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ORIGINAL ARTICLES

Prevalence of Sleep Abnormalities and Their Association with Metabolic Syndrome among Asian Indians: Chennai Urban Rural Epidemiology Study (CURES – 67)

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Abstract

Objective:

To estimate the prevalence of sleep abnormalities and their association with glucose intolerance and metabolic syndrome (MS) in the normal-weight urban South Indian population.

Methods:

This population-based, cross-sectional study was carried out in 358 subjects aged 20–76 years randomly selected from the Chennai Urban Rural Epidemiology Study in South India. A validated questionnaire assessing various sleep abnormalities (snoring, daytime sleepiness, lack of refreshing sleep, and number of hours of sleep) was administered. All subjects underwent an oral glucose tolerance test, and anthropometric biochemical measurements were obtained to assess cardiometabolic risk factors including glucose intolerance. Diabetes risk was assessed using a previously validated Indian Diabetes Risk Score (IDRS).

Results:

The overall prevalence of snoring and daytime sleepiness was 40% and 59%, respectively. Snorers were more male, older, smokers, and had higher levels of cardiometabolic risk factors. Subjects with daytime sleepiness had higher body mass index (BMI) and abdominal obesity. Both snoring (50.9% vs 30.2%, $p < 0.001$) and daytime sleepiness (68% vs 49.7%, $p < 0.001$) were more prevalent among subjects with impaired glucose metabolism compared to those with normal glucose metabolism. Both sleep measures were associated with higher diabetes risk scores, as assessed by the IDRS (snoring: trend χ^2, 11.14, $p = 0.001$; daytime sleepiness: trend χ^2, 5.12, $p = 0.024$). Metabolic syndrome was significantly associated with snoring even after adjusting for age, sex, family history of diabetes, physical activity, smoking, and alcohol.

Conclusion:

The prevalence of snoring and daytime sleepiness is high among urban South Indians and these two sleep measures are associated with glucose intolerance, MS, and higher diabetes risk scores.

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Abbreviations: (BMI) body mass index, (CI) confidence interval, (CURES) Chennai Urban Rural Epidemiology Study, (CVD) cardiovascular disease, (HbA1c) glycated hemoglobin, (IDRS) Indian Diabetes Risk Score, (IFG) impaired fasting glucose, (IGT) impaired glucose tolerance, (MS) metabolic syndrome, (NCEP-ATPIII) National Cholesterol Education Program and Adult Treatment Panel III, (NGT) normal glucose tolerance, (STOP) snoring, tiredness during daytime, observed apnea, and high blood pressure, (WHO) World Health Organization

Keywords: sleep abnormalities, snoring, daytime sleepiness, cardiometabolic risk factors, metabolic syndrome, Asian Indians

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Introduction

There is increasing evidence that sleep abnormalities in general and sleep-disordered breathing, such as snoring in particular, have deleterious effects beyond the neurocognitive realm. While excessive daytime fatigue, impaired cognition, and reduced productivity are the commonly recognized consequences of sleep abnormalities, numerous studies have also shown sleep abnormalities to be associated with hypertension, cardiovascular disease (CVD), and abnormal glucose metabolism.[1–3] The prevalence of obstructive sleep apnea in the general population is estimated to be 2–4%;[4] however, this is largely based on studies done in North America, Europe, and Australia. Community-based studies have shown that the prevalence estimates vary greatly based on age, sex, body mass index (BMI), and ethnicity.[4] This suggests the need for obtaining population-based data on sleep abnormalities in non-Western populations and developing countries, particularly from South Asia and India, the current epicenter of the global diabetes and CVD epidemic.[5,6] Unfortunately such data are almost nonexistent.

Given the recognized association of sleep abnormalities with cardiometabolic disorders, it is not surprising that age and obesity are risk factors that are common to both diabetes and CVD. Indeed, in most cases, snoring is associated with severe obesity, defined according to Western definitions as BMI >40. As pointed out above, there are very little data on snoring and related sleep abnormalities in normal-weight populations. Asian Indians have a high prevalence of diabetes, metabolic syndrome (MS), and premature CVD despite being relatively lean[7,8] and hence are an ideal population in which to study sleep abnormalities. There have been only a few sleep studies in this ethnic group and most have been clinic-based.[9,10] The three aims of the current investigation are to: (1) look at the prevalence of sleep abnormalities (snoring and daytime sleepiness) in subjects with impaired glucose metabolism; (2) look at the association of MS with snoring; and (3) assess the prevalence of snoring and daytime sleepiness in relation to the Indian Diabetes Risk Score (IDRS).

Research Design and Methods

The Chennai Urban Rural Epidemiology Study (CURES) is a large cross-sectional study conducted on a representative population of the metropolitan city of Chennai (formerly Madras) in southern India. The detailed study design and various phases of CURES are described in previous publications,[11–13] and the sampling frame is also shown in the website http://www.mdrf.in/misc/CURES.pdf.

For the current study, a subset of 358 subjects, randomly selected from Phase 3 of CURES using computer generated numbers, were administered a standard validated questionnaire on sleep behavior. This questionnaire was adopted from a previously validated and published snoring, tiredness during daytime, observed apnea, and high blood pressure (STOP) questionnaire.[14] The original STOP questionnaire has three questions: (1) "Do you snore loudly (louder than talking or loud enough to be heard through closed doors, as noticed by you or any of your close relatives)?"; (2) "Do you experience daytime sleepiness, i.e., do you often feel tired or sleepy during daytime?"; and (3) "Has anyone observed you stop breathing (for 10 seconds or longer) during your sleep?" The questionnaire was rephrased and modified to make it suitable for the local population by adding two more questions: (1) "How refreshing is your sleep?", and (2) "How long do you sleep on an average every night?" We first did a pilot study on 50 individuals in order to test the feasibility of this questionnaire as well as to validate the modified STOP questionnaire with the original STOP questionnaire. We found an excellent correlation, and the internal consistency of the modified sleep questionnaire was evaluated using Cronbach's test. The alpha coefficient was 0.812, showing good reliability of this tool. Institutional ethical committee approval and informed consent were obtained from all study subjects.

An oral glucose tolerance test was done using 75 g glucose load (except in self-reported diabetic subjects, for whom fasting glucose was done). Plasma glucose and serum lipids were estimated using a Hitachi 912 Chemistry Analyzer (Hitachi, Tokyo, Japan) and Roche kits (Roche Diagnostics GmbH, Mannheim, Germany). Glycated hemoglobin (HbA1c) was measured by the Variant II Hemoglobin Testing System (Bio-Rad, Hercules, CA).

Anthropometric measurements, including weight, height, waist, and hip measurements, were obtained using standardized techniques.[11] Body mass index was calculated using the formula *weight* (kg)/*height* (m)^2. Blood pressure was recorded in the sitting position in the right arm to the nearest 2 mm Hg using a mercury sphygmomanometer (Diamond Deluxe BP Apparatus, Pune, India), and the mean of the two readings, taken 5 minutes apart, was used.

Definitions

Snoring

According to the American Academy of Sleep Medicine, snoring is the production of sufficiently loud inspiratory or expiratory sounds that disturb the bed partner or others nearby. The patient is occasionally aware of the snoring. The snoring typically occurs while the patient is in the supine position and is usually continuous, present with each breath, and not accompanied by arousals or other evidence of sleep disturbance. The patient has no complaint of insomnia or excessive sleepiness.[15]

Daytime Sleepiness

Daytime sleepiness is defined as excessive sleepiness commonly occurring during the daytime, with a subjective report of difficulty in maintaining the alert awake state, usually accompanied by a rapid entrance into sleep when the person is sedentary. [15]

Elevated Blood Pressure

Elevated blood pressure was diagnosed if blood pressure was ≥130/85 mm Hg, based on the National Cholesterol Education Program and Adult Treatment Panel III (NCEP-ATPIII) guidelines,[16] or if the subject was on drug treatment for hypertension.

Abdominal Obesity

This was defined as a waist circumference ≥90 cm for men and ≥80 cm for women, based on World Health Organization (WHO) Asia Pacific guidelines.[1]

Metabolic Syndrome

Metabolic syndrome was diagnosed based on modified NCEP-ATPIII guidelines,[16] as described earlier, with modified waist measurement according to WHO Asia Pacific guidelines.[17] A subject was classified as having MS if three or more of the following were present: triglycerides ≥150 mg/dl (1.7 mmol/liter); high-density lipoprotein (HDL) cholesterol <40 mg/dl (1.0 mmol/liter) in men or <50 mg/dl (1.3 mmol/liter) in women; blood pressure ≥130/85 mm Hg; fasting glucose ≥100 mg/dl [5.6 mmol/liter, slightly below cutoff for impaired fasting glucose (IFG)]; or waist circumference ≥90 cm in men or ≥80 cm in women (abdominal obesity).

Glucose Intolerance

Glucose intolerance was diagnosed based on American Diabetic Association (ADA) criteria.[18] Impaired glucose tolerance (IGT) was diagnosed if the 2 h plasma glucose was between 140 and 200 mg/dl (7.8–11.1 mmol/liter); IFG was diagnosed if the fasting plasma glucose was between 100 and 125 mg/dl (5.6–6.9 mmol/liter); normal glucose tolerance (NGT) was diagnosed if the 2 h plasma glucose was <7.8 mmol/liter. Diabetes was diagnosed if fasting plasma glucose ≥126 mg/dl (≥7.0 mmol/liter), 2 h post-load plasma glucose ≥200 mg/dl (≥11.1 mmol/liter), or the subject had self-reported diabetes diagnosed by a physician and was on drug treatment for the same.

IDRS Assessment

The IDRS was designed based on multiple logistic regression analysis that used four simple parameters: age, abdominal obesity, family history of type 2 diabetes, and physical activity to quantify risk. An IDRS score ≥60 had a sensitivity of 72.5% and a specificity of 60.1% for predicting undiagnosed diabetes. Accordingly, subjects in this study with an IDRS of <30 were categorized as low risk, 30–60 as medium risk, and ≥60 as high risk for diabetes.[19] The correlation between IDRS and various sleep abnormalities was compared.

Statistics

Statistical analyses were performed using SPSS 10.0 for Windows software (SPSS Inc., Chicago, IL). To compare prevalence of the four sleep abnormalities according to glucose intolerance, MS, and diabetes risk, the χ^2 test was used. To compare the various cardiometabolic and anthropometric values across each of the sleep abnormalities, trend χ^2, Student's *t*-test, was used. We performed the test for normality using Kolmogorov-Smirnov test for all continuous variables. Continuous variables with non-normal distributions were presented as median with interquartile range and compared using Wilcoxon Rank Sum test. To determine the confounding effect of various risk factors, such as age, sex, physical activity, smoking, and alcohol, on the association of sleep abnormalities with cardiometabolic indices, logistic regression analysis was conducted, using MS as the dependent variable and snoring or daytime sleepiness (the two sleep disorders associated with cardiometabolic risk factors) as independent variables. To check for the presence of multicollinearity, variance inflation factor and tolerances for each of the risk factors were calculated. Tolerances less than the predetermined tolerance of 0.20 were removed from the model. For all analyses, $p < 0.05$ was considered significant.

Results

Sample Characteristics

The study group comprised 358 subjects, of whom 53% were male. The age group ranged from 20–76 years, and the

mean BMI was 23.5 ± 3.8 kg/m^2 (males: 23.6 ± 3.7 kg/m^2, females: 23.4 ± 3.9 kg/m^2). The mean waist circumference was 85.9 ± 11.2 cm (males: 89.0 ± 10.3 cm, females: 82.5 ± 11.3 cm).

Among the males, 48.1% had NGT, 7.4% had IFG, 18% had IGT, and 26.5% had diabetes. Among the females, 53.3% had NGT, 12.1% had IFG, 20.6% had IGT, and 13.9% had diabetes.

Sleep Abnormalities and Cardiometabolic Risk

Table 1 shows the anthropometric and cardiometabolic characteristics of the study subjects according to their snoring status. Subjects who snored vs non-snorers, were more often male, older, smokers, had higher BMI (24.9 ± 3.7 kg/m^2 vs 22.6 ± 3.6 kg/m^2, $p < 0.001$), waist circumference (90 ± 11 cm vs 83 ± 10 cm, $p < 0.001$), systolic and diastolic blood pressures, fasting plasma glucose (105 ± 35 mg/dl vs 96 ± 25 mg/dl, $p = 0.007$) and triglyceride levels (121 vs. 106 mg/dl, $p = 0.007$). A larger percentage of snorers were abdominally and generally obese and had hypertension and MS.

The overall prevalence of daytime sleepiness in this cohort was 59% (211/358 subjects). **Table 2** shows the anthropometric and cardiometabolic characteristics of the study subjects according to daytime sleepiness status. There was no significant age or sex difference between those with and without daytime sleepiness. Daytime sleepiness vs no daytime sleepiness, was significantly associated with higher BMI (24.3 ± 3.4 kg/m^2 vs 23.2 ± 3.9 kg/m^2, $p = 0.014$), larger waist circumference

Table 1:
Anthropometric and Cardiometabolic Characteristics of Subjects According to Snoring Status (n = 358)

Variables	Subjects who snore (n = 144)	Subjects who do not snore (n = 214)	p value
Age (years)[a]	43 ± 11	39 ± 12	0.002
Men [n (%)][b]	98 (68.1)	93 (43.5)	<0.001
BMI (kg/m^2)[a]	24.9 ± 3.7	22.6 ± 3.6	<0.001
Waist circumference (cm)[a] Overall Men Women	90.3 ± 10.8 91.8 ± 9.8 87.2 ± 12.3	82.8 ± 10.3 85.7 ± 9.8 80.5 ± 10.1	<0.001
Smoking [n (%)][b]	38 (24.2)	28 (13.1)	0.010
Systolic blood pressure (mm Hg)[a]	123 ± 17	119 ± 15	0.044
Diastolic blood pressure (mm Hg)[a]	78 ± 11	74 ± 10	0.003
Fasting plasma glucose (mg/dl)[a]	105 ± 35	96 ± 25	0.007
Triglycerides (mg/dl)[c]	121 (88–176)	106 (73–147)	0.007
HbA1c (%)[a]	6.5 ± 1.5	6.2 ± 1.5	0.147
Generalized obesity [n (%)] (BMI >25 kg/m^2)	66 (46.2)	59 (27.6)	<0.001
Abdominal obesity [n (%)] (waist circumference: men: ≥90 cm, women: ≥80 cm)[b]	102 (71.3)	103 (49.5)	<0.001
Elevated blood pressure (≥130/85 mm Hg)[b] [n (%)]	19 (12.1)	9 (4.2)	0.002
MS [n (%)] (Modified NCEP ATPIII criteria)[b]	68 (47.2)	56 (26.2)	<0.001
Subjects with high IDRS (≥60) [n (%)][b]	93 (64.6)	100 (46.7)	0.001

[a] Represented as mean ± standard deviation.
[b] Represented as proportions using χ^2 test.
[c] Represented as median (interquartile range) and compared using Wilcoxon Ranked Sum test.

(87 ± 10 cm vs 84 ± 12 cm, $p = 0.017$), increased levels (6.1 ± 1.4% vs 6.5 ± 1.6%, $p = 0.042$), and abdominal obesity (65.2% vs 48.2%, $p = 0.002$), respectively.

Tables 1 and 2 show that the number of subjects with higher IDRS scores (≥60) was greater in snorers than nonsnorers (64.6% vs 46.7%, $p = 0.001$), and in those with daytime sleepiness than no daytime sleepiness (58.3% vs 47.6%, $p = 0.046$).

Glucose Stratified Analysis

The prevalence of the four sleep abnormalities was analyzed in relation to impaired glucose metabolism, and **Table 3** presents the results. The impaired glucose metabolism group includes those with diabetes ($n = 73$), IGT ($n = 68$), or IFG ($n = 34$). The results show that a higher percentage of subjects with impaired glucose metabolism reported all four measures of sleep abnormalities compared to those with normal glucose metabolism, and snoring (50.9% vs 30.2%, $p < 0.001$), daytime sleepiness measure (68% vs 49.7%, $p < 0.001$), and number of hours of sleep per night (6.9 ± 1.2 h vs 7.2 ± 1.2 h, $p = 0.040$), respectively, reached statistical significance.

IDRS and Sleep Abnormalities

Figure 1 shows that the prevalence of both snoring and daytime sleepiness increased dramatically with an increase in IDRS scores (snoring: 22.2% low risk, 31.4% moderate risk, and 48.2% high risk, trend χ^2: 11.14, $p = 0.001$; daytime sleepiness: 33.3% low risk, 54.5%

Table 2:
Anthropometric and Cardiometabolic Characteristics of Subjects According to Daytime Sleepiness Status ($n = 358$)

Variables	Subjects who report daytime sleepiness ($n = 211$)	Subjects who report no daytime sleepiness ($n = 147$)	p value
Age (years)[a]	45 ± 13	42 ± 12	0.093
Men [n (%)][b]	111 (52.6)	80 (54.4)	0.735
BMI (kg/m^2)[a]	24.3 ± 3.4	23.2 ± 3.9	0.014
Waist circumference (cm)[a] Overall Men Women	 87.1 ± 10.13 89.7 ± 9.92 84.2 ± 9.62	 84.2 ± 12.4 87.9 ± 10.6 79.8 ± 13	0.017
Smoking [n (%)][b]	38 (18.0)	24 (16.3)	0.679
Systolic blood pressure (mm Hg)[a]	121 ± 16	120 ± 16	0.531
Diastolic blood pressure (mm Hg)[a]	76 ± 11	76 ± 11	0.989
Fasting plasma glucose (mg/dl)[a]	109 ± 38	106 ± 45	0.485
Triglycerides (mg/dl)[c]	114 (79–159)	110 (76–159)	0.617
HbA1c (%)[a]	6.5 ± 1.6	6.1 ± 1.4	0.042
Generalized obesity [n (%)] (BMI >25 kg/m^2)	76 (36.0)	49 (33.6)	0.632
Abdominal obesity [n (%)] (waist circumference: men: ≥90 cm, women: ≥80 cm)[b]	137 (65.2)	68 (48.2)	0.002
Elevated blood pressure pressure (≥130/85 mm Hg)[b] [n (%)]	19 (9.0)	9 (6.1)	0.318
MS [n (%)] (modified NCEP ATPIII criteria)[b]	80 (37.9)	44 (29.9)	0.111
Subjects with high IDRS (≥60) [n (%)][b]	123 (58.3)	70 (47.6)	0.046

[a] Represented as mean ± standard deviation.
[b] Represented as median (interquartile range) and compared using Wilcoxon Ranked Sum test.
[c] Represented as proportions using χ^2 test.

moderate risk, and 63.7% high risk, trend χ^2: 5.12, $p = 0.024$).

Metabolic Syndrome and Snoring

Table 4 shows the logistic regression analysis of the association of MS with snoring. In the unadjusted analysis, MS was associated with snoring, with an odds ratio of 2.558, confidence interval (CI): 1.635–4.004, $p < 0.001$. This association remained significant even after adjusting for age, sex, family history of diabetes, physical activity, smoking, and alcohol. Also the relationship between snoring and MS lost significance when waist circumference was introduced into the model.

Discussion

This study reports a high prevalence of snoring (40%) and daytime sleepiness (59%) in the normal- weight urban South Indian population, with a mean BMI of 23.5 ± 3.8. These values are higher than the study from Western India by Udwadia and colleagues,[20] who reported habitual snoring in 26% and daytime sleepiness in 22% of their study subjects.[20] These figures were found to be consistent with levels in others populations.[21] Our study results are in agreement with that of Ohayan and colleagues, who reported snoring in 40% of the study population.[22] However, there are studies that report an even higher prevalence (51.6%) of snoring in Asian populations such as the Chinese population.[23]

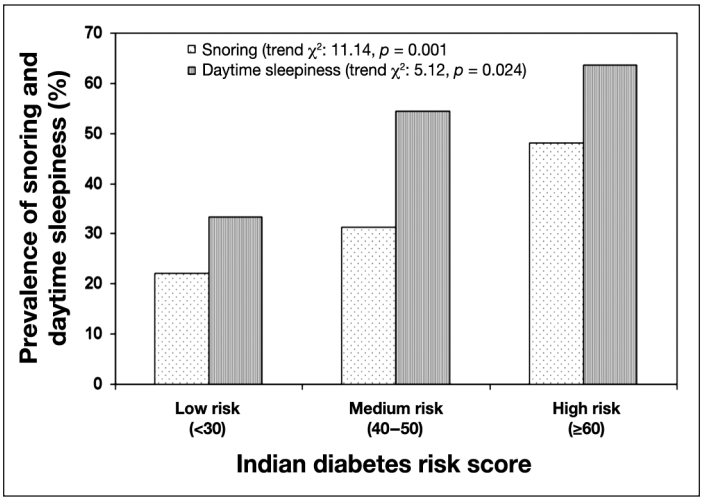

Figure 1. Snoring and daytime sleepiness in relation to IDRS.

Table 3: Prevalence of Sleep Abnormalities in Relation to Impaired Glucose Metabolism ($n = 358$)[a,b]

Sleep abnormalities	Subjects with impaired glucose metabolism ($n = 175$)	Subjects with normal glucose metabolism ($n = 179$)	p value
Snoring [n (%)]	89 (50.9)	54 (30.2)	<0.001
Daytime sleepiness [n (%)]	119 (68.0)	89 (49.7)	<0.001
Lack of "refreshing" sleep [n (%)]	44 (25.1)	33 (18.5)	0.133
Number hours of sleep per night [n (%)]	7.0 ± 1.2	7.2 ± 1.2	0.040

[a] This group includes those with diabetes ($n = 73$), IGT ($n = 68$), or IFG ($n = 34$).
[b] Values are results of χ^2 test.

Table 4:
Logistic Regression Analysis of Association of Metabolic Syndrome with Snoring[a]

Snoring and related risk indices	Odds ratio (95% CI)	p value
Snoring (unadjusted)	2.558 (1.635–4.004)	<0.001
Snoring adjusted for:		
Age	2.245 (1.403–3.593)	0.001
Age, sex	2.109 (1.304–3.413)	0.002
Age, sex, physical activity	2.271 (1.312–3.930)	0.003
Age, sex, physical activity, smoking	2.268 (1.310–3.926)	0.003
Age, sex, physical activity, smoking, alcohol	2.252 (1.298–3.906)	0.004

[a] Metabolic syndrome is the dependent categorical variable. Risk factors common to snoring were adjusted for in the regression.

The snoring measure used in our study was found to be associated with a host of anthropometric and cardiometabolic factors. In line with earlier literature, male sex and age both showed an association with the snoring measure.[1] In our study, snorers were 3 years older than nonsnorers among both females and males. As our males were generally older than the female snorers, this could be another explanation for the higher incidence of snoring among males, although abdominal obesity could also be a contributing factor.

Similar to results shown by other population-based studies,[24–26] the snorers showed higher values of BMI, waist circumferences, systolic/diastolic pressure, fasting blood glucose, and serum triglycerides than nonsnorers. Despite the small number of smokers, they too had a higher frequency of snoring.

Daytime sleepiness did not have nearly the same degree of association with cardiometabolic risk factors as snoring and indeed was not associated with MS. This is likely a methodological issue, as the term "daytime sleepiness" is a rather ambiguous measure, open to misinterpretation in a self-report questionnaire. Nevertheless, the daytime sleepiness measure showed a significant association with BMI and waist circumference. However, Bixler and colleagues have shown an association of daytime sleepiness with depression and metabolic factors.[27]

Both snoring and daytime sleepiness showed a significant relationship with impaired glucose metabolism. However, whether the sleep abnormalities had an independent association with MS is questionable. In our study we found that snoring, but not daytime sleepiness, is associated with MS.

The daytime sleepiness measure retained a correlation with glucose intolerance when sex and age were controlled for, but this, again, was weakened when measures were adjusted for obesity.

The most significant finding in our study was the high prevalence of snoring and daytime sleepiness in a normal-weight Indian population. It is important to note that of those who reported snoring, 90% had a BMI <30, the cut point for obesity in Europeans.[17] Thus, while the snorers in our study had higher BMIs, these individuals were not obese from the Western standpoint. This suggests that sleep abnormalities are also found in those who are slightly overweight. Also our data suggest that the prevalence of sleep abnormalities may be higher in our population. A study of Indians in Singapore showed that Indians had higher snoring prevalence rates than Chinese and Malays.[9] It is possible that sleep abnormalities could be another feature of the so-called "Asian Indian phenotype," which makes this ethnic group more susceptible to diabetes and premature coronary artery disease.[7,28]

Both snorers and those with daytime sleepiness had significantly higher IDRS scores compared to those who did not snore or have daytime sleepiness. Thus this study shows another use of the IDRS score—to identify those with sleep abnormalities such as snoring and daytime sleepiness.

This study has certain limitations. While the study used self-report to measure sleep quality, the presence of sleep abnormalities, such as snoring, arousals, and apneas, are best detected through overnight polysomnography, which is the gold standard measure for detecting sleep apnea.[4] Further, the simplicity of the sleep questions did not elicit specifics of the subjects' sleep patterns, thus restricting the study to an over-simplified analysis of the sleep abnormalities. Also, the confounding effect of central nervous system depressants, enlarged tonsils, and retrognathia, a familiar pattern could not be ruled out, as these parameters were not measured in this study. The possible implications of a mixed male–female cohort is not reported, as further stratifying data based on gender will lower the sample size. Hence, the analysis includes all subjects as a whole, which is one of the limitations of the study. Finally, being a cross-sectional study, no inferences can be drawn about causality. However, one of the strengths of this study is that it is a population-based sample, unlike most earlier sleep studies from India, which were hospital-based and subject to referral bias.[20,29] It is worth noting that despite the risk of over or under reporting, the self-report methodology of our study still shows compelling associations between at least two sleep abnormalities and cardiometabolic factors in our population. Future longitudinal work can aid the understanding of the sleep-cardiometabolism relationship.

In summary, this is the first Indian population-based study to investigate the prevalence and risk factors of sleep abnormalities and their relationship to cardiometabolic phenomenon in a representative population of South India. Given the rising epidemic of non-communicable diseases worldwide and the fact that South Asia in general—and India in particular—bears the brunt of the diabetes and CVD burden, further longitudinal, population-based research in this important area of sleep health is essential.

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