Prevalence and risk factors of obstructive sleep apnea syndrome in a Saudi Arabian population

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Abstract:

BACKGROUND: Obstructive sleep apnea (OSA) is a common disorder worldwide; however, epidemiological studies on its prevalence lack in Saudi Arabia. This study aimed to determine the prevalence and risk factors of OSA in Saudi Arabia.

METHODS: The study was performed from 2013 to 2015 in two stages. The screening stage was first; a random sample of Saudi employees (n = 2682) 30–60 years of age completed a survey that included the Wisconsin questionnaire. According to these data, the subjects were categorized as habitual, moderate, or nonsnorers (NSs). The confirmatory second stage was a case–control study conducted on 346 individuals selected from each group using polysomnography (PSG).

RESULTS: In the first stage, the prevalence of habitual snoring was 23.5%, moderate snoring was16.6%, while 59.9% of the sample was NSs. Among the 346 individuals who underwent PSG, a total of 235 (67.9%) subjects had OSA with an apnea-hypopnea index (AHI) of ≥5; 76 (22.0%) had OSA syndrome (OSAS), defined by an AHI of ≥5 plus daytime sleepiness; and 227 (65.6%) had clinically diagnosed OSA syndrome (COSAS), as defined by the American Academy of Sleep Medicine. A conservative estimate of at least 8.8% (12.8% in men and 5.1% in women) was calculated for the overall prevalence of OSA. Similarly, the overall estimated prevalence of OSAS and COSAS was 2.8% (4.0% in men and 1.8% in women) and 8.5% (12.4% in men and 4.8% in women), respectively. A multivariate analysis revealed age, gender, obesity, and hypertension as independent risk factors of OSA.

CONCLUSIONS: Our study demonstrated that the rate and risk factors of OSA in the Saudi population are similar to those observed in Western studies.

Key words:

Daytime sleepiness, obstructive sleep apnea, prevalence, risk factors, syndrome

Obstructive sleep apnea (OSA) refers to recurrent episodes of an absence of or decline in breathing during sleep despite a continuous effort to breathe normally. The condition is characterized clinically by excessive daytime sleepiness (EDS), disruptive snoring, and periodic nocturnal hypoxemia with frequent arousals during sleep.[1,2] OSA is also associated with serious health complications, such as an increased risk of vehicle crashes, occupational accidents, hypertension, cardiovascular and cerebrovascular diseases, glucose intolerance, decreased functional ability, and impotence.[2,3] Furthermore, OSA may also increase all-cause mortality, particularly vascular mortality, which leads to increased utilization of health-care services.[4-6] More importantly, treating OSA may reduce not only morbidities and mortalities but also the related economic burden.[2,7-9]

In the Western world, the prevalence of OSA syndrome (OSAS), defined as OSA with associated EDS, is 3%–7% in men and 2%–5% in women.[10,11] Despite lower obesity rates, the prevalence is similar in Asia, possibly due to the craniofacial features among Asians.[12] This finding suggests that OSA is an equally common disorder in both the developing and developed world.[13] Nevertheless, few studies from the Middle East have estimated the prevalence of sleep apnea. Furthermore, those studies actually evaluated the risk of OSA using simple validated questionnaires and were not based on the gold standard objective measures, namely, overnight polysomnography (PSG).[14-16] Therefore, the aim of this study was to assess the prevalence

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of OSA based on PSG findings in a random sample from the Saudi population and determine the potential risk factors. Accordingly, this study may lay a foundation for reducing the burden of OSA through early diagnosis, appropriate treatment, and the modification or reduction of predictive risk factors.

Methods

Study population

Our target population comprised Saudi school employees aged 30–60 years, including porters, drivers, teachers, and administrators. Schools were selected using a stratified random sample from two lists of male and female schools. A school-based cross-sectional survey was adopted given that schools are the most feasible source of national employees in Saudi Arabia; the stratified random sample was conducted with equal allocation in gender. The sample excludes older age groups (retired people) and people living in small cities, towns, and villages. Nevertheless, the sample age range represented a wide spectrum of the Saudi population. Furthermore, the total sample size was 3000, which is sufficiently large to allow for generalizing the results to the Saudi population. In total, 129 schools were randomly selected from the 1119 schools in the Jeddah area. Ethical approval was obtained from the Ethical Committee of King Abdulaziz University Hospital, Jeddah.

Stage 1: Screening procedure

The study was performed in two stages (from 2013 to 2015). Stage 1 was a cross-sectional study of a random sample of the target population. It consisted of two trained teams of male and female interviewers interviewing school employees. A pilot study was conducted involving one school and 21 subjects from both genders. The aim of the pilot study was to assess the implementation of the questionnaire and reliability of the measurements.

Camps for interviews and another for performing measurements were organized in each selected school after obtaining written informed consent. A modified Wisconsin sleep questionnaire[17] that also included questions about demographics, EDS using the Epworth Sleepiness Scale,[18] sleep symptoms, medical history, social class, and consanguinity was used. Biometric data were also collected, including height (H), weight (W), body mass index (BMI), neck circumference (NC), triceps skin fold thickness, waist/hip ratio, and percent predicted neck circumference (PPNC) using the formula $PPNC = (1000 \times NC)/([0.55 \times H] + 310)$.[19,20] Furthermore, blood pressure was measured according to standard methods using a digital sphygmomanometer (OMRON, Kyoto, Japan).

Based on the Wisconsin questionnaire and using a five-point scale (0–4), data from six survey questions were used to categorize subjects based on the frequency of snoring as habitual snorer (HS), moderate snorer (MS), or nonsnorer (NS).[17]

Stage 2: Polysomnography

The second (confirmatory) stage was a case–control study involving the collection of PSG data. After analyzing the stage 1 data, respondents were classified based on snoring status. The initial plan was to obtain PSG on all HS, 50% of MS, and 25% of NS. Polysomnography (SOMNO Medics Plus; SOMNOmedics, Randersacker, Germany) consisted of continuous recordings from surface leads for electroencephalography (EEG), electrooculography, electromyography (submental and bilateral anterior tibialis muscles), electrocardiography, nasal pressure, nasal and oral airflow (thermocouple), chest and abdominal impedance belts for respiratory muscle efforts, pulse oximetry for oxygen saturation and pulse rate, a tracheal microphone for snoring, and body position sensors for sleep position. PSG records were scored manually according to the American Academy of Sleep Medicine (AASM) 2012 scoring.[21] Full PSG was conducted in two different locations, the participants' homes and the Sleep Medicine and Research Center at King Abdulaziz University Hospital, using the same device to increase convenience and participant cooperation.

Abnormal obstructive breathing events during monitored sleep were described according to the latest recommendation of the AASM as a decrease in airflow by 90% or more from baseline for at least 10 s (apnea) and a discernible reduction in airflow of at least 30% of the pre-event baseline using nasal pressure associated with a reduction in oxygen saturation of at least 3% and/or followed by an EEG arousal (hypopnea), despite persistent chest and abdominal muscle efforts to overcome the obstruction.[22] EEG arousal was defined according to the recommendation of the AASM.[22] The average number of these apnea and hypopnea events per hour of sleep (i.e., the apnea-hypopnea index [AHI]) was then calculated.

Subjects with an AHI of ≥ 5 were categorized as having OSA, whereas those with EDS and an AHI of ≥ 5 were categorized as having OSAS.[1,10,11] Clinically diagnosed OSA (COSAS) was defined as per the latest AASM recommendations (2014),[23] i.e., A-an AHI of ≥ 15 determined by PSG or B-an AHI of ≥ 5 but <15 events, in addition to one of the following: (1) Daytime sleepiness, nonrestorative sleep, fatigue, or insomnia symptoms; (2) incidences of waking up with gasping or choking sensations; (3) reported snoring, breathing interruptions, or both during sleep; or (4) a known history of hypertension, mood or cognitive dysfunction, coronary artery disease, stroke, congestive heart failure, atrial fibrillation, or diabetes mellitus. Three registered polysomnographic technologists were assigned to manually score data from these PSG studies. Quality control of the scoring process was achieved by randomly selecting five cases every month to be scored by all three technologists to audit interobserver reproducibility and accuracy.

Calculation of prevalence

Subjects in the PSG group were compared with those in the non-PSG group in terms of the mean age and BMI. If no significant differences were identified, the prevalence of OSA in the PSG group of the HS, MS, or NS groups would be considered representative of the entire screened population.[24] If significant differences were observed between the PSG and non-PSG groups, a conservative estimate was implemented, and the OSA subjects were handled as the only OSA subjects in the entire screened population. The extrapolated prevalence of OSA in the whole cohort would be estimated as follows:

Number of subjects with OSA/total number of questionnaire respondents × 100%.[24-26]

Statistical analysis

The data were collected and analyzed using the Statistical Package for the Social Sciences (SPSS Inc., Chicago, IL, USA), version 21. Data were presented using the means ± standard deviations for continuous variables and percent frequency for categorical variables. Comparisons between groups were performed using Student's *t*-test for continuous variables and a Pearson Chi-square test for discrete variables. Statistical significance was set at an alpha level of 0.05 with two-tailed probability. Multiple logistic regression analysis was used to identify significant independent risk factors of OSA (0 = no, 1 = yes) using the forward conditional stepwise method with 0.05 probabilities for entry and 0.1 for removal. Odds ratios (ORs) and 95% confidence intervals (CIs) were presented.

Results

A total of 2682 participants (52.1% females, n = 1397) were recruited, assuming a participation rate of 89.4%. Snoring was reported in 40.1% of the participants (53% of males and 28% of females, $P < 0.01$). The rate of HS, MS, and NS in the screened population was 23.5%, 16.6%, and 59.9%, respectively.[27] The demographic data of the screened population are summarized in Table 1.

Polysomnography

A descriptive flowchart of the screened population is illustrated in Figure 1.

PSG studies were conducted for 375 subjects. Studies were conducted at home for 301 subjects, while 74 studies were performed at the sleep center as per the participants' request. Thirty-five subjects had PSG repeated due to insufficient data in the initial trial. However, 29 of these 35 subjects were ultimately excluded due to persistently poor sleep efficiency. Thus, the final data included that of 346 subjects, which was 12.9% of all questionnaire responders. Table 2 summarizes the PSG parameters.

Unfortunately, we were unable to perform PSG on the target participants as initially planned despite the capacity to do so within the time limit. This was mainly due to the poor response rate from participants in the second stage despite all efforts. Consequently, all subjects in the screened population were eventually approached to participate in stage 2. Hence, the demographic data of the PSG group were not similar to the non-PSG group. The mean age was 42.86 ± 6.64 and 40.31 ± 6.38 years in the PSG and non-PSG groups, respectively, with $P < 0.05$; however, the mean BMI was 30.11 ± 5.52 and 30.14 ± 5.82 kg/m^2, respectively, with no significant differences ($P > 0.05$).

Prevalence of obstructive sleep apnea

Among the 346 subjects who underwent PSG, 235 had OSA, and 151, 23, and 61 subjects were categorized as HS, MS, and NS. The prevalence of OSA was 72.3% in HS, 71.9% in MS, and 58% in NS. The characteristics of the PSG group are summarized in Table 3.

Considering that significant differences were noted in the mean age between the PSG and non-PSG groups, a conservative estimate was implemented, and the documented OSA subjects were considered the only subjects with OSA in the screened population. Accordingly, the overall prevalence of OSA and OSAS in the screened population was estimated to be at least 8.8% and 2.8%, respectively, affecting 12.8% and 4.0% of men

Table 1: Demographic profile of the study population (*n*=2682)*

Variables	Values (%)
Age (year)	40.65±6.48
Female/male (ratio)	1396/1286 (1.09)
BMI (kg/m^2)	30.13±5.79
Habitual snorers	630 (23.5)
Hypertension	266 (9.9)
EDS	132 (4.9)

*Values are provided as the mean±SD or *n* (%) unless otherwise indicated. SD = Standard deviation, BMI = Body mass index, EDS = Excessive daytime sleepiness

Table 2: Descriptive statistics of polysomnography parameters in the polysomnography group

Parameters	PSG group *n*=346 (mean±SD)
Total bed time (min)	362±79
Total sleep time (min)	248±72
Sleep efficiency (%)	68±17
REM sleep (%)	15.9±8.1
Total arousal index	20.7±12.20
Respiratory arousal index	6.2±7.6

REM = Rapid eye movement, PSG = Polysomnography, SD = Standard deviation

Table 3: Characteristics of the polysomnography group (*n*=346)

Variables	Level/category	*n* (%)
Age (years)	30-39	86 (24.9)
	40-49	185 (53.9)
	≥50	75 (21.7)
Sex	Male	230 (66.5)
	Female	116 (33.5)
Hypertension	Not told by a doctor	282 (81.5)
	Told by a doctor	64 (18.5)
Diabetes mellitus	Not told by a doctor	305 (88.2)
	Told by a doctor	41 (11.8)
Snorers	Nonsnorers	105 (30.3)
	Moderate snorers	32 (09.2)
	Habitual snorers	209 (60.4)
Obesity (BMI≥30)	Normal	164 (47.4)
	Obese	182 (52.6)
EDS	ESS <10	235 (67.9)
	ESS ≥10	111 (32.1)
OSA#	AHI <5	111 (32.1)
	AHI ≥5	235 (67.9)
AHI ≥15	<15	230 (66.5)
	≥15	116 (33.5)
OSAS	None	270 (78.0)
	OSAS	76 (22.0)
COSAS	None	119 (34.4)
	COSAS	227 (65.6)

AHI = Apnea-hypopnea index, OSA = Obstructive sleep apnea, OSAS = Obstructive sleep apnea syndrome, COSAS = Clinically diagnosed obstructive sleep apnea syndrome, EDS = Excessive daytime sleepiness, ESS = Epworth sleepiness scale

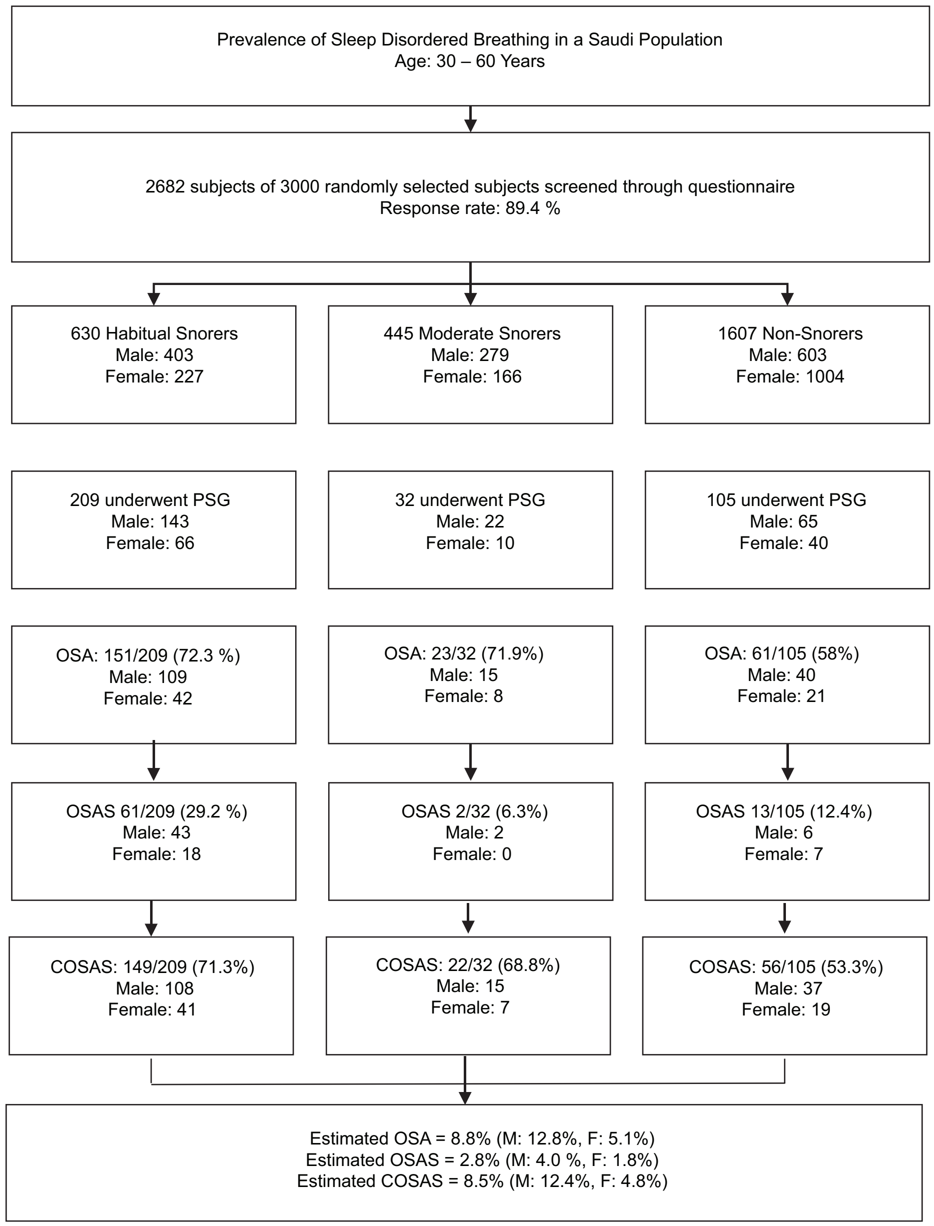

Figure 1: A descriptive flowchart of the screened population. OSA: AHI ≥5. OSAS: AHI ≥5 with EDS. COSAS: AHI ≥5 and any symptoms based on AASM criteria. EDS = Excessive daytime sleepiness, OSA = Obstructive sleep apnea, AHI = Apnea-hypopnea index, OSAS = Obstructive sleep apnea syndrome, COSAS = Clinically diagnosed obstructive sleep apnea syndrome, AASM = American Academy of Sleep Medicine

and 5.1% and 1.8% of women, respectively. Furthermore, when COSAS was taken into consideration, its prevalence among the PSG group as recommended by the AASM was 65.6% (227). Hence, the extrapolated prevalence among the screened population was 8.5% (12.4% in males and 4.8% in females).

Risk factors associated with obstructive sleep apnea

The univariate analysis results are presented in Table 4. However, the multiple logistic regression analysis only identified the male gender, age ≥50 years, obesity as defined by a BMI ≥30 kg/m^2, and a history of hypertension as significant risk factors associated with OSA [Table 5].

Discussion

The present study is the first population-based survey of OSA from Saudi Arabia. The estimated prevalence of OSA and OSAS in the screened population was 8.8% and 2.8%, respectively, and the prevalence of OSAS in men and women was 4.0% and 1.8%, respectively. However, the overall prevalence of COSAS was 8.5%, affecting 12.4% of men and 4.8% of women. The multivariate analysis revealed that age, male gender, obesity, and hypertension were independent predictive risk factors of OSA.

Table 4: Sociodemographic, anthropometric, and comorbidity profiles in obstructive sleep apnea and nonobstructive sleep apnea subjects

Variable	OSA subjects* (*n*=235)	Non-OSA subjects$ (*n*=111)	*P*
Male	70.2**	59.5	0.047++
Age (years)	44.60 (6.9)#	42.90 (6.7)	0.030^
Consanguinity	79.9**	77.3	0.574++
Habitual snoring+	74.0**	60.4	0.010++
Percent EDS (ESS score 10)	32.3**	31.5	0.979++
BMI (kg/m^2)	33.22 (15.8)#	29.61 (5.8)	0.020^
Neck circumference (cm)	31.11 (12.1)#	30.47 (11.03)	0.641^
PPNC	75.98 (30.48)#	78.02 (29.09)	0.581^
Waist-to-hip ratio	0.88 (0.19)#	0.88 (0.15)	0.983^
Triceps skin FT (mm)	27.60 (17.32)#	26.54 (15.44)	0.604^
Hypertension	22.6**	9.9	0.005++
Asthma	16.7**	14.4	0.593++
Chronic bronchitis	4.3**	4.5	0.915++
Diabetes mellitus	13.6**	8.1	0.139++
Systolic BP (mmHg)	127.3 (15.9)#	127.60 (12.5)	0.881^
Diastolic BP (mmHg)	83.55 (10.07)#	82.05 (8.5)	0.192^

*Obstructive sleep apnea (AHI ≥5), $Nonobstructive sleep apnea (AHI <5), #Mean (SD), ^Independent *t*-test, **Percent, ++Chi-square test, +Habitual and moderate snorers versus nonsnorers. OSA = Obstructive sleep apnea, ESS = Epworth sleepiness scale, FT = Fold thickness, SD = Standard deviation, BP = Blood pressure, PPNC = Percent predicted neck circumference, AHI = Apnea-hypopnea index

Table 5: Predictors of OSA* status identified by a stepwise multiple logistic regression analysis

Variables	Level/category	*n* (%)	OSA multivariate analysis		*P*
			OR	95% CI	
Age (years)	30-39	86 (24.9)	1.00	-	0.042
	40-49	185 (53.9)	1.01	0.58-1.79	
	≥50	75 (21.7)	2.41	1.09-5.34	
Sex	Female	116 (33.5)	1.000	-	0.024
	Male	230 (66.5)	1.79	1.08-2.97	
Obesity (BMI ≥30)	Normal	164 (47.4)	1.00	-	0.004
	Obese	182 (52.6)	2.00	1.25-2.22	
Hypertension	Not told by a doctor	282 (81.5)	1.00	-	0.019
	Told by a doctor	64 (18.5)	2.47	1.16-5.23	

*OSA = Obstructive sleep apnea (AHI ≥5). OR = Odds ratio, CI = Confidence interval, BMI = Body mass index, AHI = Apnea-hypopnea index

Prevalence of sleep apnea

As far as OSAS is concerned, the observed outcomes fall within the range of most reported rates. Young *et al*. established the first recognition of OSA as a public health problem in 1993.[1] In the Wisconsin Sleep Cohort Study, Young *et al*. stated that the prevalence of sleep apnea was 24% and 9% in middle-aged men and women, respectively.[1] However, only 4% of men and 2% of women met the diagnostic criteria for OSAS.[1] Subsequently, in a large-scale population-based study, Bixler *et al*. confirmed that 3.9% and 1.2% of men and women, respectively, suffer from OSAS.[28,29] In Spain, a population-based study focusing on both genders between 30 and 70 years reported that OSAS (AHI of ≥10 plus EDS) was identified in 3.4% of men and 3% of women.[30] As such, our findings are in agreement with those of studies conducted in the Western world.

On the other hand, studies have also reported rates similar to our findings in China, Korea, and India. Ip *et al*. assessed OSA in middle-aged Chinese men. In total, 784 subjects were recruited, and full PSG was performed on 150 of these patients.[25] The prevalence of OSA and OSAS was confirmed to be 8.8% and 4.1%, respectively.[25] In a similar study, PSG was performed in 106 out of 854 female Chinese respondents.[26] OSA and OSAS were identified in 3.7 and 2.1%, respectively.[26] In contrast, Kim *et al*. performed PSG on 457 Koreans randomly allocated from an initial cohort of 5020 participants between 40 and 69 years of age. The prevalence of OSA was 27% in males and 16% in females; however, the prevalence of OSAS was 4.5% in males and 3.2% in females.[31] A similar epidemiological study was conducted in a semi-urban Indian population aged 30–60 years. OSA was identified in 13.7% of patients, and OSAS was identified in 3.6%.[20]

As reported by Sharma *et al*.[20] and demonstrated in our current study, it is interesting that the prevalence of OSA is comparable among Chinese, Korean, Indian, American, and Saudi Arabian populations, despite disparate ethnic backgrounds, cephalic features, and obesity rates. This finding may be difficult to explain but warrants further investigation in the future.

Moreover, we used another clinical definition of OSAS (COSAS) in our study based on the AASM diagnostic criteria for sleep apnea.[23] Accordingly, the estimated overall prevalence of COSAS was 8.5% (male: 12.4%, female: 4.8%). To the best of our knowledge, no such data of COSAS have been reported in previous epidemiological studies. We feel that the prevalence of COSAS is likely more practically meaningful, with significant clinical implications, than OSA (≥5) and OSAS (≥5 and EDS).

Few studies attempting to address the prevalence of OSA in the Middle East have been reported in the literature, and these studies were solely based on validated questionnaires with no PSG. Therefore, it is not surprising that these studies tended to report a significantly increased prevalence of OSA compared with our study (up to 40%).[15,16,32-34] To the best of our knowledge, our study is the first in the region to use objective tests, such as PSG, to determine the prevalence of OSA.

Risk factors of obstructive sleep apnea

OSA is more common in men than women.[2,10,11] Our survey again confirmed the findings of previous epidemiological studies regarding this male predominance, with this condition occurring in 70.2% of males versus 29.8% of females [Figure 1]. This male predominance may be related to several factors, including hormonal effects in the muscles of the upper airways, gender-based differences in the distribution of adipose tissue, variances in pharyngeal shape, size, and collapsibility, and differences in ventilation control.[35] In our study, more males than females participated in stage 2; this difference may have at least partly contributed to the increased male preponderance in the current study. Furthermore, a recent study among the Swedish population reported a high prevalence of OSA among females and no significant association with EDS.[36] This finding raises the possibility that OSA is underestimated in females simply because they have a more diverse clinical presentation of OSA than males.[11]

The prevalence of OSA increases with age independent of other confounders.[28,36-38] This finding was confirmed in our survey for OSA [Table 5]. Subjects 50 years or older had a 2.4-fold increased risk of OSA compared to subjects 30–39 years old [Table 5]. Bixler *et al.* described such an increase in OSA among individuals older than 65 years but a decline in OSAS.[28] Moreover, several studies have reported little if any association between OSA and serious medical consequences at older ages, suggesting that sleep apnea in middle-aged adults, as in our population, is more serious than in seniors.[39]

Obesity is a major predictive factor for OSA, with a majority of patients being overweight.[2,10,11] On the other hand, losing weight either conventionally or through bariatric surgery reduces the severity of sleep apnea.[38,40-43] In our study, obesity, as assessed by BMI (OR: 2.0; 95% CI: 1.251–2.22; $P = 0.004$), but not other biometric data, was significantly increased in OSA patients compared with non-OSA patients [Table 5].

Several population-based epidemiological studies have confirmed an independent association between sleep apnea and hypertension.[30,36,44-47] In our survey, a history of hypertension was significantly increased among OSA patients compared with non-OSA patients, and it was confirmed as an independent risk factor of OSA in the multivariate regression analysis (OR: 2.47; 95% CI: 1.16–5.23; $P = 0.019$) [Table 5].

Limitations of the study

One of the limitations of this study is our target population, i.e., school employees, which may not be representative of the whole Saudi population. However, our sample population comprised randomly selected Saudi school employees, including porters, teachers, and administrators. Furthermore, this wide spectrum of sociodemographic classes of workers in the Ministry of Education closely resembles the sociodemographic classes of the society as a whole. In addition, our large sample size of 2682 increases the validity of the results in representing the whole Saudi population.

A disappointing limitation of our study was the inability to perform PSG on the snorer and NS participants as initially planned, despite the capacity to do so within the provided time limit. This was mainly due to the poor acceptance rate of participants in the second stage of the study, despite our best efforts.

Conclusion

Similar to other populations, sleep apnea syndrome is a common disorder among Saudis as it is noted in at least 4.0% and 1.8% of males and females, respectively. COSAS is likely a more practically applied definition; its estimated overall prevalence was 8.5%, affecting 12.4% of males and 4.8% of females. The male gender, age, obesity, and hypertension were independent predictive risk factors of OSA based on a multivariate regression analysis.

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Conflicts of interest

There are no conflicts of interest.

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