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Original Article

Estimating obstructive sleep apnea in Cyprus: a randomised, stratified epidemiological study using STOP-Bang sleep apnea questionnaire

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ABSTRACT

Introduction: Several epidemiological studies have demonstrated that Obstructive Sleep Apnea (OSA) is a highly prevalent disorder in the general population and increases over time all over the world. The high prevalence is in part due to increasing rates of obesity. However, estimates of OSA prevalence in Southern Europe are generally lacking.
Aim: The aim of our study was to predict the risk of OSA in the general population of Cyprus, the southeast part of Europe, by using a dedicated questionnaire like STOP-Bang.
Subjects and method: We screened 5736 sample housing units for eligible adults and a total population of 4118 eligible responders completed the STOP-Bang questionnaire. Participants were all adults, age 18 + residing in Cyprus. The sample was stratified according to the last demographic report (2016) by district, rural or urban area, gender and age and the estimated sample size needed was 2000. Our survey was conducted by Computer Aided Telephone Interviewing (CATI) method. The question about Neck Circumference was removed from the final evaluation due to the uncertainty of most of the participants and the risk of bias.
Results: From a total of 4118 participants (2252 males – 54.7%, 1862 females – 45.3%), with 46.6% over 50 years old, 2641 (64.1%) were at low risk for OSA (0–2 positive answers), 1200 (29.1%) at intermediate risk (3–4 positive answers) and 277 (6.7%) at high risk (≥5 positive answers). In sum, 29.9% responded positively for snoring, 39.3% for feeling tired or sleepy during the day, 12.3% for observed apnea during sleep, and 24.6% for having or being treated for hypertension. Class II and III obesity with Body Mass Index (BMI) > 35 kgr/m^2 was observed in 192 subjects (4.7%). In the subpopulation of obese participants (BMI>30 kg/m^2), intermediate to high risk of OSA was present in 45%, whereas in obesity class II and III the percentage reached almost 90%.
Conclusions: Our survey yielded that the prevalence of intermediate to high risk for OSA was 50% in males and 18% in females, in the general population of Cyprus. These findings were similar to previously reported high OSA prevalence worldwide, considering the fact that a single questionnaire is only a screening tool and cannot alone diagnose sleep apnea.

1. Introduction

Obstructive sleep apnea (OSA) is a chronic condition characterized by repetitive collapse of the upper airway during sleep, leading to oxygen desaturation, sympathetic activation and recurrent arousals. It is associated with considerable morbidity and mortality and numerous studies indicate a causal relationship between OSA and hypertension, cardiovascular disease, insulin resistance and diabetes mellitus [1].

OSA is a prevalent disorder, particularly among middle-aged, obese men [2]. Initial large-scale cohort studies in general population were conducted in the USA, between 1980 and 1990 – the Wisconsin Sleep Cohort Study [3], the Sleep Heart Health Study [4] and the Penn State Cohort [5]. An apnoea-hypopnea index (AHI)

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greater than five events per hour of sleep was diagnostic for OSA and the prevalence ranged between 6.5% and 9% in women and between 17% and 31% in men. In 2007–2010, the estimated prevalence rates in the USA have increased significantly over the last two decades, ranging from approximately 14% up to 55% depending on age group, sex, and Sleep Disordered Breathing (SDB) severity level [6]. In Northern Europe (Switzerland), the HypnoLaus study (2009–2013) recorded a prevalence of moderate-to-severe SDB ($\geq$15 events per h) 23.4% in women and 49.7% in men [7]. The reported prevalence of OSA has increased over time due to the ongoing epidemic of obesity and due to more sophisticated polysomnographic recording techniques and revised diagnostic criteria [7,8].

In-laboratory polysomnography (PSG) is the accepted gold standard for the diagnosis of OSA [9]. However, PSG is time consuming, costly and requires the expertise of sleep medicine specialists. Therefore, a number of screening questionnaires have been developed to help identify patients with OSA. STOP – Bang is a simple, easy to remember, and self-reportable screening tool, which includes four subjective (STOP: Snoring, Tiredness, Observed apnea and high blood Pressure) and four demographic items (BANG: BMI, Age, Neck circumference, Gender) [10]. The probability of moderate to severe OSA increases in direct proportion to the STOP – Bang score [11], with a sensitivity of 90%, 94% and 96% to predict any OSA (AHI $\geq$ 5), moderate-to-severe OSA (AHI $\geq$15) and severe OSA (AHI $\geq$30), respectively [10–12]. As OSA is becoming a major health problem, screening tools with high sensitivities, like the STOP-Bang, can reliably estimate the prevalence of the disease in the general population and help the healthcare providers to design the appropriate services for early diagnosis and therapy. However, studies about OSA risk and prevalence in Southern Europe are generally missing.

We designed this study in order to (1) record the most common, self-reported symptoms of apnea (snoring, tiredness and/or sleepiness, observed apneas); (2) demonstrate possible differences between males and females during adult lifespan; and (3) estimate the risk for OSA, in the general population of Cyprus, Southern Europe, by using a dedicated questionnaire like STOP-Bang.

2. Subjects and method

The participants selected for our cross-sectional study included individuals, aged 18+, residing in Cyprus, during the period January 2017–June 2018. The eligibility criteria for inclusion were as follows: (1) age $\geq$ 18 years old; (2) Cypriot citizens with permanent residence under the effective control of the Republic of Cyprus; and (3) consent and willingness to participate to the survey. No other exclusion criteria existed. The sample was stratified according to the last demographic report (2016) by district, rural or urban area, gender and age. Stratification ensures that the sample is representative of the population with respect to the chosen population parameters [13]. The estimated sample size needed was 2000.

The survey was conducted by Computer Aided Telephone Interviewing (CATI) method. Telephone surveys play a vital role in public health research and practice as they can examine cross-sectional characteristics of population subgroups, track trends in prevalence of conditions and risk behaviors over time, and identify risk factors associated with multiple health conditions [14]. Moreover, ongoing technology has aided telephone research through recent advances such as CATI and cell phones [14].

All willing participants were interviewed by phone and answered STOP-Bang questionnaire. The STOP-Bang questionnaire is a concise and easy to-use, self-reportable, screening tool for OSA that includes eight yes/no questions about snoring, tiredness, observed apnea, high blood pressure, BMI >35 kg/m^2, age >50 years old, neck circumference >40 cm, and male gender [10]. It is validated among different populations [12], in both English and Greek speaking populations [15].

In our survey the question about neck circumference was removed from the final evaluation due to the uncertainty of most of the participants and the risk of bias. The limitation of the self-reported neck circumference was well documented in a short pilot study that was conducted prior to the main survey. A short internal validation of the modified questionnaire was performed by using the complete questionnaire in participants that their neck circumference was appropriately measured. Comparison of the full and the modified, by erasing the neck circumference question, screening tool only slightly underestimated the risk for OSAS. None of the low risk participants was miscategorized due to the absence of neck circumference and only 2 out of 50 patients (1%) were misplaced at the intermediate risk group than the high risk group.

Snoring was considered affirmative if the participant reported snoring loudly. Tiredness/sleepiness during the day was affirmative if the participant reported yes to feeling unrested during the day and feeling tired, no matter how many hours of sleep they had. Observed pause in breathing was defined as positive if participant answered affirmative to the question “based on what you have noticed or household members have told you, are there times when you stop breathing during your sleep?” Blood pressure was defined as positive if the participant answered yes to being treated with medication for high blood pressure. One point was assigned for each affirmative answer; zero for no answers. Low risk for OSA was defined as $\leq$ 2 positive answers, intermediate risk as 3–4, and high risk $\geq$5. Positive answers were summed to yield total surrogate STOP-Bang score and were used to estimate the proportion of enrollees at low, intermediate and high risk for OSA.

The key measures of location, as well as the measures of spread in order, describe the distribution of the study population. Data collected were also categorized in seven age groups (less than 30 years old, 31–40, 41–50, 51–60. 61–70, 71–80 and over 80 years old), in order to evaluate the different self – reported symptoms of apnea during lifespan. Furthermore, they were classified according to gender, in order to evaluate possible differences between men and women.

The ethical committees of both the General Hospital in Nicosia, Cyprus and the “Alexandra” University Hospital, in Greece, approved the study protocol. All subjects gave consent to participate in the study after appropriate information was given.

Statistical analysis included summarization of the data in tables and charts and was performed by using an IBM SPSS Statistics v.25 program. Descriptive statistics procedures for complex survey data (chi-square) were used to examine demographic and health characteristics for all participants. Two-sided hypothesis testing was performed in order to reject or not the null hypothesis. Specifically, χ^2 test was performed due to the nature of the variables (nominal). Tests were adjusted for all pairwise comparisons within a row of each innermost sub-table using the Bonferroni method of correction. A p-value less than 0.05 was regarded as statistically significant.

3. Results

A total number of 5736 sample housing units were screened. Of those, 182 respondents did not meet the eligibility criteria and were excluded from the survey, whereas 1436 denied to participate. The remaining 4118 eligible, willing responders (2252 males – 54.68%, 1862 females – 45.22%) answered the questionnaire, yielding a margin of error of $\pm$1.53%, at a Confidence Level of 95%. The response rate was 74.14%.

The sample was stratified according to the demographic report of 2016 (estimated population of Cyprus 947.000 inhabitants) [16], by district, rural or urban area in the following regions of Cyprus: Nicosia, Limassol, Larnaca, Paphos, and Famagusta (Ammochostos) (Fig. 1).

In the whole population, 2640 subjects answered positive in 0–2 questions (64.1%) in the modified STOP – Ba(n)g Sleep Apnea questionnaire, whereas 1477 (35.9%) answered positive in >2 [3–7] questions. The results are presented in Table 1. According to the total score, 2640 subjects (64.1%) were at low risk of OSA, 1200 (29.1%) at intermediate risk, and 277 (6.7%) at high risk of OSA. The distribution of positive answers between the sample with intermediate to high risk of OSA, as opposed to those who were characterized as low risk, are presented in Fig. 2. No statistically significant differences were observed between rural and urban populations (Table 2).

A significant percentage of our participants was overweight (38.2%), especially men (46.4%). Class II and III obesity with Body Mass Index (BMI) > 35 kgr/m^2 was observed in 192 subjects (4.7%). In the subpopulation of obese participants (BMI>30 kg/m^2), intermediate to high risk of OSA was present in 45%, whereas in obesity class II and III the percentage reached almost 90%.

3.1. Symptoms versus age

Snoring was less frequently reported in younger age groups, in particular, age groups less than 30 years ($p = 0.001$) and 31–40 y ($p = 0.001$). On the contrary, snoring was significantly more frequent in the 51–60 y ($p = 0.001$) and the 61–70 y age groups ($p = 0.001$).

There were no statistically significant differences between “yes” and “no” answerers in all age groups about feeling tired, fatigued, or sleepy during daytime.

Observed apnea was less common in younger age groups (less than 30, and 31–40 y with $p = 0.026$, and $p = 0.001$, respectively) and in the 80 + y age group ($p = 0.049$) and it was significantly more common in 51–60 y ($p = 0.001$) and 61–70 y ($p = 0.002$) age groups.

Finally, diagnosed hypertension was statistically less common in the younger age groups (<30 y, $p = 0.001$, 31–40 y, $p = 0.001$, and 41–50 y, $p = 0.001$) and significantly more frequently reported in the other groups (51–60 y, $p = 0.001$, 61–70 y, $p = 0.001$, 71–80 y, $p = 0.001$, and 80 + y, $p = 0.001$).

The distribution of the self – reported symptoms between the different age groups is summarized in Fig. 3. Snoring and observed apnea had a peak incident in the fifth and sixth decade of life, whereas complaints of tiredness were common in ages <50 y. Hypertension had a plain pattern of increased percentage by more than 10% every decade after 40 y.

3.2. Symptoms versus age versus sex

In the total population sampling, snoring and observed apnea showed an almost twofold increase in men compared to women (37.7% vs 20.3%, and 15.7% vs 8.1%, respectively). In addition, men suffered more often from hypertension (28.3%) compared to women (20.1%) whereas tiredness was equally described by both sexes (Fig. 4a).

Women tended to admit snoring more often than men in the age of 30 years or less ($p = 0.019$) but reported snoring significantly less than men between 31 and 40 y ($p = 0.009$), 41–50 y ($p = 0.010$) and 51–60 y ($p = 0.017$). Men snored significantly less compared to women over 61 years old (61–70 y, $p = 0.001$, 71–80 y, $p = 0.011$, and 80 + y, $p = 0.007$, respectively).

Women <30 y and women aged 41–50 y felt tired statistically significant more often than men of similar age ($p = 0.012$, and $p = 0.027$, respectively). Men reported feeling tired significantly more often than women only in the 61–70 y age group. Women reported not feeling tired significantly more often in the 51–60 y age group ($p = 0.046$), as men did so in the 71–80 y age group ($p = 0.042$).

There were no significant differences between genders of the same age group considering a positive answer for observed apneas. Nevertheless, women answered negatively in a significant manner in the 41–50 y age group, whereas men over 61 years old answered the question negatively. ($p = 0.010$, $p = 0.017$, and $p = 0.020$, respectively).

Finally, women tended to have hypertension issues significantly more often than men in the <30 y group ($p = 0.001$), whereas hypertension was less common for females between 51 and 60 y age group compared to same age males ($p = 0.019$). Men reported significantly fewer hypertension issues in the 61–70 y and the 80 + y age groups ($p = 0.006$, and $p = 0.030$, respectively).

The distribution of the self – reported symptoms between men and women into the different age groups is summarized in Fig. 4b.

4. Discussion

Little is known about the southern Europe's OSA evaluation and prevalence. Our study yielded that the prevalence of risk for OSA, as

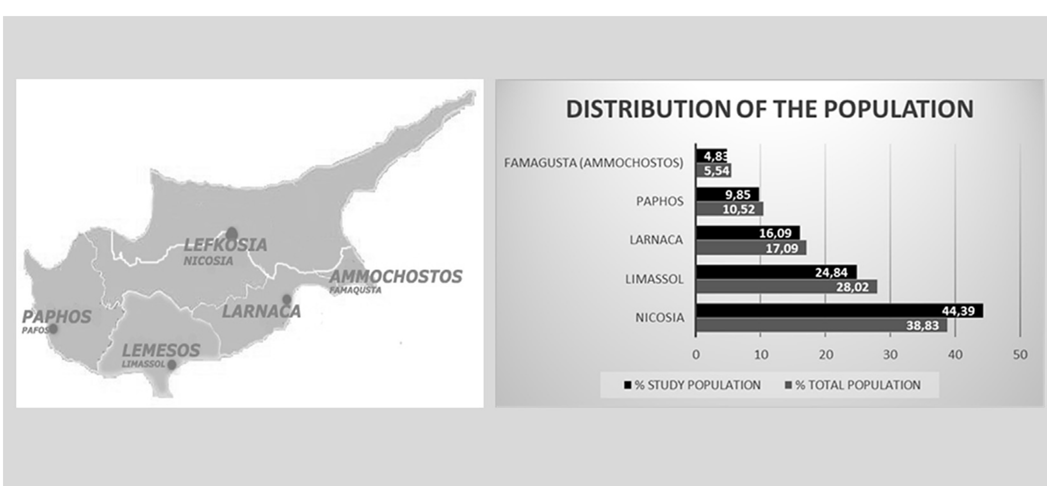

Fig. 1. Distribution of the study population.

Table 1
Results of the modified STOP-Ba(n)g questionnaire in the whole study population.

STOP - Ba(n)g questionnaire	YES (n and %)	NO (n and %)
Do you **snore** loudly (louder than talking or loud enough to be heard through closed doors)?	1184 **29.9%**	2776 70.1%
Do you often feel ***tired***, fatigued, or sleepy during daytime?	1616 **39.3%**	2492 60.7%
Has anyone ***observed*** you stop breathing during your sleep?	491 **12.3%**	3516 3516
Do you have or are you being treated for high blood ***pressure***?	1011 **24.6%**	3098 75.4%
BMI > 35 kg/m^2?	192 **4.7%**	3910 95.3%
Age > 50 years old?	1918 46.6%	2199 53.4%
Neck circumference > 40 cm?	–	–
Gender: male?	2252 54.7%	1862 45.3%

The bold are indicative of the initials of S(nore)T(ired)O(bserved)P(ressure) - B(MI)a(ge)n(eck)g(ender) questionnaire.

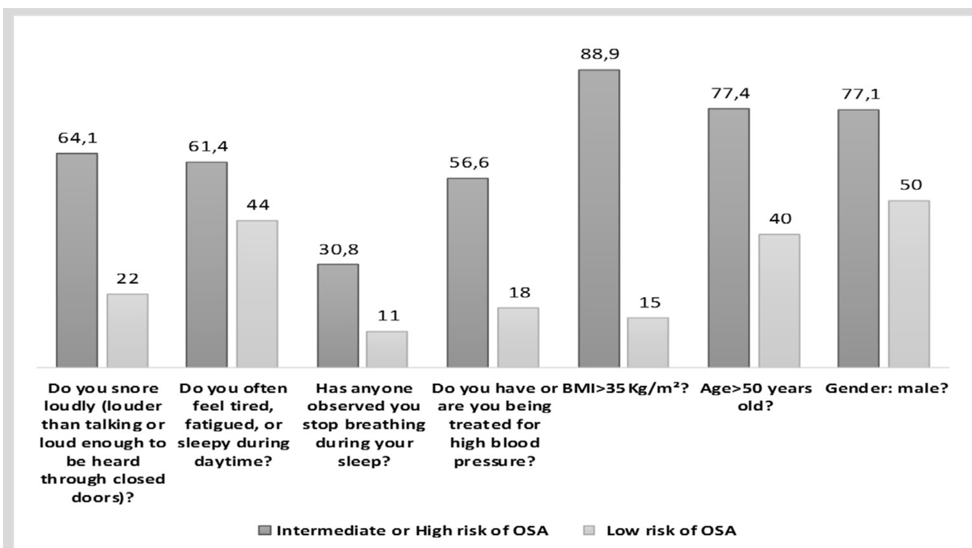

Fig. 2. The distribution of positive answers between the samples with intermediate to high risk of OSA versus those which were characterized as low risk.

Table 2
Distribution of symptoms and risk for OSA between urban and rural populations.

Positive answer to:	Urban	Rural	Total
Do you **snore** loudly (louder than talking or loud enough to be heard through closed doors)?	853	331	1184
% in urban or rural population	*29.4%*	*31.1%*	*29.9%*
Do you often feel **tired**, fatigued, or sleepy during daytime?	1167	449	1616
% in urban or rural population	*38.7%*	*41.0%*	*39.3%*
Has anyone **observed** you stop breathing during your sleep?	358	133	491
% in urban or rural population	*12.2%*	*12.4%*	*12.3%*
Do you have or are you being treated for high blood **pressure**?	731	280	1011
% in urban or rural population	*24.3%*	*25.5%*	*24.6%*
AGE> 50y	1413	505	1918
% in urban or rural population	*46.8%*	*46.0%*	*46.6%*
Risk for OSA			
Low risk of OSA: Yes 0–2	1945	695	2640
% in urban or rural population	64.4%	63.2%	64.1%
Intermediate risk of OSA: Yes 3–4	873	327	1200
% in urban or rural population	28.9%	29.8%	29.1%
High risk of OSA: Yes 5–7	200	77	277
% in urban or rural population	6.6%	7.0%	6.7%
TOTAL	3018 100.0%	1099 100.0%	4117 100.0%

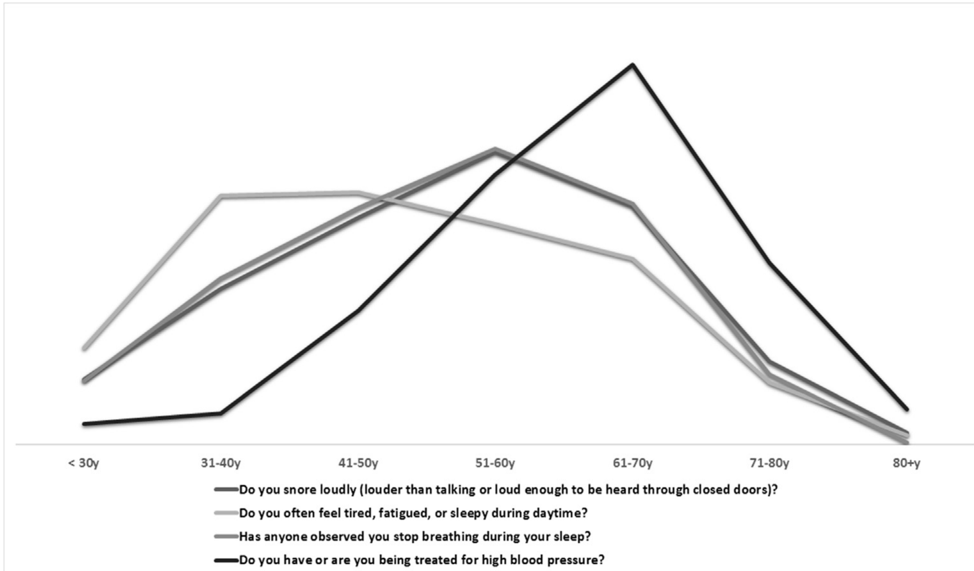

Fig. 3. Self-reported symptoms between different age groups.

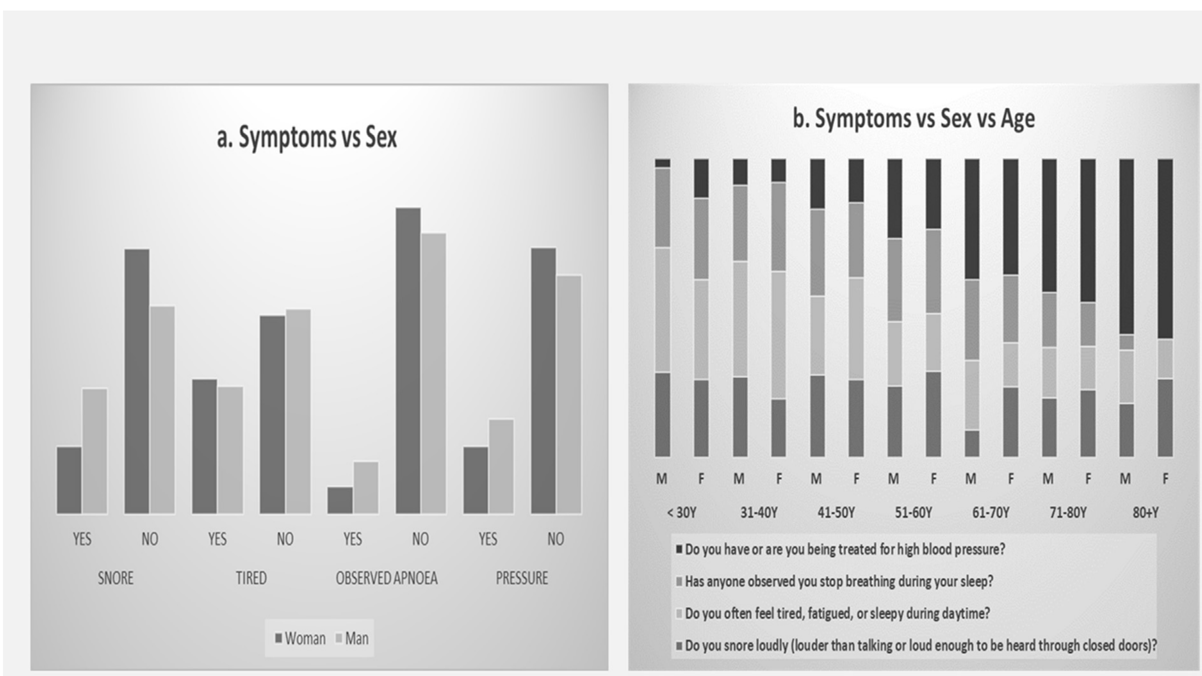

Fig. 4. Self-reported symptoms between men and women a. in the whole population and b. in the different age groups.

assessed by the modified STOP – Ba(n)g sleep questionnaire, was low in 64.1%, intermediate in 29.1% and high in 6.7% of participants (n = 4118), in a community study in Cyprus, Southern Europe.

Self – reported snoring and observed apnea had a peak incident in the fifth and sixth decade of life, more often in men than in women. Obese subjects, especially those with morbid obesity, were more prone to the disease. To our knowledge this is the first study that evaluates the self – reported symptoms of apnea in a Mediterranean, general population of Southern Europe, in men and women between 18 + to 80 + years old, in order to estimate the risk of OSA.

Although OSA is a particularly common disease, several countries – including Cyprus - lack any epidemiologic data based on general population [2–7]. Sleep apnea is associated with increased morbidity and mortality mainly due to cardiovascular causes, as well as road accidents, as a consequence of excessive daytime sleepiness. Unfortunately, up to 80% of individuals with moderate-to-severe OSA may remain undiagnosed [17]. The prevalence of OSA, especially in developed, Western communities has increased during the last decades [6,7]. Recently, an AHI ≥5 (mild-to-severe sleep-disordered breathing) was recorded in 858 (83.8%) men and 667 (60.8%) women, whereas an AHI ≥15 (moderate-to-severe sleep-disordered breathing) was noted in 509 (49.7%) men and 257 (23.4%) women, in a community study, in Switzerland [7]. In another study, approximately one third of primary care outpatients reported symptoms and risk factors indicative of a high probability for sleep apnea; 35.8% of 3915 participants in the United States, and 26.3% of 2308 participants in Europe [18].

Our findings were in accordance with previously published data since more than one third of our population in Cyprus was categorized as intermediate to high risk of OSA, when interviewed with a reliable, self-reportable, sleep apnea questionnaire like STOP – Bang [10–12]. The risk was higher within the 51–70 years old age group for males, and in participants with higher BMI. Although sleep questionnaires are only suitable for the detection of patients with a high pretest probability of OSA, STOP – Bang is recommended due to its high-quality methodology and reasonably accurate results [19]. Based on its sensitivity to predict moderate to severe OSA, the estimated prevalence of the disease could range between 31.2 and 33.71%, among our responders.

It is well documented that the prevalence of apnea dramatically increases in elderly patients, however they do not typically present with the classic symptoms of OSA; snoring, observed apnea, sleepiness, or obesity [20]. Elderly patients may complain about other symptoms (eg, enuresis, depression, cognitive impairment, repeated falls and ophthalmic conditions) and so the physician must be careful in recognizing such reported symptoms of OSA in this population.

The cardinal symptoms of apnea – snoring and observed apnea - increased proportionally and progressively over the age group of 51–60 y, with a peak in the fifth and sixth decade of life, and then decreased abruptly in participants >60 y (Fig. 3). Several researchers report that "snoring exists at one end of a continuum, with OSA at the polar end" [21]. Snoring, one of the earliest symptoms of "symptomatic" OSA, is common worldwide, with prevalence rates ranging from 2% to 85% [21]. In our study, the prevalence of self – reported snoring was 29.9%, occurring more often in men than women. Notably, 17.8% of women aged under 30 y reported snoring as opposed to only 9.3% between 30 and 40 y. Likely, this places women in the marriageable age range in an inferior position, as younger women felt free to express a symptom like snoring; and therefore the percentage is comparable with women in their fourth decade of life (16.9%). So snoring may be a tricky question for young women. On the other hand, observed apnea is a more specific symptom that alarms a patient's social environment to ask for medical advice. Observed apnea was reported more often by men (twice as often as women) in their fifth decade (20.6%), whereas women had their peak in observed apneas in their sixth decade (11.4%). In this decade of life the greatest percentage of women are post – menopausal.

Tiredness, fatigue, and sleepiness are also highly prevalent in the general population, in primary care, and in specialty medicine. In the annual US National Sleep Foundation poll, 63% of respondents reported that they have driven drowsy and 67% woke up unrefreshed, with more than 1 to 10 (13%) to be categorized as "sleepy" in Epworth Sleepiness Scale (ESS) [22]. In our study 39.3% of respondents answered positive about feeling tired, fatigued, or sleepy during daytime. People who reported feeling tired more often included respondents under the age of 50 y. This finding probably reflects the increased socioeconomic responsibilities during the more productive years of life (eg, work, family, and friends), and cannot be attributed solely to sleep disturbances.

Hence, the most common symptoms of apnea tend to increase progressively over the age of 60 y and decrease later in life (>60–80 + y), suggesting a more "symptomatic" disease in younger people compared to elderly.

The absence of significant differences between rural and urban populations in Cyprus was anticipated, as the population is uniformly distributed nationwide. Furthermore, the distances between villages and cities are minimal, and the road network is excellent at facilitating commute and thus avoiding urbanism. There is no population divergence locally, neither differences in medical access nor habits (eating, exercising etc.).

The major strength of our study is the validity of our results that is fortified by the large representative population-based sample studied and by the high response rate in a validated questionnaire. This allows us to generalize the results enabling extrapolation of findings to the original population. Moreover, we included all adult age groups, from 18 + to 80 + years old. Finally, epidemiological data about OSA in Southern Europe are generally lacking.

Potential limitations should be acknowledged. The main limitation is that polysomnography was not performed for verification and a single questionnaire is only a screening tool and cannot alone diagnose sleep apnea. Additionally, we have to acknowledge that by removing the neck circumference question from the assessment we may have excluded some at-risk participants. However, the modified questionnaire slightly underestimated the risk in our short internal validation study (unpublished observation) of the modified questionnaire. Moreover, this is a cross sectional study and the population is derived from a small segment of Southern Europe. The corresponding results are applicable only in Cyprus and are only indicative for the prevalence in Southern Europe.

5. Conclusions

To our knowledge this is the first study to characterize the Southern European scope of OSA risk. We conclude that the estimated prevalence for sleep-disordered breathing in the general population of Cyprus is considerably high, but lower compared to a recent Northern European survey [7]. Further studies are required to extrapolate the prevalence of OSA with recording techniques, compare any differences in epidemiology to the Mediterranean lifestyle and evaluate prospectively the prognosis of symptomatic versus asymptomatic patients.

Conflict of interest

The ICMJE Uniform Disclosure Form for Potential Conflicts of Interest associated with this article can be viewed by clicking on the following link: https://doi.org/10.1016/j.sleep.2019.04.013.

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