

# Prevalence and Risk Factors for OSA among Urban and Rural Subjects in Bengaluru District, South India: A Cross-sectional Study

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## ABSTRACT

**Introduction:** Prevalence rates of obstructive sleep apnea (OSA) in India vary widely due to diverse study settings. Besides, the literature comparing the prevalence of OSA between urban and rural settings is sparse.

**Aims and objectives:** To determine prevalence and risk factors for OSA among urban and rural South Indian subjects.

**Materials and methods:** This prospective study was carried out in seven census blocks in Bengaluru and seven villages in Anekal taluk. Clinical data were collected; Epworth sleepiness scale and Berlin questionnaire were used to screen for sleepiness and OSA, respectively. Subjects deemed high risk for OSA during screening underwent level III sleep study.

**Results:** A total of 709 subjects (388 urban and 321 rural) were included. The mean age was  $35.5 \pm 10.6$  years (urban subjects) and  $39.4 \pm 15.6$  years (rural subjects). Those at risk of OSA after screening were 36 (6.7%) and 28 (8.7%) among urban and rural participants, respectively. The prevalence of OSA was 18 (4.6%) in urban and 12 (3.7%) in rural subjects.

**Discussion:** The urban OSA group had significantly higher body mass index (27.6 vs 24.2 kg/m<sup>2</sup>;  $p = 0.05$ ) and neck circumference (38.9 vs 34.4 cm;  $p = 0.0001$ ). Although the overall prevalence of OSA was similar in both groups, urban subjects had a significantly higher prevalence of severe OSA (44 vs 8.4%).

**Conclusion:** Prevalence of OSA was similar in urban and rural subjects but risk factors and OSA severity showed variation between the two groups, with urban subjects having unfavorable anthropometry and a higher proportion of severe OSA.

**Keywords:** Berlin questionnaire, Epworth sleepiness scale, Level III sleep study, Obstructive sleep apnea, Rural and urban setting.

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## INTRODUCTION

Obstructive sleep apnea (OSA) is one of the commonest sleep disorders. Subjects with OSA have episodic upper airway obstruction and hypoxemia, which form the basis for symptoms like intrusive snoring, witnessed apneas, excessive daytime sleepiness (EDS), and an increased propensity for accidents.<sup>1,2</sup> Besides, OSA has also been proven to be associated with complications such as hypertension, ischemic heart disease,<sup>3</sup> and stroke.<sup>4</sup> It also results in poor quality of life and increase in health care utilization.<sup>5,6</sup> The diagnosis of OSA is confirmed by polysomnography, with Apnea-Hypopnea Index (AHI) >5 per hour being diagnostic.

OSA is largely under-diagnosed due to lack of awareness among the general population and medical fraternity; added to this are long waiting times for sleep study and expensive diagnostic evaluation. The prevalence data of OSA in the Indian subcontinent are variable with figures ranging from 1.7 to 12.2<sup>7</sup> and 13.7%,<sup>8</sup> based on the study setting. The majority of data available are from the urban population<sup>8-10</sup> whereas data on the rural population are limited.<sup>11,12</sup> Moreover, there are no studies comparing the prevalence and risk factors of OSA between urban and rural populations. This study was done to analyze the prevalence and epidemiology of OSA in urban and rural subjects.

## AIMS AND OBJECTIVES

- To compare the prevalence of OSA in urban and rural South Indian population.

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- To evaluate the differences in risk factors for OSA in these subjects.

## MATERIALS AND METHODS

This prospective study was initiated after approval from the institutional ethics review board. Participants were included after obtaining written informed consent. A simple stratified random sample of adult subjects from seven census blocks (population of 2,720) in Bangalore urban district and from a rural population in seven villages of Anekal taluk (population of 2,247) was taken up

for the study. Total adult population in the two areas was obtained from the Bangalore City Corporation records and national census data and every seventh individual listed was approached for inclusion in the study. It was decided *a priori* that the next person on the list would be approached if a subject denied consent for the study. Subjects who were too sick (terminally ill, psychiatric illness) to cooperate for a sleep study were excluded. The investigators S.B. and A.M.P. visited the respective urban and rural areas during college holidays and weekends to collect data by a house to house survey and interviewed subjects. All subjects aged 18 years and above were included.

All included subjects were screened for OSA using a clinical pro forma which included demographic data and questions specific for OSA (intrusive snoring, EDS, and witnessed apneas). Epworth sleepiness scale (ESS) and Berlin questionnaire were administered to assess for EDS and risk stratification of OSA, respectively. Anthropometric parameters (body mass index (BMI), neck, waist circumference, and hip circumference) were measured and the upper airway was assessed based on Malampatti classification. History of comorbid illnesses such as diabetes, hypertension, stroke, and ischemic heart disease was noted. Subjects categorized as high risk for OSA (based on classical OSA symptoms as mentioned above, ESS score >10 and Berlin questionnaire score positivity in two or more categories) were subjected to a level III sleep study (Resmed Apnea-link plus™) in the comfort of their home. One of the two certified sleep physicians (U.M.K. or U.D.) manually scored the sleep study and a diagnosis of OSA was made if the AHI was more than 5 per hour.

**Outcome Measures**

OSA diagnosis was defined by an AHI of  $\geq 5$  per hour on the level III sleep study. Apnea and hypopnea were defined as per American Academy of Sleep Medicine scoring manual (version 2.2).<sup>13</sup>

The AHI is computed as the average number of apneas (>90% fall in oronasal airflow rate as detected by a thermal sensor, for  $\geq 10$  seconds) and hypopneas (fall in oronasal flow rate by 30% for  $\geq 10$  seconds, with a 3% fall in oxygen saturation) per hour. Further evaluation and management were offered to subjects diagnosed with OSA.

**Sample Size**

Considering the prevalence rate of OSA to be 10% in the urban population,<sup>8</sup> with a relative precision of 25% and desired confidence level of 90%, and an alpha error of 5%, the estimated sample size for the urban cohort was 380 subjects. Similarly, the calculated sample size for the rural population was 268 subjects.

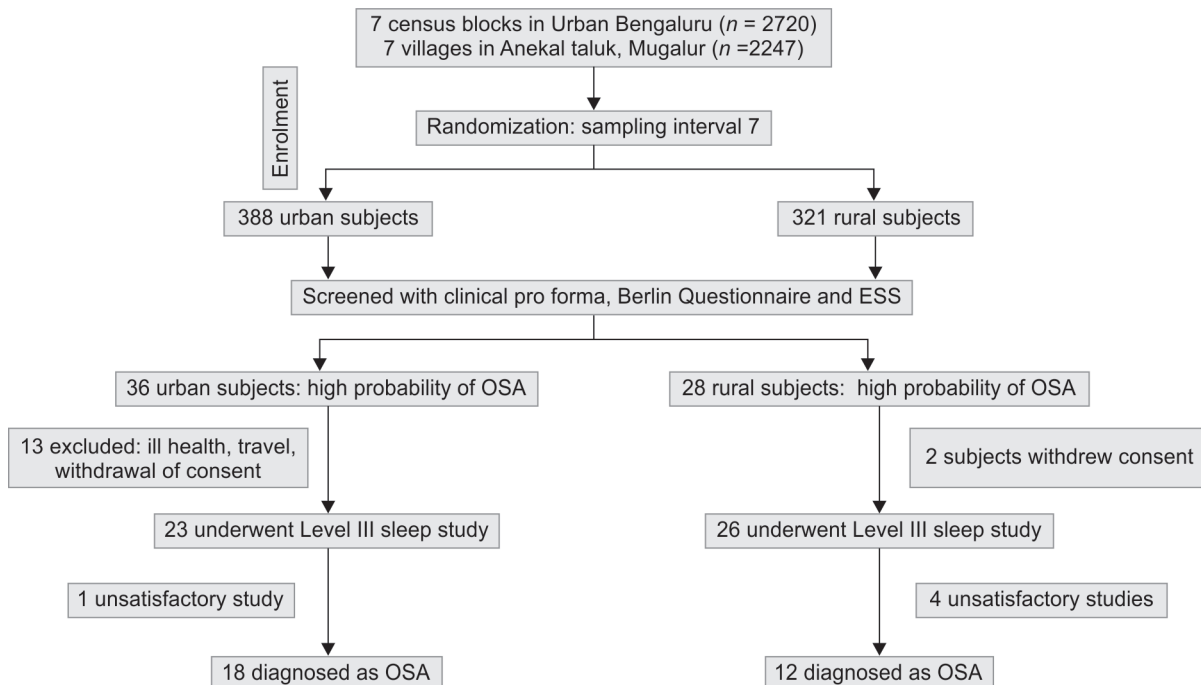
**Statistical Analysis**

Descriptive statistics were used to express the demographic data as mean, median, standard deviation, and range. The effect of risk factors on the prevalence of OSA was analyzed with multivariate binary logistic regression. Chi-square test and Mann-Whitney *U* test were used to compare risk factors between the urban and rural subjects diagnosed with OSA. Statistical significance was pegged at a *p* value of <0.05. SPSS version 17 (SPSS Inc, Chicago, Illinois, USA) and was used for statistical analysis.

**RESULTS**

The study population comprised of 2,720 and 2,247 subjects from the urban and rural areas, respectively, and the study was carried out as depicted in the flowchart (Flowchart 1).

A total of 388 and 321 adult subjects from urban and rural areas, who were selected by simple stratified random sampling and sampling interval of 7 were included. The demographic characteristics are shown in Table 1.



Flowchart 1: Study flow



**Table 1:** Demographic characteristics of study subjects

Characteristics	Urban (N = 388)	Rural (N = 321)	p value	95% confidence interval
Age (mean age in years)	35.5 ± 10.6	39.43 ± 15.6	0.0001	1.9, 5.8
Sex (males)	230 (59.4%)	162 (50.5%)	0.01	OR1.42*; 1.06, 1.92
<b>Occupation</b>				
Homemaker/unemployed	89 (22.9%)	150 (46.7%)	0.0001	
Blue-collar workers	192 (49.5%)	146 (45.5%)		
White-collar workers	107 (27.6%)	25 (7.8%)		
Height (m)	1.61 ± 0.12	1.59 ± 0.09	0.006	−0.03, −0.006
Weight (kg)	63.45 ± 12.4	61.19 ± 13.2	0.02	−4.16, −0.37
BMI mean (kg/m <sup>2</sup> )	24.4 ± 5.3	24.02 ± 4.6	0.27	−1.15, 0.33
Obesity (BMI ≥25)	141 (36.4%)	121 (37.7%)	0.72	OR 0.94; 0.69, 1.28
Mallampati score (3 and 4)	73	102	<0.0001	OR 0.49; 0.35, 0.70
Neck circumference (cm)	35.8 ± 4.37	33.7 ± 5.1	0.0001	−2.66, −1.27
Waist–hip ratio	0.93 ± 0.11	0.86 ± 0.08	0.0001	−0.077, −0.077
Snoring	94 (24.2%)	90 (28%)	0.26	0.58, 1.14
Hypertension	35 (8.8%)	24 (7.5%)	0.54	OR 1.2; 0.71, 2.1
Diabetes	18 (4.6%)	25 (7.8%)	0.08	OR 0.57; 0.30, 1.07
Ischemic heart disease	2 (0.5%)	2 (0.6%)	1	OR 0.82; 0.11, 5.9
ESS >10	30	2	<0.0001	OR 13.3; 3.16, 56.3
OSA (AHI >5)	18	12	0.58	OR 1.2; 0.59, 2.6

\*OR, odds ratio

Prevalence of “high-risk” category of OSA after screening with the clinical pro forma and questionnaires was 36 (6.7%) vs 28 (8.72%) in the urban and rural populations, respectively. The prevalence of OSA by AHI criteria was 4.6 and 3.7% in urban and rural subjects, respectively.

### Rural Population

Among the 321 subjects, 28 subjects were in the high-risk category by Berlin questionnaire, of whom 26 underwent the level III sleep study, as two subjects withdrew consent. Four studies were technically unsatisfactory (for reasons such as: flow sensors were disconnected, recording available for 2–3 hours only). OSA was diagnosed in 12 subjects, of whom seven were males. Thus, the prevalence of OSA by AHI criteria was 3.7%.

The mean AHI of this group was 13.9 ± 12.7 per hour and range of 0 to 53.2 per hour. Among the 12 rural subjects with OSA, 9 (75%) had mild OSA, 2 (16.6%) had moderate OSA, and 1 (8.4%) had severe OSA.

### Urban Population

Of the 388 urban subjects, 36 were in the high-risk category and 23 consented to undergo a level III sleep study. Out of the 23 studies performed, 1 was excluded due to inadequate sleep time during the sleep study. OSA was confirmed in 18 subjects. Thus, the overall prevalence of OSA in the urban population was 4.6%.

A wide range of AHI ranging from 0 to 70 and a mean AHI of 19.5 ± 16.2 per hour was observed in the subjects who underwent sleep study. Among the 18 urban subjects with a confirmed diagnosis of OSA, 5 (27.7%) had mild OSA, 5 (27.7%) had moderate OSA, and 8 (44.4%) had severe OSA.

### Comparison between Urban and Rural OSA Subjects (Table 2)

It was observed that urban OSA subjects were younger with a male preponderance compared to their rural counterparts. Urban

patients were also more obese, had a higher proportion of snoring, and were sleepier based on ESS scores. A higher number of urban OSA patients were employed in sedentary jobs.

Among systemic co-morbidities, diabetes was more prevalent in urban OSA subjects. However, only anthropometric measures (BMI, waist, and neck circumference) were significantly higher among urban OSA group. In addition, urban OSA subjects had a significantly higher prevalence of severe OSA compared to rural subjects.

## DISCUSSION

Although awareness about sleep disorders has been on the rise in recent times, OSA continues to be an under-diagnosed sleep disorder. Sleep medicine is still an emerging specialty in our geographic region, with many health professionals and most of the general population being unaware of sleep-disordered breathing.<sup>7</sup> OSA has been inferred as a causal factor for myriad cardiovascular complications such as stroke, myocardial infarction, arrhythmias, and sudden cardiac death.<sup>14</sup> OSA is also known to result in cognitive dysfunction and accidents due to difficulty in concentration and sleepiness while driving.<sup>15,16</sup>

Overnight sleep studies can be used to confirm the presence of OSA, and the backbone of treatment is continuous positive airway pressure therapy. While the prevalence of OSA has been reported widely in the urban population,<sup>8,17,18</sup> only a few studies have described OSA prevalence in rural communities.<sup>11,12</sup> The literature is also limited on drawing parallels between the characteristics of OSA between urban and rural populations. There are many unanswered queries on the similarities and differences in clinical presentation, anthropometry, risk factors, and comorbidities in OSA between the urban and rural populations. This study is the first of its kind to compare the prevalence and risk factors for OSA between urban and rural communities.

**Table 2:** Comparison of characteristics between urban and rural OSA-positive groups

Characteristics	Urban (N = 18)	Rural (N = 12)	p value	95% confidence interval
Age (mean age in years)	45.5 ± 6.1	48.34 ± 12.2	0.42	−4.60, 10.33
Sex (males)	13	6	0.26	OR2.6*; 0.56, 12.02
<b>Occupation</b>				
Homemaker/unemployed	4	5	0.20	
Blue-collar workers	5	5		
White-collar workers	9	2		
Height (m)	1.68 ± 0.07	1.60 ± 0.09	0.017	−0.14, −0.01
Weight (kg)	78.6 ± 10.5	62.5 ± 11.9	0.001	−25.48, −6.76
BMI mean (kg/m <sup>2</sup> )	27.6 ± 4.4	24.2 ± 4.1	0.05	−6.96, 0.07
Obesity (BMI ≥25)	11 (61%)	5 (41%)	0.72	OR 2.2; 0.49, 9.74
Mallampati score (3 and 4)	7	7	0.36	OR 1.4; 0.10, 2.01
Neck circumference (cm)	38.9 ± 4.05	34.4 ± 2.7	0.0001	−7.42, −1.61
Waist circumference (cm)	100.1 ± 24.3	85.7 ± 8.3	0.04	−28.08, 0.66
Waist–hip ratio	0.94 ± 0.08	0.90 ± 0.07	0.24	−0.10, 0.02
Snoring	17	8	0.12	OR 8.5; 0.81, 88.8
Hypertension	6	4	1	OR 1; 0.21, 4.7
Diabetes	5	2	0.66	OR 1.9; 0.30, 12
ESS >10	6	1	0.18	OR 5.5; 0.56, 53.2
Mean AHI	19.5 ± 16.2	13.9 ± 12.7	0.36	
Severe OSA	44%	8.4%	0.006	

\*OR, odds ratio

The prevalence of OSA as reported from different parts of the world varies widely from 2 to 4%<sup>2</sup> to 49%<sup>19</sup> and 71%.<sup>20</sup> The prevalence of OSA in the urban population in the current study (4.6%) is lower than that reported from previous studies 9.3,<sup>8</sup> 13.7,<sup>18</sup> and 19.5%,<sup>9</sup> reported from northern parts of India. The North Indian population was older (mean age 45.8 ± 8.3 years), had a higher BMI (27 ± 5.2 kg/m<sup>2</sup>), and a higher proportion of hypertension (55%) as compared to the current study population (35.5 ± 10.6 years, 24.4 ± 5.3 kg/m<sup>2</sup> and 33%), respectively. Hence, differences in sociodemographic characteristics between North India and South India are one possible explanation for the lower prevalence of OSA in the current study.

OSA in rural population is yet unexplored and few studies from the world over have stated the prevalence of OSA as 18.6,<sup>21</sup> 6.0,<sup>22</sup> and 4.1%.<sup>23</sup> Berlin questionnaire-based assessment of the prevalence of risk of OSA has estimated 25% prevalence in rural Odisha.<sup>12</sup> There are no previous studies from rural population in India, where OSA was confirmed objectively by sleep studies, apart from the one by the current study authors.<sup>11</sup>

Our comparative study demonstrates that the prevalence of OSA is quite similar in urban and rural communities. This similarity was unforeseen given the significant differences in many of the risk factors of OSA between the two communities.

The rural community had a significantly older population and equal gender distribution in comparison to the urban community. However, OSA was diagnosed more in females in rural area (Table 2). Previous studies have reported menopause as a risk factor for OSA in women with an odds ratio of 2.6.<sup>24</sup> The mean age of the rural women in our study (51.16 years) tended toward postmenopausal age as compared to the mean age of the urban group (45 years), though menopausal status was not included in the pro forma.

The urban OSA group also had a significantly higher BMI (27.6 vs 24.2 kg/m<sup>2</sup>), waist circumference (100.1 vs 85.7 cm) and neck circumference (38.9 vs 34.4 cm) when compared to the rural OSA

group. Male gender, snoring an ESS score of >10 emerged as risk factors in the urban population with an odds ratio of 2.6, 8.5, and 5.5, respectively. These factors could have been the possible reasons for the higher percentage of OSA in the urban population.

The rural population was always on the move and it was challenging for them to attend our screening interview, which had to be rescheduled multiple times before completion. Most of the rural households were pucca houses with more than two generations of family living under one roof. Most of the interviewed rural subjects were involved in agricultural work involving manual labor, though a few subjects reported work as supervision of white-collared workers in the urban area, which has a comparatively sedentary job profile. Although formal physical activity scales were not used in our study, the rural population was more physically active than their urban counterparts by the nature of their job description. Both the urban and rural OSA groups had a similar frequency of comorbidities such as hypertension and diabetes.

Although the prevalence of OSA was noted to be similar in both populations, the urban population had a conspicuously higher percentage of severe OSA (44%) in comparison to their rural counterparts (8.4%). The higher BMI, waist and neck circumference, sedentary job profile, and the higher proportion of males among the afflicted may be the causative factors for the considerable difference noted in the severity distribution of OSA. The reasons behind why an active rural population with a lesser prevalence of obesity had a similar prevalence of OSA as that seen in the urban group remains to be explored further.

Epidemiological investigation of sleep-disordered breathing has been hampered by difficulties in obtaining valid data from adequate population-based sample, especially in rural population. This study has the benefit of a structured study design and a representative sampling from the two population groups. The presence of OSA

was not questionnaire based but objectively confirmed by a level III sleep study. The limitation of this study was that it did not offer sleep tests for a control group within the selected population (e.g., nonsnorers or nonobese) wherein the identification of those with OSA with lesser risk factors could have been missed.

## CONCLUSION

The current study has thrown light on an unmapped territory of rural OSA and its comparison with urban OSA. The prevalence of OSA in the urban and rural populations in South India was similar. However, urban population suffered from a higher percentage of severe OSA and there was variation in the risk factor profile between the two groups. The potential rationale for this finding should be ascertained in further larger studies.

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