Sleep Medicine 10 (2009) 913–918

Contents lists available at ScienceDirect

Sleep Medicine

journal homepage: www.elsevier.com/locate/sleep

Original Article

Prevalence and risk factors of obstructive sleep apnea among middle-aged urban Indians: A community-based study

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ARTICLE INFO

Article history:
Received 7 May 2008
Received in revised form 21 August 2008
Accepted 25 August 2008

Keywords:
Community survey
Indians
Obesity
Obstructive sleep apnea
Polysomnography
Prevalence

ABSTRACT

Background: The epidemiology of obstructive sleep apnea (OSA) and obstructive sleep apnea syndrome (OSAS) is not well studied among Indians. We sought to determine the prevalence and risk factors of OSA in a middle-aged urban Indian population.
Methods: We conducted a two-stage, cross-sectional, community-based study in four different socioeconomic zones of the South Delhi district, India, from April 2005 to June 2007. In stage 1, subjects of either gender aged 30–65 yrs were administered a questionnaire by door-to-door survey using systematic random sampling. Subjects that responded were classified as habitual and non-habitual snorers. In stage 2, all the habitual and 10% of randomly selected non-habitual snorers were invited for overnight polysomnographic study.
Results: Of the 2860 subjects approached, 2505 (88%) completed stage 1. Habitual snoring was present in 452 (18%) subjects. In stage 2, OSA defined as apnea–hypopnea index $\geqslant$5 was observed in 94 (32.4%) of 290 habitual snorers and 3 (4%) of 75 non-habitual snorers. Estimated population prevalence of OSA and OSAS was 9.3% (95% CI 8.2–10.5%) and 2.8% (2.1–3.4%) respectively. On multivariable analysis, male gender (adjusted odds ratio 3.8 [1.7–4.9]), body-mass index $\geqslant$25 kg/m^2 (4.1 [2.0–8.3]), and abdominal obesity (2.2 [1.9–5.3]) were independently associated with the presence of OSA. A linear trend was observed in the prevalence of OSA across the socioeconomic strata.
Conclusions: OSA is a significant public health problem in the middle-aged Indian population across the socioeconomic spectrum. OSA is associated with some of the well known risk factors for cardiovascular disease.

1. Introduction

Obstructive sleep apnea syndrome (OSAS) is a potentially disabling condition characterized by disruptive snoring, repeated episodes of complete or partial pharyngeal obstruction during sleep resulting in nocturnal hypoxemia, frequent arousals during sleep, and excessive daytime sleepiness. Undiagnosed OSAS represents a major public health problem. It is receiving increased attention because of convincing data showing its association with adverse cardiovascular, neurocognitive, and metabolic consequences [1–3]. Sleep fragmentation leads to impaired neurocognitive function, poor quality of life, and predisposes to motor vehicle and workplace accidents. Notwithstanding, the condition remains mostly undiagnosed.

Several population-based studies have found the prevalence of OSAS to be 0.3–5.1% [4–8]. These estimates, however, are based on data from predominantly white populations and may not be applicable to others. Indians are prone to develop obesity and its consequences [9]. Increased urban migration and economic growth have led to an epidemic of lifestyle-related health problems among Indians [10]. Data regarding the prevalence of OSA in Asians, particularly the Indian population, are sparse [11–14]. Earlier, we studied the prevalence of OSA in a semi-urban Indian population; however, it was a small-sized study, and different socioeconomic strata were not adequately represented in the study population [14]. In the present study, we sought to determine the prevalence of OSA and the risk factors associated with it across the spectrum of socioeconomic classes in an urban Indian population.

2. Methods

2.1. Study design

Two-stage, cross-sectional, community-based study.

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doi:10.1016/j.sleep.2008.08.011

2.2. Study population

The national capital territory of Delhi has a population of 13.8 million spread over an area of 1483 km^2. Of the nine administrative districts of Delhi, South Delhi is the second most populous, having a population of 2.26 million. This study was conducted in four zones of the South Delhi district. Each of these zones is relatively homogeneous with respect to the socioeconomic class of people living in that zone, with Okhla industrial area (Sanjay colony and Indira Kalyan vihar slums) representing low socioeconomic class, Ambedkar Nagar (Dakshin Puri) representing lower-middle class, Netaji Nagar representing upper-middle class, and Gautam Nagar representing higher socioeconomic class. The study period was from April 2005 to June 2007. The study protocol was reviewed and approved by the Institute ethics committee at the All India Institute of Medical Sciences, New Delhi.

2.3. Sampling strategy

A random sample of the population from these zones was drawn using a two-stage probability sampling method. Electoral roll of South Delhi district (last updated February 2005) served as the sampling frame. It enlists all individuals aged $\geqslant$18 yrs living in that area serially according to their house number and also contains information regarding their gender and age as in February 2005. In each of the zones, one or two electoral wards were randomly chosen from which subjects of either gender aged 30–65 yrs were recruited by a systematic random sampling strategy. Every 10th subject on the electoral roll was approached. In case of non-responders or ineligible subjects (age <30 or >65 yrs), the next individual from the electoral roll was selected with subsequent shift in the sampling frame. The number of participants chosen in each individual zone was proportionate to the size of its population.

2.4. Stage 1: screening

The selected subjects were contacted in person at their homes by a trained field worker who sought written informed consent. Subjects who consented were administered the modified version of the Wisconsin Sleep Cohort Study questionnaire (Courtesy: Dr. Terry Young, Wisconsin, USA) translated into Hindi language, in the presence of their spouse or room partners. Fidelity of translation was earlier confirmed by back translation into English. It incorporated questions about demographics, sleep symptoms, medical and treatment history, and the Epworth sleepiness scale (ESS) [15]. Excessive day time sleepiness (EDS) was defined as an ESS score greater than 10. Socioeconomic status was assessed by the updated Kuppuswami socioeconomic status score; the income cut-offs were updated using the All India Consumer Price Index for industrial workers as in January 2005, as described earlier [16]. Habitual smoking/drinking was defined as smoking/alcohol intake for at least three days a week. Predefined exclusion criteria were tracheostomy or recent upper airway surgery, airway cancers, congestive heart failure, known hypothyroidism, chronic renal failure, or pregnancy.

A limited physical examination was performed in which patients underwent anthropometry, body composition analysis by bipedal bio-electric impedance, and blood pressure measurement, as described earlier [14]. A height-corrected measure of neck circumference, percent-predicted neck circumference (PPNC), was computed using the formula: PPNC = (1000 $\times$ neck circumference in cm)/(0.55 $\times$ height in cm + 310) [17]. Abdominal obesity was defined as a waist-hip ratio >0.95 in men and >0.88 in women [18]. Obesity was defined as a body-mass index (BMI) $\geqslant$25 kg/m^2 [19]. Subjects were considered hypertensive if they were currently receiving antihypertensive medication or if they fulfilled the Joint National Committee 7 (JNC7) criteria for hypertension [20].

2.5. Stage 2: polysomnography

In stage 2 of the study, subjects were classified into habitual snorers (snoring three or more nights a week) and non-habitual snorers; non-snorers were classified as non-habitual snorers. All the subjects who had habitual snoring were invited for overnight polysomnography (PSG). To yield a wide variance in the expected apnea–hypopnea scores, subjects from the non-habitual snorer group were also invited for PSG. But the invitation was limited to only 10% of the non-habitual snorers (selected using a computer-generated random number list) due to operational constraints. Consenting subjects underwent PSG at the Sleep Laboratory of All India Institute of Medical Sciences, New Delhi, as described earlier [21]. Recorded sleep data were scored manually according to standard criteria by experienced laboratory technicians blinded to clinical data. Apnea and hypopnea were defined according to the Chicago criteria as recommended by the American Academy of Sleep Medicine [22]. OSA was defined as apnea–hypopnea index (AHI) $\geqslant$ 5; OSAS was defined as AHI $\geqslant$ 5 accompanied by EDS.

2.6. Statistical analysis

Statistical analyses were performed using a statistical software package (Intercooled Stata 8.0 for Windows, Stata Corporation, College Station, TX). Continuous variables were summarized as mean ± SD or median (IQR) and categorical variables as proportions, n (%). The prevalence of OSA was calculated among both the habitual as well as non-habitual snorer groups. Then, the overall prevalence of OSA in the study population was calculated by combining the estimates into a weighted-average. Comparison between two groups was done with the student's t-test or Mann–Whitney U-test for continuous variables and chi-square test for categorical variables. A chi-square test for trend was applied to look for any linear trend in the prevalence of OSA across the quartiles of socioeconomic status score. A multivariable analysis was performed by multiple logistic regression with OSA as the dependent variable. Variables associated with OSA on univariate analyses at $P < 0.1$ significance level were included as independent variables; the quartile of socioeconomic status score was treated as an ordinal variable and was entered into the equation using multiple dummy variables. All tests were two-sided, and a $P < 0.05$ was considered statistically significant.

3. Results

Over a period of 23 months, 2860 subjects were surveyed, of which 2505 (88%) responded. A flow diagram depicting the number of subjects recruited at each step is shown in Fig. 1. The response rate in stage 1 was comparable among the four different socioeconomic zones (Okhla – 656/781 [84%], Ambedkar Nagar – 646/673 [96%], Netaji Nagar – 603/663 [91%], and Gautam Nagar – 600/682 [88%]).

3.1. Demographic and anthropometric profile of screened subjects

Among the respondents, men and women were nearly equally distributed (male: 1263 [50.4%]). Mean age and BMI of the study group was 41 ± 9 yrs and 24.3 ± 4.6 kg/m^2, respectively. The prevalence of habitual smoking and habitual alcohol intake in the study population was 470 (18.7%) and 343 (13.7%) respectively, and that of hypertension was 591 (23.5%). Habitual snoring was present in 452 (18.1%) subjects. Comparison of habitual snorers and non-habitual snorers is presented in Table 1.

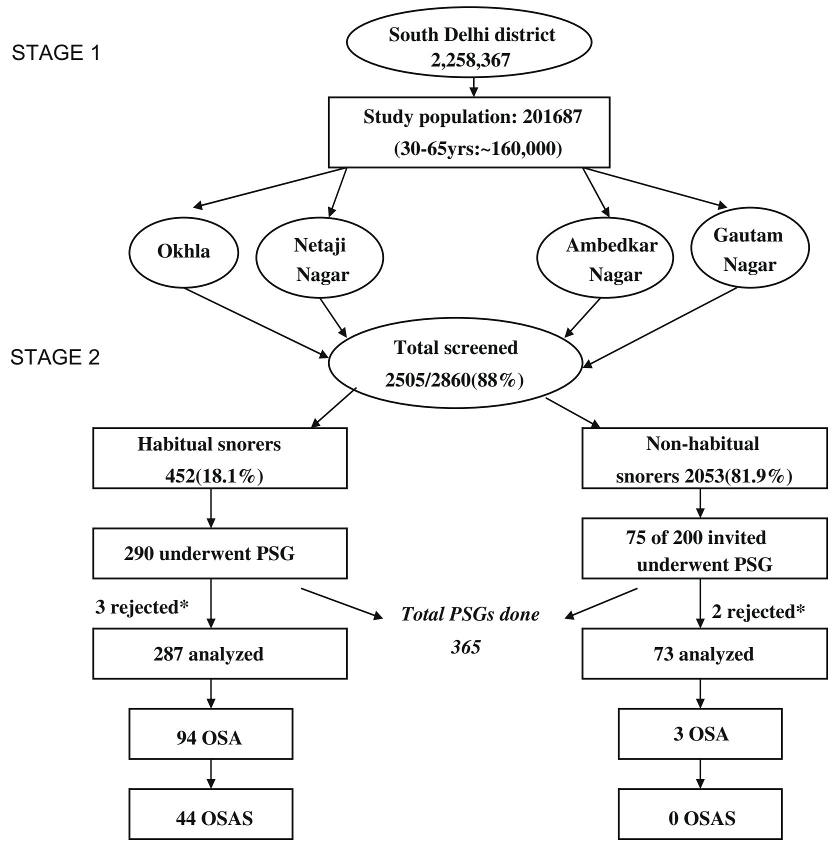

Fig. 1. Sampling strategy and the disposition of subjects through the study. PSG, overnight polysomnography; OSA, obstructive sleep apnea; OSAS, obstructive sleep apnea syndrome. *Three PSG studies in habitual snorers and two in non-habitual snorers were rejected in view of insufficient total sleep time (<240 min).

3.2. Polysomnographic studies

Of the 452 habitual snorers, 290 underwent PSG giving a response rate of 64%. Of the 200 (10%) randomly selected non-habitual snorers, 75 underwent PSG giving a response rate of 37.5%. No systematic difference was found when the subjects who declined PSG were compared with those who underwent PSG within their respective subgroup, with respect to age, gender distribution, and BMI. Five of the total 365 PSG studies performed were rejected in view of insufficient total sleep time (less than 240 min).

Table 1
Demographic and anthropometric characteristics of the respondents in stage 1 of the study.

Characteristic	Habitual snorers $n = 452$ (18%)	Non-habitual snorers $n = 2053$ (82%)	*P* value
Age (yr)	43.9 ± 9.5	40.5 ± 9.4	<0.001
Male gender	279 (62)	985 (48)	<0.001
Habitual smoking	127 (28.1)	343 (16.7)	0.001
Habitual drinking	54 (16.5)	289 (14.1)	0.019
Excessive day time sleepiness	152 (33.6)	26 (1.3)	<0.001
Hypertension	219 (48.5)	372 (16.7)	<0.001
Known type 2 diabetes mellitus	66 (14.6)	90 (4.4)	<0.001
Body-mass index (kg/m^2)	27.0 ± 5.2	23.7 ± 4.2	<0.001
Body-mass index $\geqslant$ 25 (kg/m^2)	259 (57.3)	609 (29.7)	<0.001
SSFT (mm)	24.7 ± 13.4	19.3 ± 6.8	<0.001
SIFT (mm)	29.4 ± 8.5	23.8 ± 9.1	<0.001
Neck circumference (cm)	34.2 ± 3.6	31.7 ± 2.7	<0.001
PPNC (%)	86.1 ± 8.9	79.9 ± 6.9	<0.001

SSFT, subscapular skinfold thickness; SIFT, suprailiac skinfold thickness; PPNC, percent-predicted neck circumference. Data presented as *n* (%) or as mean ± SD.

3.3. Prevalence of OSA and OSAS

OSA was present in 94 (32.4%) of 290 habitual snorers and 3 (4%) of 75 non-habitual snorers. EDS was present in 44 (45%) of 97 subjects with OSA, all in the habitual snorer group. Considering the fact that habitual snorers constituted 18% of the study group, the overall prevalence of OSA in the screened population was calculated as 9.3% (95% CI 8.2–10.5%) and that of OSAS as 2.8% (2.1–3.4%). Using AHI cut-offs of $\geqslant$10 and $\geqslant$15, the prevalence of OSA was 7.9% and 6.1%, respectively. Among men, the prevalence of OSA and OSAS was 13.5% (11.7–15.6%) and 4% (3.0–5.2%) respectively. In women, the prevalence of OSA was 5.5% (4.3–6.9%) and OSAS was 1.5% (0.9–2.4%). Prevalence of OSA was higher among men as compared to women across all age groups. Age-specific prevalence showed an increasing trend with age in men but not in women (Table 2). A significant linear trend in the prevalence of OSA was observed when the study subjects were stratified based on the socioeconomic status score (cut-offs 1st quartile: 1–10; 2nd quartile: 11–14; 3rd quartile: 15–21; 4th quartile: 22–29; $P = 0.01$); whereas, the proportion of habitual snorers who underwent PSG in each stratum was not significantly different (Fig. 2).

3.4. Risk factors associated with OSA

Comparison of apneic and nonapneic subjects is shown in Tables 3 and 4. The average age and BMI of the OSA subjects was 46 yrs and 31.0 kg/m^2 while that of non-OSA subjects was 43 yrs and 26.2 kg/m^2, respectively. On univariate analyses, increasing age, male gender, socioeconomic status score, habitual smoking, hypertension, obesity, high waist-hip ratio, PPNC > 90, and high subscapular and suprailiac skinfold thicknesses were significantly

Table 2
Estimated prevalence of OSA in the study population stratified by age and gender.

Age group (yrs)	No. of study subjects	No. of PSGs performed	Prevalence of OSA (95% CI)[a]
Men			
30–39	559	78	9.7 (7.5–12.6)
40–49	397	64	13.5 (10.4–17.4)
50–65	307	57	17.6 (13.8–22.7)
Women			
30–39	666	50	6.4 (4.7–8.6)
40–49	339	63	5.0 (2.9–7.9)
50–65	237	48	6.9 (4.2–11.2)
All age groups			
Men	1263	199	13.5 (11.7–15.6)
Women	1242	161	5.5 (4.3–6.9)
Both	2505	360	9.3 (8.2–10.5)

OSA, obstructive sleep apnea; PSG, overnight polysomnography.
[a] Estimated prevalence of OSA.

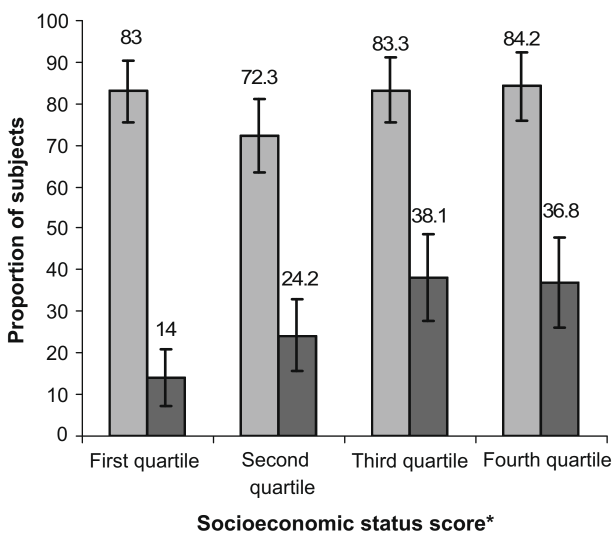

Fig. 2. Proportion of subjects with habitual snoring and OSA across the socioeconomic strata among the 360 subjects who underwent polysomnography. *Based on updated Kuppuswami socioeconomic status score[16]; light gray bars represent the proportion of habitual snorers; dark gray bars represent the proportion of subjects with OSA; the error bars represent 95% CIs; $P = 0.01$ for trend in the prevalence of OSA.

Table 3
Demographic and anthropometric characteristics and sleep-related symptoms in 360 subjects who underwent polysomnography in stage 2 of the study.

Characteristic	OSA ($n = 97$)	Non-OSA ($n = 263$)	Difference of means/ proportions (95% CI)
Age (yr)	45.8 ± 8.3	43 ± 9.6	2.8 (0.65–4.90)*
Male gender	66 (68)	133 (51)	0.17 (0.06–0.28)†
Socioeconomic status score			
First quartile	14 (14)	86 (33)	0.18 (0.09–0.65)
Second quartile	23 (24)	72 (27)	0.03 (0.01–0.58)
Third quartile	32 (33)	57 (22)	0.11 (0.05–0.66)*
Fourth quartile	28 (29)	48 (18)	0.11 (0.07–0.78)*
Habitual smoking	35 (37)	52 (20)	0.16 (0.05–0.27)†
Habitual drinking	25 (26)	37 (14)	0.12 (0.02–0.21)†
Hypertension	53 (55)	90 (34)	0.20 (0.09–0.32)‡
Type 2 diabetes mellitus§	18 (19)	35 (13)	0.05 (−0.03–0.14)‖
Body-mass index (kg/m^2)	31.0 ± 6.5	26.2 ± 5.4	4.8 (3.46–6.15)‡
PPNC (%)	95.7 ± 9.9	85.4 ± 9.9	10.3 (8.02–12.70)‡
Habitual snoring	94 (97)	193 (73)	0.23 (0.17–0.30)‡
Habitual choking	29 (30)	45 (17)	0.12 (0.03–0.23)†
EDS	44 (45)	38 (14)	0.31 (0.20–0.42)‡

OSA, obstructive sleep apnea; SSFT, subscapular skinfold thickness; SIFT, suprailiac skinfold thickness; PPNC, percent-predicted neck circumference; EDS, excessive day time sleepiness. Data presented as n (%) or as mean ± SD.
* $P < 0.05$.
† $P < 0.01$.
‡ $P < 0.001$.
§ Includes known as well as newly diagnosed type 2 diabetes mellitus.
‖ $P \geqslant 0.05$.

associated with the presence of OSA and were included in the multivariable model (Table 5). After adjusting for confounding variables, male gender (adjusted odds ratio 2.2 [1.7–4.9]), BMI $\geqslant$ 25 kg/m^2 (3.8 [1.8–7.8]), and abdominal obesity (1.9 [1.1–3.3]) were independently associated with the presence of OSA. Since smoking was infrequent among women, it was not included in the multivariable model. Its association with the presence of OSA in men was looked into separately and was found to be insignificant (data not shown).

4. Discussion

We found the prevalence of OSA in a middle-aged urban Indian population to be 9.3% and that of OSAS to be 2.8%. Ours is the first community-based prevalence study in the Indian subcontinent to cover such a wide socioeconomic base that faithfully characterizes the urban communities in India. Our sample population was selected in such a manner that all socioeconomic groups were adequately represented. We employed a two-stage probability sampling method, thus minimizing the chance of selection bias.

Diagnosis of OSA was made using the standard technique of in-hospital PSG, both in the habitual as well as non-habitual snorers, thereby eliminating an ascertainment bias. However, due to logistic constraints, only a fraction of non-habitual snorers underwent PSG. Notwithstanding, this is an accepted methodology in population-based studies on OSA [4,11]. This process is unlikely to have introduced any bias since the non-habitual snorers were randomly selected and non-respondents were not significantly different from those who underwent PSG. We used the electoral roll as the sampling frame. The electoral roll is a more complete, reliable, up-to-date, and easily accessible database than others such as house numbers and telephone registries; social security numbers are non-existent in India. However, the migrant workers and homeless population are unlikely to be included in the electoral roll.

Earlier studies had reported widely varying prevalence of OSA in different populations [4–8,11–14]. This is partly attributable to differences in study design, diagnostic technique, different cut-offs for defining OSA, as well as differences in prevalence of obesity, which is an important risk factor for OSA. Young and colleagues in the Wisconsin cohort reported the prevalence of OSA to be 24% in men and 9% in women; the prevalence of OSAS was 4% in men and 2% in women [4]. In a community-based study from Hong Kong, Ip and colleagues reported the prevalence of OSA and OSAS among men to be 8.8% and 4.1%, respectively [11].

Only a few studies have looked into the prevalence of OSA in India. High prevalence rate of OSA as observed in an earlier study by Udwadia and colleagues was probably due to selection bias as it was not a community-based study and women were not included in the study [12]. Moreover, the diagnostic tool used was a home-based limited PSG, which has a low specificity as compared to the gold standard in-hospital multichannel PSG used in the present study [23]. In the only community-based prevalence study from India so far, conducted in a semi-urban population of Delhi, we reported the prevalence of OSA and OSAS as 13.7% and 3.8%, respectively [14]. In this study, subjects were recruited from a small geographic location, and only 7% of the study population underwent PSG. In contrast, in the present study, subjects were re-

Table 4
Polysomnographic parameters in 360 subjects who underwent polysomnography in stage 2 of the study.

Variable	OSA ($n = 97$)	Non-OSA ($n = 263$)
Total sleep time (min)	336.4 ± 76.2	340.4 ± 76.8*
Sleep efficiency (%)	80.1 ± 13.5	81.5 ± 13.6*
Sleep stages (% of total sleep time)		
Stage 1 sleep	12.4 (6.1–24.3)	11.2 (5.1–18.7)*
Stage 2 sleep	41.2 (23.2–51.5)	41.0 (15.8–52.5)*
Slow wave sleep	20.9 (7.9–29.5)	17.9 (7.9–27.4)*
REM sleep	12.6 (4.2–16)	13.4 (7.5–15.2)*
Sleep latencies (min)		
Sleep onset latency	11.9 (0–15.6)	11 (0–18)*
REM onset latency	91.0 (37.7–160)	95.7 (46.3–145)*
AHI (events/h)	21.7 (10.3–50.5)	0.7 (0–0.9)
Arousal index (arousals/h)	21.0 (13.2–33.1)	16.8 (9.7–29.1)*
Baseline SaO_2 (%)	94.8 ± 3.3	97.0 ± 1.8†
SaO_2 < 90% (min)	35 (8.2–104)	0 (0–2.0)†
SaO_2 < 90% (% of total sleep time)	9.3 (2.8–28.5)	0 (0–0.5)†
Oxygen desaturation events	65 (20–141)	1 (0–5)†

OSA, obstructive sleep apnea; REM sleep, rapid eye movement sleep; AHI, apnea–hypopnea index; SaO_2, oxygen saturation; data presented as median (interquartile range) or as mean ± SD.
* $P \geqslant 0.05$.
† $P < 0.05$.

Table 5
Risk factors for obstructive sleep apnea in 360 subjects who underwent polysomnography.

Risk factor	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	*P* value
Age > 45 (yrs)	1.42 (0.9–2.3)	0.96 (0.5–1.6)	0.876
Male gender	2.08 (1.3–3.4)	2.16 (1.7–4.9)	0.01
Socioeconomic status score			
First quartile	1	1	–
Second quartile	1.96 (0.9–4.1)	1.32 (0.6–2.9)	0.497
Third quartile	3.44 (1.7–7.0)	1.86 (0.8–5.1)	0.129
Fourth quartile	3.58 (1.7–7.4)	2.24 (0.9–5.0)	0.055
BMI $\geqslant$ 25 (kg/m^2)	5.02 (2.7–9.4)	3.75 (1.8–7.8)	<0.001
Habitual smoking	2.29 (1.4–3.8)	1.56 (0.7–3.0)	0.242
Hypertension	2.31 (1.4–3.7)	1.66 (0.9–2.8)	0.059
Abdominal obesity	2.88 (1.7–4.8)	1.89 (1.1–3.3)	0.013

BMI, body-mass index; OR, odds ratio.

cruited from a wider geographic area representing all socioeconomic classes. Moreover, 14.5% of the study population underwent PSG, thereby improving the precision of the point estimates of prevalence, evidenced by the narrow 95% CIs.

The prevalence of OSA in our study was nearly three times higher among men as compared to women. These results are similar to those found in Western studies [4,8]. These gender differences have been attributed to differential distribution of adipose tissue, differences in upper airway anatomy, upper airway muscle function, control of ventilation, and the effects of sex hormones [24,25]. Prevalence of OSA increased with age, but increasing age was not an independent risk factor for OSA in our study. Similar observations were reported by previous studies [4,5].

Obesity was a strong risk factor for OSA, and different parameters of obesity analyzed in our study population were strongly associated with OSA. Studies from the West have clearly shown that a high BMI ($\geqslant$30 kg/m^2) is an important risk factor for OSA, and longitudinal studies have shown that weight loss significantly improves the AHI in obese individuals, suggesting that obesity plays a causative role [26]. We used the currently recommended cut-off in an Asian population of BMI $\geqslant$ 25 kg/m^2 to define obesity [19]. We found obese subjects had nearly four times higher risk of having OSA as compared to non-obese subjects independent of age and gender. Similar associations were observed for abdominal obesity. Various cross-sectional, longitudinal, and interventional studies from the West have found an association between OSA and hypertension [1,27]. In our study, though hypertension was significantly more common in subjects with OSA, it was not independently associated with OSA. Further longitudinal studies are required to elucidate the association of OSA and hypertension in the Indian population. Smoking and drinking habits did not turn out to be significant risk factors for OSA in our population.

To the best of our knowledge, a pronounced gradient in the prevalence of OSA across the socioeconomic strata has not been described before. Interestingly, the frequency of habitual snoring was comparable across the strata. An appropriate interpretation of our findings would be as follows: while snoring is a necessary (risk) factor, by itself it is not a sufficient (risk) factor to result in OSA. An additional risk factor is probably required, and obesity seems to account for a substantial part of this "additional" risk. This might be the reason why the prevalence of OSA was not significantly different across the strata after adjusting for obesity. However, if one carefully inspects the results of the multivariable analysis, there is a residual gradient in risk across the strata even after adjusting for the BMI and waist-hip ratio. We believe, this is probably due to residual confounding – BMI and waist-hip ratio may not faithfully reflect the risk for OSA conferred by obesity. Another possible explanation for the non-concordance of habitual snoring and OSA might be that the habitual snorers were in fact a heterogeneous group with varying severity, which was non-uniformly distributed across the strata.

One possible limitation of the present study was the low response rate for PSG, especially in the non-habitual snorer group. This was anticipated because these were asymptomatic subjects. Notwithstanding, this is unlikely to have introduced a spectrum bias since the characteristics of the subjects who underwent PSG were no different from those who declined PSG.

To conclude, we found that the burden of OSA is substantial in an urban Indian population. With changing lifestyles, rapid economic growth, and an increase in the prevalence of obesity, the prevalence of OSA is bound to increase. If appropriate scientifically-based public health interventions are not implemented, this could potentially constrain the already overburdened health resources of India.

Conflict of interest

We declare that we have no conflict of interest.

Funding

Supported by an unrestricted educational grant from Pfizer India Ltd. to SKS.

Acknowledgments

We thank Dr. Kalaivani for her help in statistical analyses; sleep technicians Mr. Hridesh Mishra, Mr. Jitender Sharma, and Mr. Jitender Kumar; field workers Mr. Balram, Mr. Kuldeep, and Mr. Santosh for their assistance in data collection. TK is supported by the Scientists' Pool Scheme of the Council of Scientific and Industrial Research, Government of India. We are grateful to the anonymous reviewer for his/her invaluable suggestions.

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