Obstructive Sleep Apnea among the Lebanese general population: Prevalence, associated factors and knowledge

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Research

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Abstract

Background : To date, there has been no large population-based study associated with public awareness in Lebanon about sleep apnea. Our study investigated the prevalence of, associated factors and knowledge of Obstructive Sleep Apnea (OSA) among a representative sample of Lebanese adults.

Methods: A cross-sectional study, conducted between June and August 2019, enrolled 472 people aged above 18 years. A proportionate random sample from all Lebanese Mohafazat was applied.

Results: The study results showed that a higher number of cigarettes per day, having diabetes mellitus, myocardial infarction, hypertension and arrhythmia were associated with higher daytime sleepiness. Participants living in the North had less daytime sleepiness, whereas those living in Beqaa had higher daytime sleepiness compared to those living in Beirut. Concerning knowledge, having heard about sleep apnea and having a university level of education were associated with a higher score, whereas having cerebrovascular accidents was associated with lower knowledge scores.

Conclusion Complications of OSA are still poorly known, as are certain suggestive symptoms. Given the local relevance of OSA, ongoing health campaigns and innovative educational programs should be assigned to target the general community.

Background

Obstructive sleep apnea (OSA) is a common Sleep Disordered Breathing (SDB)[1] with various life-threatening impacts[2]. Described by the World Health Organization (WHO) as a complete or partial collapse of the airways[3], OSA is characterized by recurrent hypopnea during sleep, leading to a loss of saturated oxyhemoglobin[4]. Despite diaphragm contractions in opposition to this obstruction, hypoxemia occurs, hence, provoking arousals and sleep deprivation[1]. According to the American Academy of Sleep Medicine, undiagnosed sleep apnea costs $30 billion annually linked to the comorbid health risks of OSA[5].

Patients with OSA present symptoms of functional impairment and decrease cognitive performance, aside from snoring, morning headache, day-time hypersomnolence, nocturia and fatigue[6,7]. The estimated prevalence of OSA ranges from 9% to 38%[8] in community-screened populations to a significantly higher prevalence in those older than 60 years[9]. In the middle- to older-aged general population, it affects 49% of men and 23% of women[10]. Based on socio-demographic studies, men are three times more likely than women to have OSA[9].

It is well known that OSA is tightly linked to multifactorial etiologies and physical attributes such as oropharyngeal narrowed airway, neck and waist circumference[11], body mass index (BMI) and obesity[9]. In fact, the Wisconsin Sleep Cohort proved a 32% rise in Apnea-hypopnea index (AHI) and a six-fold increased risk of developing OSA with every 10% weight gain[12]. Other factors also associated with OSA

include hypertension [13], smoking and alcoholism [12] with a higher prevalence seen in those categories of people. Association of snoring with cardiovascular disease suggests that even a mild degree of sleep-disordered breathing may have adverse health effects[14,15]. Lack of sleep has an effect on the immune, endocrine and nervous systems[16] and is associated with poor glycemic control[17]. Afterwards, insufficient sleep is an influencer of body metabolism[18].

Insightful that sleep plays a role in intellectual and academic attainments[19,20], OSA has been involved with impaired daytime function and psychiatric symptom[21]. It has a relevant impact on road safety, as it substantially contributes to the burden of road-related morbidity and mortality[22].

An awareness study done in Singapore showed a currently poor knowledge level among the general population[23]. Similar results were found in Lorraine-France as the complications and suggestive symptoms were still barely known[24]. In Riyadh, Primary Health Care physicians didn't completely recognize the importance and impact of Obstructive Sleep Apnea[25].

Patients today need to be aware of common pathologies and symptoms that should lead them to consult. Several research studies have shown a positive relationship between obstructive sleep apnea knowledge, and application of preventive measures. Moreover, patient education improves treatment compliance[24]. Sleep-disordered breathing is highly prevalent, with important public health outcomes. Individuals at high risk of incident SDB should be identified so treatment efforts can be focused on them.

To date, there has been no large population-based study associated with public awareness in Lebanon about sleep apnea. Besides, SDB prevalence is still unknown. A study conducted in Beirut, reported that although 31% participants were at high risk for sleep apnea, only 5% were diagnosed by a physician, which makes sleep apnea likely prevalent but underdiagnosed in Lebanon[26]. Conscious of the medical comorbidities associated to OSA, and its socioeconomic disadvantages, we developed a study to evaluate the prevalence of and factors associated with OSA and knowledge about it among a representative sample of Lebanese adults.

Methods

Study and population

A cross-sectional study was conducted between June and August 2019, which enrolled 500 people aged above 18 years using a proportionate random sample from all Lebanese governorates (Beirut, Mount Lebanon, North, South, and Beqaa). Each governorate is divided into Caza (stratum), which in turn is divided to multiple villages. Two villages selected randomly from the list of villages provided by the Central Agency of Statistics in Lebanon. Households were randomly selected from each village using an online software[27]. Excluded were people unable to understand Arabic -the national language- people with cognitive impairment (trouble remembering or concentrating)[28] as reported by a family member, or who refused to participate in the survey.

Sample size calculation

According to the Epi info sample size calculations with a population size of 5 million in Lebanon, assuming a 50% frequency of OSA knowledge among the general population in the absence of similar studies in the country, a 95% confidence level, a power of 80%, and an acceptable bound of error of 5%, a sample of 384 contestants was required to fulfill the objectives and allow for adequate power for bivariate and multivariable analyses. We conducted the questionnaire on a total of 600 individuals. Eighty-seven refused to participate in the study (14.5%), and twelve terminated the interview before completion (2%). A total of 472 (83.5%) completed the interview and were included in the final analysis.

Data collection

A standardized method of interviewing was adopted by trained, study independent personnel. We used as our measurement tool a strictly anonymous questionnaire divided into four parts.

The first part (Part 1: Socio-demographic characteristics) was collected through a multiple-choice format of 19 questions. The gender, the age, the weight, the height, the educational level (illiterate, primary, secondary, university level or higher education) and the health insurance were mentioned. The governorate and the lifestyle (smoking, alcohol and coffee consumption) were also included, in addition to the number of traffic accident per year. The monthly income was divided into 4 categories, as follows, based on the salary: none, low (1000 USD), intermediate (1000–2000 USD), and high (>2000 USD). We asked about last medical visit and its yearly frequency. The BMI was calculated from the reported weight and height of the individual.

The second part (Part 2: Personal diseases) asking whether the respondent had ever heard about OSA, if he/she had a prior physician diagnosis of OSA. If yes, the respondent was asked if he/she was currently on any sort of treatment. Questions about history of personal diseases included hypertension (HTA), diabetes (DM), cerebrovascular accident (CVA), arrhythmia and myocardial infarction (MI). Those where settled in a chronology compared with OSA diagnosis, if present: “yes, before OSA diagnosis” and “yes, after OSA diagnosis”; the other possible answers were “no” and “yes, without OSA diagnosis”. Nocturia was also mentioned, by citing the number of times a participant gets out of bed, at night, to urinate.

The third part (Part 3: The Knowledge Scale) intended to get information concerning the knowledge of OSA, subdivided into two main focuses: suggestive symptoms and possible complications. There were 13 items concerning suggestive OSA symptoms (10 correct, plus 3 distractors) and 13 possible complications (7 correct, plus 6 distractors), as mentioned in the Appendix1. This yielded an overall score ranged between 0 and 26.

Currently, the Obstructive Sleep Apnea and Attitudes Questionnaire (OSAKA) is valid for use in physicians to assess OSA knowledge[29]. However, few scales consisted of questions addressed to the general population[23,24]. To collect data related to knowledge and to investigate disease-related beliefs among the general population, we used a questionnaire based on the previously published “Guidelines for clinical

practice in OSAHS in adults"[30]. It has been translated from the Loraine's questionnaire[24] in Arabic. Forward and back method was adopted for the translation from French to Arabic then from Arabic to French by two different translators, the latter understanding of the content of the different scales. The two French versions were compared; discrepancies were resolved by consensus between the authors and the translators.

We considered the following answers as acceptable for the symptoms: Snoring, respiratory breaks, daytime fatigue, suffocating sensation, non-restorative sleep, daytime somnolence, concentration disorder, morning headache, nocturia and obesity. For health consequences, those were the right answers: stoke, DM, HTA, dementia, cardiac arrythmia, MI and road accident. To avoid the selection of a random answer by participants, the "I don't know" answer was added[24] in addition to the no and yes answers. One point was given for a "yes" answer, 0 for a "no" or "I don't know" answer. Although, for itchy at night, joint pain and vomiting in the morning, 1 point was given for a "no" answer and 0 for a "yes" or "I don't know" answer. Same for a "no" answer to: hair loss, depression, deafness, libido dysfunction, language disorder and respiratory failure, 1 point was given, and 0 points for "yes" or "I don't know" answers.

The fourth part (Part 4: Screening): A thorough literature review highlighted the presence of well-validated scales used in research studies to diagnose OSA: the Epworth Sleepiness Scale (ESS)[31] and the STOP-BANG questionnaire (SBQ)[32]. These two scales were chosen since the ESS is recommended to be included in screening evaluations[33,34], and the SBQ for being superior in detecting OSA in the general population[35,36].

ESS inquires about falling asleep in some circumstances, referring to the usual way of life. The Arabic form has been validated as an authentic tool[37]. The SBQ, also valid in Arabic, reported snoring behavior, tiredness, gasping, hypertension and neck circumference[38]. It is scaled as "OSA-low Risk" for a positive answer to 0-2 questions, "OSA-Intermediate Risk" for 3-4 positive answers and "OSA-High Risk" for a score of 5-8, or a minimum of 2 on the STOP questions in addition to male gender, BMI>35kg/m^2 or an elevated neck circumference (>43cm in male or >41cm in woman)[32].

A pilot study was run on about 20 subjects -not included in the study- to ensure the understanding and acceptability of the questions in the general population. Few linguistic modifications improved the response rate in the final questionnaire.

Statistical analysis

Statistical Package for Social Science (SPSS) version 23 was used for the statistical analyses. Descriptive statistics were presented using mean and standard deviation for continuous measures, frequencies and percentages for categorical variables.

The Student t-test and ANOVA test were used to assess the association between each continuous independent variable (Epworth total score, Stop Bang total score and knowledge score) and the

sociodemographic and other variables. To calculate the p-value of the statistical significance, the Bonferroni correction compensates for that increase by testing each individual hypothesis at a significance level of α/m, where α is the desired overall alpha level and m is the number of hypotheses/tests conducted (23). Concerning the knowledge, attitude and practice scores, we tested 19 hypotheses/variables in each model, with a desired error α of 0.05; therefore, the Bonferroni correction would test each individual hypothesis at a p-value of 0.05/19=0.002.

Multivariable linear regression models were done to explore factors associated with the three scores as dependent variables and taking all variables that showed a $p \leq 0.002$ in the bivariate analysis as independent variables. A $p<0.05$ in the multivariable model was considered significant. Moreover, Cronbach's alpha was recorded for reliability analysis for each scale.

Results

The mean age of the participants was 39.39 ± 15.89 (51.7% males). Other descriptive results of our sample are summarized in Table 1. The percentage of physician-diagnosed sleep apnea in our sample was 11% [95% CI 0.082–0.138] (52 participants). The Cronbach's alpha values of the scales used were as follows: Knowledge (0.833) and Epworth scale (0.761).

Moreover, the mean knowledge score was 13.72 ± 3.86. When using the visual binning option in SPSS, the results showed that 159 (33.7%) had poor knowledge (scores ≤ 11), whereas 165 (35.0%) and 148 (31.4%) had moderate (scores between 12 and 15) and good (scores ≥ 16) knowledge respectively.

Table 1. Sociodemographic and other characteristics of the participants (N = 472).

Variable	N (%)
Gender	
Male	244 (51.7%)
Female	228 (48.3%)
Mohafazat	
Beirut	87 (18.4%)
Mount Lebanon	83 (17.6%)
North Lebanon	169 (35.8%)
South Lebanon	47 (10.0%)
Bekaa	86 (18.2%)
Health coverage	
None	96 (20.3%)
Social security	174 (36.9%)
Cooperative	87 (18.4%)
Mutual funds	13 (2.8%)
Private	55 (11.7%)
Army	21 (4.4%)
Social security and private	26 (5.5%)
Monthly income	
None	101 (21.4%)
Low	203 (43.0%)
Intermediate	93 (21.1%)
High	44 (10.0%)
Education level	
Illiterate	25 (5.3%)
Primary	26 (5.5%)
Complementary	66 (14.0%)
Secondary	122 (25.8%)

Table 1. Sociodemographic and other characteristics of the participants (N = 472).	
University	233 (49.4%)
Living situation	
Alone	87 (18.4%)
With a family member	385 (81.6%)
Body Mass Index categories (Kg/m^2)	
< 18	11 (2.3%)
18-24.99	232 (49.2%)
25-29.99	166 (35.2%)
30-34.99	45 (9.5%)
35 and above	18 (3.8%)
Epworth score categories	
Lower normal daytime sleepiness	128 (27.2%)
Higher normal daytime sleepiness	133 (28.2%)
Mild excessive daytime sleepiness	68 (14.4%)
Moderate excessive daytime sleepiness	77 (16.3%)
Severe excessive daytime sleepiness	65 (13.8%)
Stop Bang categories	
Low risk	287 (60.8%)
Intermediate risk	149 (31.6%)
High risk	36 (7.6%)
	Mean ± SD
Age (in years)	39.39 ± 15.89
Body Mass Index (Kg/m^2)	25.43 ± 5.21
Epworth total score	9.51 ± 5.86
Stop Bang score	2.20 ± 1.51

Bivariate analysis

A higher mean Epworth score was significantly found in males compared to females, in those with a high monthly income compared to all other categories, in those living in Beirut compared to other regions, in those who were diagnosed with hypertension after the OSA diagnosis compared to the other groups, in those diagnosed with diabetes mellitus, cerebrovascular accidents and myocardial infarction without OSA diagnosis compared to the other groups, in those diagnosed with arrhythmia before OSA diagnosis and in those who heard about sleep apnea compared to those who did not.

A higher mean Stop Bang score was significantly found in those living in Bekaa compared to the other regions, in those who were diagnosed with hypertension after sleep apnea diagnosis and in those diagnosed with myocardial infarction without sleep apnea diagnosis compared to the other categories.

A higher mean knowledge score was significantly found in those who did not smoke waterpipe compared to those who did, in those who had a university level of education compared to all other levels, in those living in Mount Lebanon compared to all other regions, in those who had social security and private insurance compared to the other groups, in those who had cerebrovascular accidents after sleep apnea diagnosis compared to the other groups and in those who heard about sleep apnea compared to those who did not.

Table 2. Bivariate of factors associated with the Epworth, Stop Bang and knowledge scores.

Variable	Epworth score	Stop Bang score	Knowledge score
Gender			
Male	2.76 ± 1.42	-	13.47 ± 3.94
Female	2.45 ± 1.34	-	13.97 ± 3.77
p-value	< 0.001	-	0.103
Cigarette smoking			
No	2.56 ± 1.42	2.14 ± 1.50	13.78 ± 3.73
Yes	2.73 ± 1.31	2.36 ± 1.52	13.54 ± 4.19
p-value	0.084	0.176	0.367
Waterpipe smoking			
No	2.61 ± 1.44	2.28 ± 1.50	13.83 ± 3.92
Yes	2.62 ± 1.23	1.96 ± 1.50	13.35 ± 3.68
p-value	0.237	0.039	0.277
Cigar smoking			
No	2.60 ± 1.39	2.17 ± 1.50	13.56 ± 3.81
Yes	2.84 ± 1.46	2.84 ± 1.57	17.47 ± 2.99
p-value	0.342	0.059	< 0.001
Education level			
Illiterate	2.96 ± 1.51	2.48 ± 1.41	11.96 ± 3.22
Primary	3.08 ± 1.41	2.61 ± 1.76	12.92 ± 3.82
Complementary	2.56 ± 1.37	2.39 ± 1.55	11.91 ± 3.14
Secondary	2.59 ± 1.42	2.13 ± 1.53	12.85 ± 3.49
University	2.55 ± 1.36	2.10 ± 1.45	14.96 ± 3.90
p-value	0.262	0.426	< 0.001
Monthly income			
No income	2.46 ± 1.47	1.95 ± 1.55	13.76 ± 3.72
Low	2.54 ± 1.31	2.13 ± 1.53	13.14 ± 3.79

Table 2. Bivariate of factors associated with the Epworth, Stop Bang and knowledge scores.

Intermediate	2.67 ± 1.46	2.41 ± 1.41	14.78 ± 4.03
High	3.25 ± 1.41	2.65 ± 1.36	14.54 ± 4.05
p-value	0.002	0.01	0.005
Region			
Beirut	3.01 ± 1.34	2.49 ± 1.37	13.31 ± 3.50
Mount Lebanon	2.63 ± 1.45	2.27 ± 1.46	14.61 ± 4.04
North Lebanon	2.32 ± 1.43	1.68 ± 1.31	13.79 ± 3.97
South Lebanon	2.63 ± 1.32	2.40 ± 1.61	12.76 ± 3.55
Bekaa	2.73 ± 1.23	2.75 ± 1.69	13.64 ± 3.88
p-value	< 0.001	< 0.001	< 0.001
Health Insurance			
None	2.50 ± 1.43	2.06 ± 1.50	12.61 ± 3.29
Social security	2.57 ± 1.35	2.26 ± 1.47	13.47 ± 3.70
COOP	2.74 ± 1.37	2.12 ± 1.57	14.12 ± 4.01
Mutual	3.00 ± 1.73	1.92 ± 1.25	14.53 ± 3.82
Private	2.63 ± 1.43	2.52 ± 1.75	14.65 ± 4.24
Army	2.62 ± 1.39	2.00 ± 0.95	12.42 ± 3.55
Social security + private	2.61 ± 1.41	2.19 ± 1.49	16.73 ± 3.87
p-value	0.780	0.684	0.002
Housing			
Living alone	2.91 ± 1.43	2.61 ± 1.41	13.08 ± 4.07
Living with a family member	2.54 ± 1.37	2.11 ± 1.52	13.86 ± 3.80
p-value	0.015	0.003	0.043
Marital status			
Single/widowed/ divorced	2.62 ± 1.34	2.26 ± 1.52	13.37 ± 3.95
Married	2.60 ± 1.45	2.12 ± 1.49	14.16 ± 3.72
p-value	0.556	0.268	0.014
Alcohol drinking			

Table 2. Bivariate of factors associated with the Epworth, Stop Bang and knowledge scores.			
None	2.45 ± 1.36	2.01 ± 1.48	12.99 ± 3.50
Less than once a month	2.56 ± 1.41	2.23 ± 1.43	13.74 ± 3.82
At least once a month	2.73 ± 1.39	2.30 ± 1.50	13.91 ± 3.78
At least once a week	2.77 ± 1.43	2.32 ± 1.55	14.98 ± 4.11
Daily	3.10 ± 1.33	2.89 ± 1.79	13.84 ± 5.17
p-value	0.07	0.152	0.006
Coffee intake			
None/ Less than once a month/ At least once a month	9.43 ± 6.46	2.09 ± 1.49	12.99 ± 3.81
At least once a week	10.28 ± 4.36	2.59 ± 1.67	14.09 ± 4.21
Daily	9.38 ± 5.68	2.19 ± 1.46	14.19 ± 3.74
p-value	0.510	0.139	0.003
Hypertension			
No	2.30 ± 1.27	1.91 ± 1.40	13.85 ± 3.83
Yes, without sleep apnea diagnosis	3.29 ± 1.47	2.80 ± 1.57	12.83 ± 3.81
Yes, before sleep apnea diagnosis	3.31 ± 0.87	2.81 ± 1.52	14.06 ± 3.19
Yes, after sleep apnea diagnosis	3.50 ± 1.29	3.28 ± 1.33	17.43 ± 3.25
p-value	< 0.001	< 0.001	0.017
Diabetes mellitus			
No	2.40 ± 1.34	2.06 ± 1.44	13.91 ± 3.88
Yes, without sleep apnea diagnosis	3.43 ± 1.38	2.68 ± 1.68	12.55 ± 3.50
Yes, before sleep apnea diagnosis	2.75 ± 0.96	2.75 ± 0.96	15.00 ± 2.83
Yes, after sleep apnea diagnosis	3.36 ± 0.81	3.00 ± 1.48	15.54 ± 4.34
p-value	< 0.001	0.003	0.008
Cerebrovascular accidents			
No	2.54 ± 1.37	2.15 ± 1.51	13.84 ± 3.86
Yes, without sleep apnea diagnosis	3.86 ± 1.32	2.78 ± 1.16	11.17 ± 2.9
Yes, after sleep apnea diagnosis	3.20 ± 0.84	4.00 ± 1.22	14.20 ± 3.56

Table 2. Bivariate of factors associated with the Epworth, Stop Bang and knowledge scores.			
p-value	< 0.001	0.003	0.001
Arrhythmia			
No	8.74 ± 5.94	2.12 ± 1.50	13.74 ± 3.86
Yes, without sleep apnea diagnosis	12.37 ± 4.95	2.45 ± 1.56	12.98 ± 3.69
Yes, before sleep apnea diagnosis	13.27 ± 2.19	2.63 ± 0.92	16.18 ± 3.09
Yes, after sleep apnea diagnosis	10.63 ± 3.69	2.63 ± 1.50	15.72 ± 4.47
p-value	< 0.001	0.125	0.014
Myocardial infarction			
No	2.48 ± 1.35	2.11 ± 1.48	13.79 ± 3.85
Yes, without sleep apnea diagnosis	4.06 ± 1.18	3.03 ± 1.58	11.97 ± 3.58
Yes, after sleep apnea diagnosis	3.08 ± 1.18	3.00 ± 1.53	15.77 ± 3.74
p-value	< 0.001	0.001	0.006
Heard about sleep apnea			
No	2.54 ± 1.41	2.15 ± 1.51	12.47 ± 3.40
Yes	3.17 ± 1.15	2.61 ± 1.46	15.93 ± 3.65
p-value	< 0.001	0.034	< 0.001

Numbers in bold indicate significant p-values after Bonferroni corrections.

Post hoc analysis: Epworth score: monthly income (no vs high p = 0.011; low vs high p = 0.016); mohafaza (Beirut vs North p = 0.002); hypertension (no vs yes without sleep apnea diagnosis p < 0.001; no vs yes before sleep apnea diagnosis p = 0.016; no vs yes after sleep apnea diagnosis p = 0.005); diabetes mellitus (no vs yes without sleep apnea diagnosis p < 0.001); cerebrovascular accident (no vs yes without sleep apnea diagnosis p < 0.001); myocardial infarction (no vs yes without sleep apnea diagnosis p < 0.001); arrhythmia (no vs yes without sleep apnea diagnosis p < 0.001).

Stop Bang score: Mohafaza (Beirut vs North p < 0.001; Mount Lebanon vs North p = 0.023; North vs South p = 0.027; Bekaa vs North p < 0.001); hypertension (no vs yes without sleep apnea diagnosis p < 0.001; no vs yes after sleep apnea diagnosis p = 0.005); diabetes mellitus (no vs yes without sleep apnea diagnosis p = 0.004); cerebrovascular accident (no vs yes after sleep apnea diagnosis p = 0.019); myocardial infarction (no vs yes without sleep apnea diagnosis p = 0.002).

Knowledge score: education level (illiterate vs university p = 0.001; complementary vs university p < 0.001; secondary vs university p < 0.001); coffee drinking (none vs everyday p = 0.02); insurance coverage (no vs private p = 0.03; no vs social security and private p < 0.001; social security vs social security and private p = 0.001); cerebrovascular accident (no vs yes without sleep apnea diagnosis p = 0.004).

Furthermore, higher age ($r = 0.172$; $p < 0.001$), higher BMI ($r = 0.214$; $p < 0.001$) and a higher number of cigarettes per day ($r = 0.119$; $p = 0.01$) were weakly but significantly correlated with a higher Epworth total score. Higher age ($r = 0.283$; $p < 0.001$) and BMI ($r = 0.170$; $p < 0.001$) were significantly correlated with the Stop Bang score, whereas none of the variables was significantly correlated with the knowledge score.

Multivariable analysis

The results of a first linear regression, taking the Epworth score as the dependent variable, showed that having diabetes mellitus (B = 2.42), myocardial infarction (B = 2.60), arrhythmia (B = 2.16) without sleep apnea diagnosis compared to those who did not have those diseases, having arrhythmia before the sleep apnea diagnosis (B = 4.32) and a higher number of cigarettes per day (B = 0.06) were significantly associated with higher Epworth scores, whereas living in North Lebanon compared to Beirut (B=-1.26) was significantly associated with lower Epworth scores (Table 3, Model 1).

The results of a second linear regression, taking the Stop bang score as the dependent variable, showed that having hypertension (B = 0.75) without sleep apnea diagnosis compared to those who did not have diagnosis and living in Bekaa compared to Beirut (B = 0.47) were significantly associated with higher Stop Bang scores, whereas living in North Lebanon compared to Beirut (B=-0.71) was significantly associated with lower Stop Bang scores (Table 3, Model 2).

The results of a third linear regression, taking the knowledge score as the dependent variable, showed that having heard about sleep apnea compared to those who have not heard about the disease (B = 3.09), having a university level of education compared to illiteracy (B = 1.89) and living in North Lebanon compared to Beirut (B = 0.91) were significantly associated with higher knowledge, whereas having cerebrovascular accidents without sleep apnea diagnosis compared to those who did not have CVAs (B=-1.45) was significantly associated with lower knowledge scores (Table 3, Model 3).

Table 3. Multivariable analysis.

Model 1: Stepwise linear regression taking the Epworth total score as the dependent variable.					
Variable	Unstandardized Beta	Standardized Beta	p-value	95% Confidence Interval	
Diabetes mellitus (Yes, without sleep apnea diagnosis vs no*)	2.42	0.16	0.002	0.92	3.92
Number of cigarettes per day	0.06	0.11	0.02	0.01	0.10
Arrhythmia (Yes, without sleep apnea diagnosis vs no*)	2.16	0.14	0.005	0.66	3.66
North Lebanon compared to Beirut*	-1.26	-0.10	0.024	-2.35	-0.17
Myocardial infarction (Yes, without sleep apnea diagnosis vs no*)	2.60	0.12	0.019	0.42	4.77
Arrhythmia (Yes, before sleep apnea diagnosis vs no*)	4.32	0.10	0.023	0.59	8.05
Model 2: Stepwise linear regression taking the Stop Bang total score as the dependent variable.					
Variable	Unstandardized Beta	Standardized Beta	p-value	95% Confidence Interval	
North Lebanon compared to Beirut*	-0.71	-0.22	< 0.001	-1.02	-0.40
Hypertension (Yes, without sleep apnea diagnosis vs no*)	0.75	0.21	< 0.001	0.41	1.08
Bekaa vs Beirut*	0.47	0.12	0.022	0.07	0.87
Model 3: Stepwise linear regression taking the knowledge score as the dependent variable.					
Variable	Unstandardized Beta	Standardized Beta	p-value	95% Confidence Interval	

Variables entered in model 1: gender, monthly income, Mohafazat, hypertension, diabetes mellitus, cerebrovascular accidents, myocardial infarction, arrhythmia, age, having heard about sleep apnea.
Variables entered in model 2: age, gender, mohafazat, hypertension, myocardial infarction.
Variables entered in model 3: Education level, type of insurance, hypertension, having heard about sleep apnea. Physician diagnosis of sleep apnea.

Table 3. Multivariable analysis.					
Having heard about sleep apnea (yes vs no*)	3.09	0.38	< 0.001	2.43	3.74
University education level vs illiteracy	1.89	0.25	< 0.001	1.27	2.52
North Lebanon vs Beirut*	0.91	0.11	0.006	0.27	1.56
Cerebrovascular accidents (Yes, without sleep apnea diagnosis vs no*)	-1.45	-0.08	0.046	-2.87	-0.03
Variables entered in model 1: gender, monthly income, Mohafazat, hypertension, diabetes mellitus, cerebrovascular accidents, myocardial infarction, arrhythmia, age, having heard about sleep apnea.					
Variables entered in model 2: age, gender, mohafazat, hypertension, myocardial infarction.					
Variables entered in model 3: Education level, type of insurance, hypertension, having heard about sleep apnea. Physician diagnosis of sleep apnea.					

Discussion

To the best of our knowledge, this study is the first large scale survey to assess the prevalence of OSA and its level of knowledge among the general Lebanese population. In this representative sample of people aged above 18 years, 11% had already been diagnosed by a health care provider with OSA. In addition, 30.1% had moderate/high excessive daytime sleepiness according to the EES, whereas 39.2% had intermediate to high risk occurrence of OSA; 31.4% of the participants only had good knowledge. Finally, this study was able to shed light on some factors associated with daytime sleepiness and knowledge among our sample.

Multiple studies conducted worldwide have aimed to evaluate the prevalence of OSA. The proportion of Lebanese patients screening positive for OSA on the questionnaire is in harmony with the prevalence reported in the general Asian population, with 9.7% having a moderate to severe risk of OSA[39]. Recent studies have shown that the prevalence of sleep apnea in Asia is high (ranging from 3.7–97.3%)[40]. This prevalence strongly increased during the last 20 years, depending on age, gender and obesity[41]. An American study, published this year, estimated a prevalence of moderate to severe OSA of 37.0%[42]. Although Lebanon is a multiethnic society, our findings provides baseline data on the current state of OSA awareness in the community.

Having diabetes mellitus was significantly associated with higher daytime sleepiness according to the ESS. The main reason is that this population has a higher prevalence of snoring, which increases apnea/hypopnea over time and lead to OSA[43]. Mechanisms may include autonomic dysfunction and loss of upper airway innervations. Thus hypercapnic stimulus leads to a central respiratory control response giving sleep apnea[44]. Moreover, obesity is a key moderator of the effect of OSA on DM[45]. On the

other side, intermittent chronic hypoxia alters glucose metabolism, promoting insulin resistance, and thus DM[46].

Having arrhythmia and MI were both associated with higher daytime sleepiness. A systematic literature review proved an association between OSA and cardiovascular events[47]. In fact, up to 65% of patients who suffer from a cardiovascular disease are diagnosed with OSA[48]. This might be due to the fact that many shared risk factors are common between those two conditions[49]. Thus, current evidence of the association appears in middle-aged adults and patients with multiple cardiovascular risk factors[50]. In addition, OSA appears to play an important role in recurrence of Atrial Fibrillation (AF), but its independent role in the incidence of new onset AF remains unclear[50]. This might be due to the activation of the nervous system. Arousals from sleep stimulate sympathetic nervous system and hence cardioacceleration[51].

Our results showed that a higher number of cigarettes smoked per day was significantly associated with higher daytime sleepiness, in agreement with previous studies[52,53]. While the association between cigarette smoking and OSA is plausible, the evidence is less than conclusive[54]. Cigarette smoking may worsen swelling and inflammation in the upper airway, affecting the neuromuscular function, and making snoring worse[55]. It may increase the severity of OSA through arousal mechanisms and trouble sleep architecture[56]. It has been hypothesized that each of these conditions adversely affects the other, leading to increased morbidity[52].

Participants living in the North had less daytime sleepiness, whereas those living in Beqaa had higher daytime sleepiness compared to those living in Beirut. This could be explained by traffic-related pollution [57], which induces higher risk of lung diseases[58]. Exposure to fine air particle, humidity and temperature might play an important role in the incidence and the severity of SDB[59]. More studies are needed to evaluate the association between the governorate of living and sleep apnea in Lebanon.

The used questionnaire helped finding that the population sample wasn't fairly aware of suggestive symptoms and complications of OSA, compared to studies conducted in France and Singapore also aiming to evaluate the knowledge of OSA among the population[23,24]. We believe that responses to the knowledge questions are likely a reflection of what subjects in the community actually know about OSA. The majority of previous studies pointed at the need for further education[23,24,60,61,62,63].

A higher OSA knowledge score was found in participants with a university level of education, compared to illiterate ones. This is in harmony with other studies in which a superior OSA awareness level was noticed in people with higher education levels and was attributed to easier access to information[23]. Our results could be similarly explained. In fact, health information and SDB knowledge could have developed, throughout life, based on a great degree of education.

Moreover, the results showed higher knowledge scores in people who have heard about OSA, compared to those who have not heard about the disease. It is also the case of a survey carried out in Lorraine in which people with this characteristic were more aware of OSA facts regarding risk factors and complications[24]. This finding proves the need of education programs in order to improve OSA knowledge.

As previously discussed, having CVAs was associated with lower knowledge scores compared to those who did not have CVAs. This correlates well with other studies[64,65]. In this regard, rigorous studies highly value the effect of CVAs on the cognitive domain, including attention, memory and language[65].

Limitations

This cross-sectional research project has multiple limitations. Since it's a single point in time measurement, it cannot infer causality relationship. The lack of follow-up assessment increased the risk of attrition bias. Plus, the major respondents where form North Lebanon and the non-Arabic speaking participants were excluded, so the reached sample may not be representative of the whole population. Reliance on closed-ended questions may have limited the accuracy of obtained information, leading to over or under evaluated symptoms. Moreover, investigators were available for any clarifications if needed. However, social bias should be minimal as the anonymity was assured. Individuals might have tended to misrepresent self-reported behaviors and shift the response to the more socially acceptable one, instead of selecting the "real" answer, to avoid negative evaluation. Furthermore, the Arabic translation of the existing questionnaire[24] was not specifically validated in Lebanon. Lastly, it is difficult to determine whether some complications followed OSA in time or sleep apnea resulted from the already present pathology. Despite those limitations, we believe that the data found in this study will be useful in future surveys to examine trends of OSA awareness.

Conclusion

The present study shed light on the overall knowledge of OSA among the Lebanese population. Complications are still poorly known, as are certain suggestive symptoms. Given the local relevance of OSA, ongoing health campaigns and innovative educational programs should be assigned to target the general community. Patients today need to be reasonably aware of common pathologies and the symptoms that should lead them to consult. Besides, physicians should carry the responsibility for providing adequate screening.

Abbreviations

OSA=Obstructive Sleep Apnea

SDB=Sleep Disordered Breathing

WHO=World Health Organization

BMI=body mass index

AHI=Apnea-hypopnea index

HTA=hypertension

DM=diabetes

CVA=cerebrovascular accident

MI=myocardial infarction

OSAKA= Obstructive Sleep Apnea and Attitudes Questionnaire

OSAHS=Obstructive sleep apnea hypopnea syndrome

ESS=Epworth Sleepiness Scale

SBQ=STOP-BANG questionnaire

SPSS= Statistical Package for Social Science

AF= Atrial Fibrillation

Declarations

Ethics Approval and Consent to Participate

The study protocol was approved by the Holy Spirit University of Kaslik (USEK) ethics committee. A written informed consent was obtained from each participant.

Consent for publication

Not applicable.

Availability of data and materials

All data generated or analyzed during this study are not publicly available to maintain the privacy of the individuals' identities. The dataset supporting the conclusions is available upon request to the corresponding author.

Competing interests

The authors have nothing to disclose.

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None.

Author contributions

AC and DM was responsible for the data collection and designed the study; AC drafted the manuscript; SH carried out the analysis and interpreted the results, assisted in drafting and reviewing the manuscript; ED was the project supervisor. All authors reviewed the final manuscript and gave their consent.

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