyrus [33,34] which are responsible for attention [35], motor coordination, and specialized tasks respectively [36,37]. Reduction in grey matter density in localized areas of the brain may cause depression and hippocampal neuronal death due to raised cortisol levels [38]. Hypoxemia has also been reported to

interfere with the cholinergic neurotransmitter system [39], responsible for sensory perception, attention and arousal in the central nervous system (CNS). Essentially, it is believed that neuropsychological changes in patients with OSA may be attributed to localized changes in the brain.

Some limitations should be considered when interpreting the results of our study. First, this was a cross-sectional study and therefore we cannot delineate the temporal relationship between high-risk for OSA, daytime sleepiness and CMDs. It is difficult to determine whether CMDs are caused by the sleep disorders or if they are manifestations of pre-existing CMDs. A future longitudinal study would give better insight in this regard. Second, the use of the self-administered questionnaire that relied on subjective measurements of sleep disorders, CMDs, behavioral risk factors such as smoking, and consumption of caffeinated drinks, alcohol and Khat may have introduced some degree of non-systematic errors in recall, as well as systematic non-disclosure leading to misclassification. Although we used multivariable logistic regression procedures to adjust for putative confounders, we cannot exclude the possibility of residual confounding. Finally, our study was strictly comprised of college students whose sleeping environment might be different from general population.

Due to increased social, academic and financial demands placed on students in recent years, the risk and occurrence of sleep disorders is becoming a public health issue globally. Our study findings demonstrating symptoms of OSAS (as assessed using high-risk for OSA and excessive daytime sleepiness) are associated with increased risk of CMDs reiterate the fact that programs promoting healthy behavior during the college years are needed. These findings also emphasize the comorbidity of sleep disorders and CMDs and suggest that there may be benefits to investing in educational programs that extend the knowledge of sleep disorders in young adults.

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Figure 1.
Prevalence of high-risk OSA by age and gender.

Table 1

Demographic and lifestyle characteristics according to high-risk for obstructive sleep apnea (OSA)

Characteristics	Total	High-Risk for OSA		p-value
	N=2,639	Yes (N=492)	No (N=2,147)	
	n (%)	n (%)	n (%)	
Age, (years) mean $\pm$ SD	21.66 $\pm$ 1.68	21.65 $\pm$ 1.70	21.69 $\pm$ 1.61	0.656
Age				
18-19	129 (4.9)	108 (5.0)	21 (4.3)	0.641
20	546 (20.7)	452 (21.1)	94 (19.1)	
21	726 (27.5)	589 (27.4)	137 (27.8)	
22	1238 (46.9)	998 (46.5)	240 (48.8)	
Gender				
Male	2011 (77.3)	1615 (76.3)	396 (81.6)	0.012
Female	590 (22.7)	501 (23.7)	89 (18.4)	
BMI, (kg/m²) mean $\pm$ SD	19.19 $\pm$ 1.99	19.19 $\pm$ 2.03	19.15 $\pm$ 1.84	0.653
BMI				
Underweight (<18.5)	1029 (39.0)	847 (39.6)	182 (37.1)	0.299
Normal (18.5-24.9)	1567 (59.4)	1263 (59.0)	304 (62.0)	
Overweight (25.0-29.9)	35 (1.3)	31 (1.4)	4 (0.8)	
Alcohol Consumption				
< 1 drink/month	2260 (85.6)	1837 (85.6)	423 (86.3)	0.083
1-19 drinks/month	345 (13.1)	287 (13.4)	58 (11.8)	
20 drinks/month	34 (1.3)	23 (1.1)	11 (2.2)	
Smoking Status				
Never	2541 (96.3)	2068 (96.3)	473 (96.1)	0.853
Former	14 (0.5)	12 (0.6)	2 (0.4)	
Current	84 (3.2)	67 (3.1)	17 (3.5)	
Khat Consumption				
No	2071 (89.2)	1695 (89.8)	376 (86.8)	0.075
Yes	250 (10.8)	193 (10.2)	57 (13.2)	
Any Caffeinated Beverages				
No	519 (19.7)	439 (20.5)	80 (16.3)	0.034
Yes	2111 (80.3)	1700 (79.5)	411 (83.7)	
Physical Activity				
Low	2171 (82.3)	1792 (83.5)	379 (77.0)	0.001
Moderate	193 (7.3)	140 (6.5)	53 (10.8)	
High	275 (10.4)	215 (10.0)	60 (12.2)	

Chi square test used for categorical variables, T-test used for continuous variables

Table 2

Mean General Health Questionnaire (GHQ) total scores according to symptoms of obstructive sleep apnea syndrome.

	GHQ Total score	Age and sex adjusted GHQ Total score
	Mean (SD)	Mean (SD)
None	2.5 (2.8)	2.5 (0.2)
High Risk OSA	2.8 (2.9)	2.9 (0.2)
Daytime Sleepiness	3.7 (3.1)	3.7 (0.2)
High Risk OSA and Daytime Sleepiness	4.2 (3.1)	4.1 (0.1)

Table 3

Risk of common mental disorders in relation to symptoms of obstructive sleep apnea syndrome.

	N	%	Unadjusted OR (95% CI)	Age and sex adjusted OR (95% CI)	*Multivariate adjusted OR (95% CI)
None	1511	60.5	1.00 (Reference)	1.00 (Reference)	1.00 (Reference)
High Risk OSA only	319	12.8	1.26 (0.95- 1.68)	1.24 (0.93- 1.66)	1.26 (0.94- 1.68)
Daytime Sleepiness only	516	20.7	2.03 (1.62- 2.53)	2.01 (1.61- 2.52)	2.01 (1.60- 2.52)
High Risk OSA and Daytime Sleepiness	140	5.6	2.51 (1.74- 3.62)	2.41 (1.66- 3.49)	2.45 (1.69- 3.56)

^aAdjusted for age, sex, smoking, stimulant use, body mass index, and physical activity;

^bPresence of common mental disorders was defined as having GHQ total score of 5 and higher