

RESEARCH ARTICLE

Obstructive sleep apnea and hypopnea syndrome in patients admitted in a tertiary hospital in Cameroon: Prevalence and associated factors

Virginie Poka-Mayap^{1*}, Dodo Balkissou Adamou², Massongo Massongo¹, Steve Voufouo Sonwa³, Jacqueline Alime³, Ben Patrick Michel Moutlen³, Alfred Kongnyu Njamnshi^{4,5,6}, Andre Noseda⁷, Eric Walter Pefura-Yone^{1,4}

1 Pulmonology Department, Yaounde Jamot Hospital, Yaounde, Cameroon, **2** Faculty of Medicine of Garoua, The University of Ngaoundere, Garoua, Cameroon, **3** Faculty of Medicine and Biomedical Sciences, The University of Yaounde I, Yaounde, Cameroon, **4** Department of Internal Medicine and Subspecialties, Faculty of Medicine and Biomedical Sciences, The University of Yaounde I, Yaounde, Cameroon, **5** Department of Neurology, Yaounde Central Hospital, Yaounde, Cameroon, **6** Brain Research Africa Initiative (BRAIN), Yaounde, Cameroon, **7** Pulmonology Department, Brugmann University Hospital U.L.B., Brussels, Belgium

* pokavirginie@yahoo.fr



OPEN ACCESS

Citation: Poka-Mayap V, Balkissou Adamou D, Massongo M, Voufouo Sonwa S, Alime J, Moutlen BPM, et al. (2020) Obstructive sleep apnea and hypopnea syndrome in patients admitted in a tertiary hospital in Cameroon: Prevalence and associated factors. *PLoS ONE* 15(1): e0227778. <https://doi.org/10.1371/journal.pone.0227778>

Editor: James Andrew Rowley, Harper University Hospital, UNITED STATES

Received: September 13, 2019

Accepted: December 27, 2019

Published: January 16, 2020

Peer Review History: PLOS recognizes the benefits of transparency in the peer review process; therefore, we enable the publication of all of the content of peer review and author responses alongside final, published articles. The editorial history of this article is available here: <https://doi.org/10.1371/journal.pone.0227778>

Copyright: © 2020 Poka-Mayap et al. This is an open access article distributed under the terms of the [Creative Commons Attribution License](https://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited.

Data Availability Statement: The authors confirm that all data underlying the findings are fully

Abstract

Purpose

Obstructive sleep apnea and hypopnea syndrome (OSAHS) is poorly documented in Sub-Saharan Africa, especially in the hospital setting. The aim of this study was to determine its prevalence and to investigate the associated factors in patients admitted in a tertiary referral hospital in Cameroon.

Methods

In this cross-sectional study conducted in the Cardiology, Endocrinology and Neurology departments of the Yaounde Central Hospital; all patients aged 21 and older were included consecutively. A sample of randomly selected patients was recorded using a portable sleep monitoring device (PMD). OSAHS was defined as apnea-hypopnea index (AHI) ≥ 5 /hour (with $> 50\%$ of events being obstructive) and moderate to severe OSAHS as an AHI > 15 /hour. Logistic regression was used to identify factors associated to OSAHS.

Results

Of the 359 patients included, 202 (56.3%) patients were women. The mean age (standard deviation) was 58 (16) years. The prevalence of OSAHS assessed by PMD (95% CI) was 57.7% (48.5–66.9%), 53.8% in men and 62.7% in women ($p = 0.44$). The median (25th-75th percentiles) AHI, body mass index and Epworth Sleepiness Scale score of OSAHS patients were 17 (10.6–26.9)/hour, 27.4 (24.7–31.6) kg/m² and 7 (5–9) respectively. The only factor

available without restriction. All relevant data are within the Supporting Information files.

Funding: The author(s) received no specific funding for this work.

Competing interests: The authors have declared that no competing interests exist.

associated to moderate to severe OSAHS was hypertension [odds ratio (95% CI)]: 3.24 (1.08–9.72), $p = 0.036$.

Conclusion

OSAHS is a common condition in patients in this health care centre of Cameroon. In the hospital setting, screening for OSAHS in patients with hypertension is recommended.

Introduction

Obstructive Sleep Apnea and Hypopnea Syndrome (OSAHS) is now recognized as a cardiovascular risk factor responsible for significant morbidity and mortality if untreated [1–4]. Prevalence estimates depend on populations examined, time periods of assessment, and how breathing events of obstructive sleep apnea and hypopnea are defined, but can reach large minorities to majorities of specific population subgroups[5].

The prevalence of OSAHS defined as an apnea hypopnea index (AHI) ≥ 5 per hour has varied from 6% in men and 4% in women (1993) to 83.8% in men and 60.8% in women (2013)[6–8]. In developing countries, particularly in sub-Saharan Africa (SSA), the prevalence of high risk of OSAHS, assessed by questionnaires, is between 30 and 60%[9–11]. Using portable sleep monitoring devices (PMD) or polysomnography, the prevalence of the disease in the general population is 28.5% and that of moderate to severe OSAHS is 6.3% while the prevalence is between 40–60% in patients attending hospital [10,12,13].

The prevalence of OSAHS is even larger in health care setting. It amounts 40 to 80% in developed countries [14–17]. In SSA, few studies document the prevalence of OSAHS in health care setting [9,18]. In daily clinical practice, patients with high risk of OSAHS are frequently admitted to hospital, but the OSAHS is rarely detected and, as a consequence, subsequent management is not optimal [19]. Knowing the prevalence of OSAHS in our hospital patients will enable to take appropriate measures to improve the diagnosis and the overall management of patients. The aim of this study was to evaluate the prevalence of OSAHS and to investigate associated factors in patients admitted in a tertiary referral health care centre in Cameroon.

Materials and methods

Participants and study setting

This cross-sectional study, conducted over a 7-month period from November 2016 to May 2017, was carried out at the Yaounde Central Hospital (YCH), a government-run tertiary health facility in the capital city of Cameroon, which serves as referral centre for Yaounde and its environs. All patients aged 21 and older admitted in the Cardiology, Neurology and Endocrinology departments of the YCH were eligible for the study. Patients unable to answer questionnaires, with nasogastric tubes were excluded. The participants were recruited consecutively during the inclusion period.

Procedure

All eligible patients who signed an informed consent completed a STOP-BANG questionnaire. They were classified into two groups according to the risk of OSAHS (low versus high) as assessed from the STOP-BANG questionnaire. Every day, a participant was randomly selected from each group to be recorded by a portable sleep monitoring device (PMD).

Data collection

The socio-demographic characteristics recorded were: age, sex, marital status and occupational category. The comorbidities recorded were hypertension, diabetes mellitus, heart failure, stroke, human immunodeficiency virus (HIV) infection, and epilepsy. Alcohol consumption was assessed as follows: current regular, occasional, former consumer (at least 12 months without alcohol consumption) or never consumer of alcohol and the ethylic index was calculated in grams per day [amount of alcohol consumed daily in ml x alcohol percentage x density (0.8)]. Tobacco smoking was assessed and participants ranked as current smokers (participants having smoked at least one cigarette a day for at least one year, or having smoked at least 20 cigarettes in their lifetime and still smoking), ex-smokers (participants who declared having stopped smoking for at least six months) and never-smokers.

The following symptoms were collected were: snoring, apnea witnessed by family members, nocturia, daytime fatigue, daytime sleepiness, morning headaches, non-restorative sleep. The daytime sleep propensity was assessed by the Epworth Sleepiness Scale (ESS) which consists of eight items (described situations) arranged on a 4-point Likert scale ranging from 0 ('never doze') to 3 ('high chance of dozing' during daytime). The summed scores range from 0 to 24; scores above 10 are commonly interpreted as consistent with excessive daytime sleepiness [20]. Neck circumference, hip circumference, weight, height were measured and body mass index (BMI) derived as the ratio: weight (kg) / height / height (m²). A BMI ≥ 30 kg / m² defines obesity.

OSAHS assessment

Screening for risk of OSAHS. The risk of OSAHS was evaluated by the STOP-BANG questionnaire, a tool validated in different clinical situations for OSAHS screening [21]. It consists of 8 questions that can be answered by "yes" or "no". The number of "yes" answers determines the questionnaire score. The risk of OSAHS is high when the score ≥ 3 [22].

Diagnosis of OSAHS. Respiratory events during sleep were recorded by PMD (SLEEP FAIRY Lt, Co), a type III recording system. The PMD was placed on the participant in hospital at bedtime and the recording was started by the participant or his/her family member at the time of falling asleep and stopped at awakening. The signals recorded included airflow through a nasal pressure sensor, oxyhaemoglobin saturation and pulse rate from pulse oximetry as well as thoracic and abdominal movements through respiratory inductance plethysmography. The sleep recordings were manually scored by a certified polysomnologist, with appropriate sleep related training. Recordings with unreadable signal on more than 25% of the recording time and recordings of less than 4 hours were excluded. The respiratory events were scored according to the "The AASM Manual for the Scoring of Sleep and Associated Events"[23]. Obstructive sleep apnea was defined as a reduction $\geq 90\%$ in airflow for ≥ 10 seconds during sleep with persistent ventilatory efforts. Hypopnea was defined as a reduction of $\geq 30\%$ airflow for ≥ 10 seconds during sleep associated with a desaturation $\geq 3\%$. The apnea-hypopnea index (AHI) was the result of the ratio of the sum of all apneas and hypopneas divided by the total recording time. According to the "International Classification of Sleep Diseases" 3rd version criteria, OSAHS was diagnosed when the AHI was ≥ 5 per hour of recording in presence of OSAHS symptoms with $> 50\%$ of events being obstructive, and moderate to severe OSAHS when the AHI was ≥ 15 per hour[24].

Ethical statement

The study was approved by the Ethics Committee of the Faculty of Medicine and Biomedical Sciences of the University of Yaounde I, Cameroon. The study received administrative

authorisation from the Centre Region Delegation of the Ministry of Public Health of Cameroon. Subsequently, a recruitment authorization from the YCH administrative team was obtained, as well as the written informed consent of all included participants.

Statistical analysis

The sample size was determined assuming that two participants a day would be recorded by PMD during the study period, thus 400 subjects. Assuming a 40% prevalence of OSAHS in in-hospital patients [17], a type 1 error of 5%, a power of 80%, the required sample size was 182 participants.

Data were analysed using IBM-SPSS Version 20 for Windows (SPSS Inc., Chicago, IL). Qualitative data are presented as counts and proportions, and quantitative variables as mean and standard deviation (SD) or median and 25th-75th percentiles. Chi squared test and Fisher exact test were used to compare proportions. Quantitative variables were compared by Student's T test or its non-parametric equivalent. The prevalence of OSAHS was that obtained in the sub-sample of patients who were recorded by PMD. Logistic regression models were used to investigate factors associated to moderate to severe OSAHS. Potential associated factors were first tested in univariate analysis, and significant ones (based on $p < 0.10$ threshold) were further tested in multivariate models. A p -value < 0.05 was used to define statistically significant results.

Results

As shown in Fig 1, a total of 383 subjects were invited to take part in the study, of whom 24 declined (response rate of 93.7%). Three hundred and fifty-nine subjects participated in the

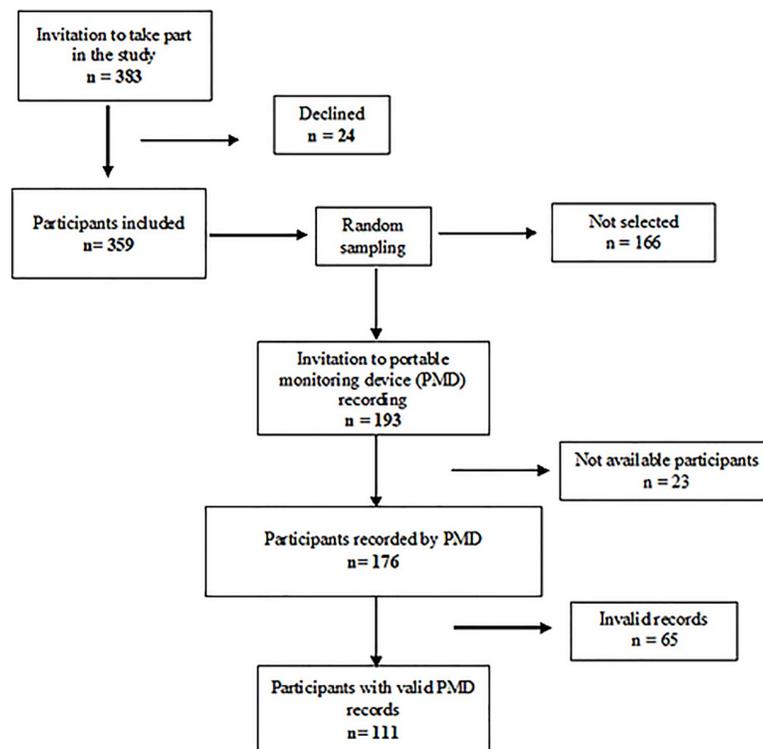


Fig 1. Flow chart of the inclusion of participants. PMD: Portable Monitoring Device.

<https://doi.org/10.1371/journal.pone.0227778.g001>

study, from which 193 patients were randomly selected for PMD recording. Only 176 subjects were recorded, of which data were valid in 111 subjects.

General characteristics of the study population

Of the 359 participants, 202 (56.3%) were women. The mean age (standard deviation) was 58 (16) years. As presented in Table 1, the most common comorbidities were hypertension (50.1%) and diabetes mellitus (34.3%). Hypertension was significantly more frequent in women than men. Current smoking and regular or occasional alcohol consumption were found in 8.6% and 58.2% of participants respectively.

The Table 2 summarises the clinical characteristics of participants. Snoring was the most common symptom of OSAHS and was significantly more prevalent in men. Two hundred and five (57.1%) participants reported sleepiness, while only 24 (6.7%) had an ESS consistent with excessive daytime sleepiness. Obesity was present in 30.6% of patients and more prevalent in women than men (28% vs. 21%, $p = 0.001$). The neck circumference of men was higher than that of women (39 vs. 35 cm, $p < 0.001$).

Prevalence of high risk of OSAHS

As shown in Fig 2, The prevalence [95% confidence interval (95% CI)] of high risk of OSAHS, as assessed from the STOP-BANG questionnaire, was 64.1% (59.1–69.1%) in the whole population, 78.3% (71.9–81.7%) in men and 53% (46.1–59.9%) in women ($p < 0.001$).

Table 1. Sociodemographic characteristics and comorbidities of the study population.

Characteristics	Overall n = 359 (%)	Men n = 157 (%)	Women n = 202 (%)	p-value
Age in years, mean (SD)	58 (16)	56 (15)	59 (16)	0.059
Marital status				
Alone	173 (48.2)	39 (24.8)	134 (66.3)	<0.001
Living in couple	186 (51.8)	118 (75.2)	68 (33.7)	
Occupational category				
Unemployed	321 (89.4)	129 (17.8)	192 (96)	<0.001
Employed	38 (10.6)	28 (82.2)	10 (4)	
Hypertension	180 (50.1)	67 (42.7)	113 (55.9)	0.014
Diabetes mellitus	123 (34.3)	55 (35)	68 (33.7)	0.823
Heart failure	53 (14.8)	20 (12.7)	33 (16.3)	0.371
Stroke	111 (31)	55 (35.3)	56 (15.6)	0.135
HIV infection	48 (13.4)	15 (9.6)	33 (16.3)	0.085
Epilepsy	10 (2.8)	7 (4.5)	3 (1.5)	0.111
Tobacco smoking				
Smokers	31 (8.6)	17 (10.8)	14 (6.9)	<0.001
Ex-smokers	30 (8.4)	24 (15.3)	6 (3)	
Non-smokers	298 (83)	116 (73.9)	182 (90.1)	
Alcohol consumption				
Regular	65 (18.1)	39 (24.8)	26 (12.9)	<0.001
Occasional	144 (40.1)	78 (49.7)	66 (32.7)	
Old consumer	78 (21.7)	26 (16.6)	52 (25.7)	
Never	72 (20.1)	14 (8.9)	58 (28.7)	
Ethylc index, g/day, median in (25 th -75 th percentiles)	16.5 (2.9–57.2)	28.6 (5.7–93.8)	2.86 (0.2–28.6)	<0.001

SD: Standard Deviation; HIV: Human Immunodeficiency Virus.

<https://doi.org/10.1371/journal.pone.0227778.t001>

Table 2. Clinical characteristics of the study population.

Characteristics	Overall n = 359 (%)	Men n = 157(%)	Women n = 202(%)	p-value
OSAHS symptoms				
Snoring	215 (59.9)	109 (69.4)	106 (52.5)	0.001
Apnea witnessed	64 (17.8)	37 (23.6)	27 (13.4)	0.018
Nocturia	141 (39.3)	94 (59.9)	124 (61.4)	0.828
Daytime fatigue	293 (81.6)	128 (81.5)	165 (81.7)	1
Non-restorative sleep	44 (31.8)	53 (33)	31 (31)	0.494
Sleepiness	205 (57.1)	91 (58)	114 (56.4)	0.83
Morning headaches	140 (39)	54 (34.4)	86 (42.6)	0.127
BMI, kg/m²	26.1 (22.3–30.8)	25.7 (23.2–29.3)	26.4 (21.3–32.9)	0,31
BMI > 30 kg/m²	110 (30.6)	33 (21)	74 (28.1)	0.001
Hip circumference, cm	90 (78–102)	88 (80–99)	94 (76–108)	0.047
Neck circumference, cm	37 (34–39)	39 (37–41)	35 (33–37.5)	<0.001
ESS	6 (3–8)	7 (5–9)	5 (3–7)	<0.001
ESS score > 10	24 (6.7)	12 (7.6)	12 (5.9)	0.531

All continuous variables are expressed as median (25th–75th percentiles); OSAHS: Obstructive Sleep Apnea and Hypopnea Syndrome; BMI: Body Mass Index; ESS: Epworth Sleepiness Scale

<https://doi.org/10.1371/journal.pone.0227778.t002>

Prevalence and characteristics of OSAHS

One hundred and eleven (30.9%) participants with valid PMD records constituted the sub-sample in which the prevalence of OSAHS was objectively evaluated. In those participants, hypertension, diabetes mellitus, snoring, non-restorative sleep and high risk of OSAHS were more frequent (Table 3).

The prevalence of OSAHS (95% CI) was 57.7% (48.5–66.9%). As presented in Table 4, of the 65 patients diagnosed with OSAHS, 35 had moderate to severe OSAHS, giving a prevalence (95% CI) of 31.5% (22.9–40.1%). OSAHS was found in 37 (62.7%) women vs 28 (53.8%) men ($p = 0.44$) and the equivalent figure for moderate to severe OSAHS was 22 (37.3%) women vs 13 (25%) men ($p = 0.22$). The median (25th–75th percentiles) AHI, BMI and ESS score of OSAHS patients were respectively 17 (10.6–26.9) per hour, 27.4 (24.7–31.6) kg/m² and 7 (5–9). The median arterial oxygen saturation was lower in women and women had a lower ESS score. None of the participants diagnosed with OSAHS was previously aware of this diagnosis.

Factors associated to moderate to severe OSAHS

Patients with moderate to severe OSAHS ($n = 35$) were compared to those without sleep apnea syndrome ($n = 40$) as presented in Table 5. In univariate analysis, hypertension was present in 82.9% of patients with moderate to severe OSAHS and in 52.9% of patients unaffected ($p = 0.004$). Forty percent of patients with moderate to severe OSAHS were living alone compared to 20% of those without OSAHS ($p = 0.032$). In multivariate analysis, the only factor associated with moderate to severe OSAHS [odds ratio (95% CI)] was hypertension [3.24 (1.08–9.72)]. Exclusion of OSAHS symptoms as potential associated factors did change neither the direction neither the strength of the association between moderate to severe OSAHS and its potentially associated factors.

Discussion

The aim of this cross-sectional study was to determine the prevalence of OSAHS and to investigate factors associated to OSAHS in patients admitted in a tertiary hospital in Cameroon.

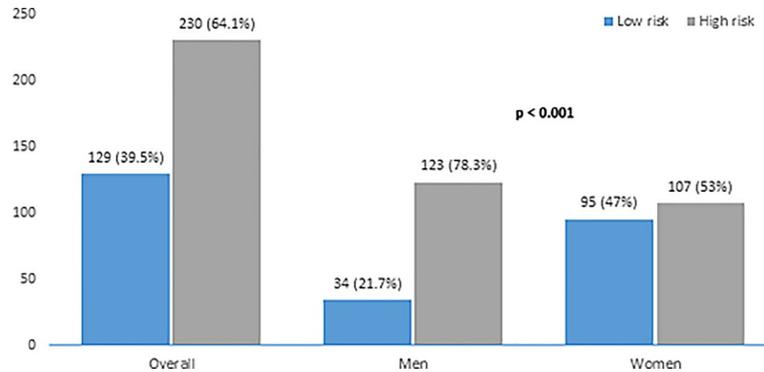


Fig 2. Risk of obstructive sleep apnea and hypopnea syndrome assessed by STOP-BANG questionnaire in the population study.

<https://doi.org/10.1371/journal.pone.0227778.g002>

The main results are: 1) a high risk of OSAHS was present in 64% of participants, as assessed from the STOP-BANG questionnaire; 2) about 2/3 of participants were diagnosed with OSAHS, while 1/3 had moderate to severe OSAHS; 3) hypertension was the only factor associated to moderate to severe OSAHS.

The prevalence of high risk of OSAHS we found in the present study using the STOP-BANG questionnaire is as high as previously reported by Sharma et al in 2015, in a study including obese patients admitted in a department of internal medicine [14]. In another study conducted by Njamnshi et al in Cameroon, 60% of patients with hypertension treated as out-patients were found to have a high risk of OSAHS using the Berlin questionnaire [25]. In the present study including patients with several comorbidities, the risk of OSAHS was found to be much higher than that assessed in the general population using the same questionnaire; namely 17.8% in Cameroon [10] or 36.9% in Nigeria [9].

Table 3. Characteristics of participants recorded and not recorded by the portable sleep monitoring device.

Characteristics	Recorded by PMD n = 111 (%)	Not recorded by PMD n = 248 (%)	p-value
Women	59 (53.2)	143 (57.7)	0.49
Age in years, mean (SD)	58 (12)	57 (17)	0.69
Hypertension	70 (63.1)	110 (44.1)	0.001
Diabetes mellitus	49 (44.1)	74 (29.8)	0.011
Heart failure	20 (18)	33 (13.3)	0.371
Stroke	38 (34.5)	73 (29.4)	0.262
Snoring	79 (71.2)	136 (54.8)	0.004
Apnea witnessed	27 (24.3)	37 (14.9)	0.037
Daytime fatigue	95 (85.6)	198 (79.8)	0.238
Non-restorative sleep	44 (39.6)	70 (28.9)	0.037
Sleepiness	71 (64)	134 (54)	0.083
Morning headaches	47 (42.3)	93 (37.5)	0.413
BMI > 30 kg/m ²	42 (37.8)	68 (27.4)	0.063
Neck circumference, cm (25 th -75 th percentiles)	37.5 (34–41)	36 (34–39)	0.106
Daytime sleepiness (ESS >10)	10 (9)	14 (5.6)	0.257
STOP-BANG ≥ 3	85 (76.6)	145 (58.5)	0.001

SD: Standard Deviation; BMI: Body Mass Index; PMD: Portable sleep Monitoring Device; OSAHS: Obstructive Sleep Apnea and Hypopnea Syndrome; ESS: Epworth Sleepiness Scale

<https://doi.org/10.1371/journal.pone.0227778.t003>

Table 4. Characteristics of patients diagnosed with obstructive sleep apnoea and hypopnea syndrome.

Characteristics	Overall n = 65 (%)	Men n = 28 (%)	Women n = 37 (%)	p-value
Total recording time, min	420 (360–480)	420 (360–450)	480 (360–480)	0.026
Number of OA	38 (12–73)	28 (11–69)	48 (15–114)	0.25
Number of hypopnea	55 (32–92)	58 (29–92)	54 (36–92)	0.88
Mean SaO ₂ , %	94 (92–96)	95 (93–96)	94 (92–95)	0.043
Minimal SaO ₂ , %	81 (73–86)	81 (74–88)	82 (72–85)	0.67
ODI, h ⁻¹	23 (15–36)	23 (13–38)	23 (16–35)	0.62
AHI, h ⁻¹	17 (10.6–26.9)	14.1 (10.8–26.6)	17.9 (9.5–29.6)	0.89
AHI > 15	35 (53.8)	13 (46.4)	22 (59.4)	0.33
Ethylic index, g/day	28.6 (2.86–59.8)	57.2 (6.2–120.3)	2.9 (0–28.6)	0.015
Sleepiness	47 (73.3)	21 (75)	26 (70.3)	0.79
BMI, kg/m ²	27.4 (24.7–31.6)	27.6 (24.7–30.9)	27.3 (24–31.6)	0.88
BMI > 30 kg/m ²	40 (61.5)	20 (71.4)	20 (54.1)	0.20
ESS score	7 (5–9)	8 (5–10)	6 (4–9)	<0.001
ESS score > 10	9 (13.8)	4 (14.3)	5 (13.5)	1

All continuous variables are expressed as median (25th-75th percentiles); OSAHS: Obstructive Sleep Apnea and Hypopnea Syndrome; AHI: Apnea-hypopnea index; SaO₂: arterial oxygen saturation; ODI: oxygen desaturation index; OA: Obstructive apnea; ESS: Epworth Sleepiness Scale; BMI: Body Mass Index

<https://doi.org/10.1371/journal.pone.0227778.t004>

To the best of our knowledge, few studies until now have characterised OSAHS in in-hospital patients in SSA. Other studies using PMD as diagnostic tool for OSAHS in hospitalized patients found that the prevalence of OSAHS was between 40 and 80% [16–18]. The prevalence of OSAHS in this cross-sectional study was 57.7%. An even higher prevalence of 87%

Table 5. Factors associated to moderate to severe OSAHS.

Factors	n (%)	Univariate analysis		Multivariate analysis	
		OR (95% CI)	p-value	OR (95% CI)	p-value
Male sex	13 (37.1)	0.62 (0.27–1.43)	0.268	-	-
Age > 50 years	31 (88.6)	1.58 (1.35–1.73)	0.05	1.81 (0.50–6.58)	0.37
Living alone	14 (40)	2.66 (1.10–6.52)	0.032	1.50 (0.46–4.93)	0.51
Illiterate	31 (88.6)	1.67 (0.42–6.68)	0.463	-	-
Employed	17 (48.6)	1.19 (0.53–2.68)	0.678	-	-
Ethylic index > 30 g/day	14 (40)	0.6 (0.26–1.41)	0.24	-	-
Hypertension	29 (82.9)	4.31 (1.59–11.68)	0.004	3.24 (1.08–9.72)	0.036
Heart failure	10 (28.6)	2.7 (0.98–7.47)	0.054	1.94 (0.63–6.01)	0.25
Stroke	10 (28.6)	0.79 (0.33–1.94)	0.619	-	-
Snoring	27 (77.1)	1.65 (0.65–4.20)	0.292	-	-
Apnea witnessed	9 (24.7)	1.17 (0.45–2.99)	0.746	-	-
Daytime fatigue	33 (94.3)	3.76 (0.79–17.71)	0.094	2.53 (0.48–13.22)	0.27
Non-restorative sleep	18 (51.4)	2.03 (0.89–4.64)	0.093	2.05 (0.82–5.13)	0.13
Sleepiness	26 (74.3)	2.04 (0.83–5)	0.118	-	-
Morning headaches	19 (54.3)	1.89 (0.83–4.30)	0.128	-	-
ESS score > 10	6 (17.1)	3.41 (0.89–13.01)	0.072	1.75 (0.41–7.53)	0.45
Neck circumference ≥ 38 cm	18 (51.4)	0.75 (0.33–1.69)	0.49	-	-
BMI > 30 kg/m ²	24 (68.4)	1.54 (0.65–3.62)	0.321	-	-

95% CI: 95% Confidence Interval; OR: Odds Ratio; OSAHS: Obstructive Sleep Apnoea and Hypopnoea Syndrome; ESS: Epworth Sleepiness Scale

<https://doi.org/10.1371/journal.pone.0227778.t005>

was found in obese patients at high risk of OSAHS at Philadelphia, using polysomnography, the gold standard for the diagnosis of OSAHS [14,26]. These prevalence rates are higher than those found in the community, probably because of the existence of an association between OSAHS and conditions leading to hospitalization, as already reported in other studies [27,28]. Furthermore, 31.5% of the participants had moderate to severe OSAHS, potentially requiring specific management. However, none of these patients were aware of their diagnosis of OSAHS, corroborating the results of previous works that underline the under-diagnosis of OSAHS in health care centres [14,29].

Factors associated to OSAHS in a hospital setting may differ according to the comorbidities present in the study population. In a Chinese study including type 2 diabetes patients, a per 1 kg/m² increase in BMI and a per 1 year increase in age were associated to OSAHS [16]. The ESS score ≥ 4 and nocturnal desaturation $< 82\%$ in hospitalized patients for acute myocardial infarction in Tunisia were associated with OSAHS [18]. In our study hypertension was independently associated to moderate to severe OSAHS, with an odd ratio as high as 3.24 in a sample where 63.1%, 44.1%, 34.5% and 18% respectively presented with hypertension, diabetes mellitus, stroke and heart failure. In a group of patients hospitalized for the management of a metabolic syndrome with controlled hypertension in France, Hansel et al also found hypertension to be associated to moderate to severe OSAHS [17].

The main limitation of the present study is that only one-third of the participants initially interviewed were recorded by PMD. Despite the random selection of patients to be recorded, while taking in consideration the risk of OSAHS, the two groups (recorded vs. non-recorded) were not entirely similar. Indeed, the frequency of known comorbidities of OSAHS (hypertension and diabetes mellitus), symptoms of OSAHS (snoring, non-restorative sleep) and high risk of OSAHS were greater in the recorded patients, probably justifying the high prevalence of OSAHS. Another limitation is the use of PMD as a diagnostic tool for OSAHS, and not the gold standard which is polysomnography. In our country, only one centre has a polysomnograph. Polysomnography, which requires more resources, is thus not very accessible. Although using PMD for the type of study that we performed seems to be appropriate, further research using the gold standard is necessary in the future. Nevertheless, PMD has a good sensitivity in high risk patients and / or with a strong clinical presumption of OSAHS [26], which was the case in this work. Furthermore, PMD yields a lower than expected AHI, since the total recording time is higher than the total sleep time and as PMD does not identify micrarousals, another diagnostic criteria of the hypopneas [26]. All this suggests that the prevalences obtained in this study may be plausible. To our knowledge, our study is the first in Cameroon, and even in whole SSA, to assess OSAHS through respiratory recordings during sleep and to evaluate the factors associated to OSAHS in a large group of hospitalized patients.

Conclusion

OSAHS is a common and under-diagnosed condition in patients with comorbidities in this Cameroonian tertiary health care centre. Hypertension is a factor significantly associated to moderate to severe OSAHS. In hospital setting, the screening for OSAHS in patients with hypertension, particularly if resistant or uncontrolled, is recommended. Additional studies, preferably using polysomnography for the diagnosis of OSAHS, are needed to confirm and extend the results obtained in this study.

Supporting information

S1 Data. Database of all patients included in the study.
(XLSX)

S2 Data. Database of randomly selected patients, recorded by portable sleep monitoring device in the study.

(XLSX)

Acknowledgments

The work was performed with the support of Nadine Kanko Nguekam.

Author Contributions

Conceptualization: Virginie Poka-Mayap, Dodo Balkissou Adamou, Massongo Massongo, Eric Walter Pefura-Yone.

Data curation: Virginie Poka-Mayap.

Formal analysis: Virginie Poka-Mayap.

Investigation: Steve Voufouo Sonwa, Jacqueline Alime, Ben Patrick Michel Moutlen.

Methodology: Dodo Balkissou Adamou.

Supervision: Dodo Balkissou Adamou, Massongo Massongo, Alfred Kongnyu Njamnshi, Eric Walter Pefura-Yone.

Writing – original draft: Virginie Poka-Mayap.

Writing – review & editing: Alfred Kongnyu Njamnshi, Andre Nosedo, Eric Walter Pefura-Yone.

References

1. Schipper MH, Jellema K, Thomassen BJW, Alvarez-Estevéz D, Verbraecken J, Rijsman RM. Stroke and other cardiovascular events in patients with obstructive sleep apnea and the effect of continuous positive airway pressure. *J Neurol*. 2017; 264(6):1247–53. <https://doi.org/10.1007/s00415-017-8522-z> PMID: 28550476
2. Xu S, Wan Y, Xu M, Ming J, Xing Y, An F, et al. The association between obstructive sleep apnea and metabolic syndrome: a systematic review and meta-analysis. *BMC Pulm Med*. 2015; 15(1):105.
3. Engel S, Karoff M, Raschke F, Fischer J. Prevalence of sleep apnea syndrome with primary arterial hypertension in a cardiologic rehabilitation clinic. *Pneumologie*. 1995 Mar; 49 Suppl 1:145–7.
4. Marin JM, Carrizo SJ, Vicente E, Agusti AGN. Long-term cardiovascular outcomes in men with obstructive sleep apnoea-hypopnoea with or without treatment with continuous positive airway pressure: an observational study. *Lancet (London, England)*. 2005 Mar; 365(9464):1046–53.
5. Peppard PE, Hagen EW. The Last 25 Years of Obstructive Sleep Apnea Epidemiology-and the Next 25? *Am J Respir Crit Care Med*. 2018 Feb 1; 197(3):310–2. <https://doi.org/10.1164/rccm.201708-1614PP> PMID: 29035088
6. Franklin KA, Lindberg E. Obstructive sleep apnea is a common disorder in the population—a review on the epidemiology of sleep apnea. *J Thorac Dis*. 2015 Aug; 7(8):1311–22. <https://doi.org/10.3978/j.issn.2072-1439.2015.06.11> PMID: 26380759
7. Heinzer R, Vat S, Marques-Vidal P, Marti-Soler H, Andries D, Tobback N, et al. Prevalence of sleep-disordered breathing in the general population: the HypnoLaus study. *Lancet Respir Med*. 2015 Apr; 3(4):310–8. [https://doi.org/10.1016/S2213-2600\(15\)00043-0](https://doi.org/10.1016/S2213-2600(15)00043-0) PMID: 25682233
8. Fietze I, Laharnar N, Obst A, Ewert R, Felix SB, Garcia C, et al. Prevalence and association analysis of obstructive sleep apnea with gender and age differences—Results of SHIP-Trend. *J Sleep Res*. 2018 Oct 1; e12770. <https://doi.org/10.1111/jsr.12770> PMID: 30272383
9. Ozoh OB, Okubadejo NU, Akinkugbe AO, Ojo OO, Asoegwu CN, Amadi C, et al. Prospective assessment of the risk of obstructive sleep apnea in patients attending a tertiary health facility in Sub-Saharan Africa. *Pan Afr Med J*. 2014 Jan; 17:302. <https://doi.org/10.11604/pamj.2014.17.302.2898> PMID: 25328598

10. Balkissou A, Pefura-Yone E, Kenyo-Kenne C, Massongo M, Afane-Ze E. Prevalence and Determinants of Obstructive Sleep Apnea in Semi-urban and Rural Area of Cameroon. In: ATS conference. 2017.
11. Obaseki DO, Kolawole BA, Gomerep SS, Obaseki JE, Abidoye IA, Ikem RT, et al. Prevalence and predictors of obstructive sleep apnea syndrome in a sample of patients with type 2 Diabetes Mellitus in Nigeria. *Niger Med J*. 2014 Jan; 55(1):24–8. <https://doi.org/10.4103/0300-1652.128154> PMID: 24970965
12. Shaheen HA, Abd El-Kader AA, El Gohary AM, El-Fayoumy NM, Afifi LM. Obstructive sleep apnea in epilepsy: a preliminary Egyptian study. *Sleep Breath*. 2012 Sep; 16(3):765–71. <https://doi.org/10.1007/s11325-011-0573-2> PMID: 21904805
13. Jniene A, el Ftouh M, Fihry MT el F. Sleep apnea syndrome: experience of the pulmonology department in Ibn Sina Hospital, Rabat, Morocco. *Pan Afr Med J*. 2012 Jan; 13:28. PMID: 23308333
14. Sharma S, Mather PJ, Efird JT, Kahn D, Shiue KY, Cheema M, et al. Obstructive Sleep Apnea in Obese Hospitalized Patients: A Single Center Experience. *J Clin Sleep Med*. 2015 Jul; 11(7):717–23. <https://doi.org/10.5664/jcsm.4842> PMID: 25766715
15. Shear TC, Balachandran JS, Mokhlesi B, Spampinato LM, Knutson KL, Meltzer DO, et al. Risk of sleep apnea in hospitalized older patients. *J Clin Sleep Med*. 2014 Oct 15; 10(10):1061–6. <https://doi.org/10.5664/jcsm.4098> PMID: 25317085
16. Zhang R, Guo X, Guo L, Lu J, Zhou X, Ji L. Prevalence and associated factors of obstructive sleep apnea in hospitalized patients with type 2 diabetes in Beijing, China 2. *J Diabetes*. 2015 Jan; 7(1):16–23. <https://doi.org/10.1111/1753-0407.12180> PMID: 24910109
17. Hansel B, Dourmap C, Giral P, Girerd EBX. Prévalence et déterminants du syndrome d'apnée du sommeil chez des hommes ayant un syndrome métabolique et une hypertension artérielle contrôlée. *Arch des Mal du coeur Vaiss*. 2007; 100(8):637–41.
18. Ben Ahmed H, Boussaid H, Hamdi I, Boujnah MR. Prevalence and predictors of obstructive sleep apnea in patients admitted for acute myocardial infarction. *Ann Cardiol d'angiologie*. 2014 Apr; 63(2):65–70.
19. Diaz K, Faverio P, Hospenthal A, Restrepo M, Amuan M, Pugh MJ, et al. Obstructive sleep apnea is associated with higher healthcare utilization in elderly patients. *Ann Thorac Med*. 2014 Apr; 9(2):92. <https://doi.org/10.4103/1817-1737.128854> PMID: 24791172
20. Johns MW. A new method for measuring daytime sleepiness: the Epworth sleepiness scale. *Sleep*. 1991 Dec; 14(6):540–5. <https://doi.org/10.1093/sleep/14.6.540> PMID: 1798888
21. Nagappa M, Liao P, Wong J, Auckley D, Ramachandran SK, Memtsoudis S, et al. Validation of the STOP-Bang Questionnaire as a Screening Tool for Obstructive Sleep Apnea among Different Populations: A Systematic Review and Meta-Analysis. *PLoS One*. 2015 Jan; 10(12):e0143697. <https://doi.org/10.1371/journal.pone.0143697> PMID: 26658438
22. Chung F, Yegneswaran B, Liao P, Chung SA, Vairavanathan S, Islam S, et al. STOP questionnaire: a tool to screen patients for obstructive sleep apnea. *Anesthesiology*. 2008 May; 108(5):812–21. <https://doi.org/10.1097/ALN.0b013e31816d83e4> PMID: 18431116
23. Berry R, Brooks R, Gamaldo C, Harding S, Llyod R, Marcus C, et al. The AASM Manual for the Scoring of Sleep and Associated Events: Rules, Terminology and Technical specifications, Version 2.1. Darien, Illinois: American Academy of Sleep Medicine; 2014.
24. Sateia MJ. International classification of sleep disorders-third edition: highlights and modifications. *Chest*. 2014 Nov; 146(5):1387–94. <https://doi.org/10.1378/chest.14-0970> PMID: 25367475
25. Njamnshi AK, Mengnjo MK, Mbong EN, Kingue S, Fonsah JY, Njoh AA, et al. Hypertension in Cameroon associated with high likelihood of obstructive sleep apnea: a pilot study. *BMC Cardiovasc Disord*. 2017; 17(1):112. <https://doi.org/10.1186/s12872-017-0542-1> PMID: 28482815
26. Epstein LJ, Kristo D, Strollo P, Friedman N, Malhotra A, Patil S, et al. Clinical Guideline for the Evaluation, Management and Long-term Care of Obstructive Sleep Apnea in Adults. *J Clin Sleep Med*. 2009; 5(3):263–76. PMID: 19960649
27. Van den Broecke S, Jobard O, Montalescot G, Bruyneel M, Ninane V, Arnulf I, et al. Very early screening for sleep-disordered breathing in acute coronary syndrome in patients without acute heart failure. *Sleep Med*. 2014 Dec; 15(12):1539–46. <https://doi.org/10.1016/j.sleep.2014.06.017> PMID: 25308397
28. Martínez-García MA, Galiano-Blancart R, Soler-Cataluña J-J, Cabero-Salt L, Román-Sánchez P. Improvement in Nocturnal Disordered Breathing After First-Ever Ischemic Stroke. *Chest*. 2006 Feb; 129(2):238–45. <https://doi.org/10.1378/chest.129.2.238> PMID: 16478837
29. Correia LCL, Souza AC, Garcia G, Sabino M, Brito M, Maraun M, et al. Obstructive sleep apnea affects hospital outcomes of patients with non-ST-elevation acute coronary syndromes. *Sleep*. 2012; 35(9):1241–5A. <https://doi.org/10.5665/sleep.2078> PMID: 22942502