DOI: 10.7860/JCDR/2026/79478.22257

Original Article

Biochemistry Section

Association of Cardiometabolic Risk and Sleep Quality among Adults with Self-reported Sleep Disordered Breathing: A Cross-sectional Study

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ABSTRACT

Introduction: Sleep Disordered Breathing (SDB) refers to the periodic disruption of breathing that occurs during sleep. As a result, the affected individuals experience poor sleep quality. The effects of the same include daytime fatigue, sleepiness, functional impairment, and an overall reduction in quality of life. Recently, several studies have linked SDB with obesity, diabetes, and Cardiovascular Disease (CVD).

Aim: The aim of this study was to compare the cardiometabolic risk and its correlation with sleep quality among individuals with and without self-reported SDB aged between 30-50 years.

Materials and Methods: The present analytical cross-sectional study was conducted at SRM Medical College, Hospital and Research Centre, Chengalpattu, Tamil Nadu, India, from January 2024 - April 2024. The study involved 136 participants irrespective of gender, aged between 30-50 years. Out of 136 participants, 68 were apparently healthy individuals without SDB, and the remaining 68 were individuals with self-reported SDB based on the Neck Circumference (NC), Obesity, Snoring, Age, and Sex (NoSAS) score. A score of ≥8 was considered SDB positive, and sleep quality was evaluated using the Pittsburgh Sleep Quality Index (PSQI) questionnaire. Anthropometric measurements such as Weight (kg), Height (cm), Waist Circumference (WC) (cm), Neck Circumference (NC) (cm) and Body Mass Index (BMI) (Kg/m^2) were noted. Biochemical parameters such as Fasting Plasma Glucose (FPG) and lipid profile [Total Cholesterol (TC), Triglycerides (TGL), Low-density Lipoprotein Cholesterol (LDL-C), High-density Lipoprotein Cholesterol (HDL-C)] were also analysed. Descriptive statistics, student's t test, Mann-Whitney U test, Spearman correlation test, Chi-square test were used to statistically analyse the data.

Results: In the present study, the average age of SDB positive group was 40.88±6.04 years and SDB negative group was 41.20±5.6 years. The SDB positive group had a male to female ratio of 40:28 and the SDB negative group had a male to female ratio of 23:45. Furthermore, the SDB positive group had higher BMI, NC, WC, biochemical parameters (FPG, TC, TGL, LDL-C) as well as lower HDL-C levels and poor sleep quality, compared to the SDB negative group.

Conclusion: Individuals with SDB had poorer sleep quality and a higher risk of developing CVD as exhibited by the elevated lipid parameters, compared with that of the SDB negative group. Future studies could focus on exploring the directionality and causality of the said associations.

Keywords: Cardiovascular disease, Lipid parameters, Obesity, Obstructive sleep apnoea

INTRODUCTION

Sleep Disordered Breathing (SDB) refers to the periodic cessation of breathing during sleep, with each period lasting more than 10 seconds [1]. It is mainly composed of Obstructive Sleep Apnoea (OSA), Central Sleep Apnoea, and Mixed Sleep Apnoea. However, the present study primarily focused on OSA. A variety of factors contribute to the pathogenesis of SDB, notably an anatomically compromised or collapsible upper airway being one of them [2,3]. Regardless of the aetiology, the resulting fragmented sleep cycle takes a toll on the affected individuals.

Sleep, being an essential component of the human biological system, plays a vital role in maintaining optimal health, cognitive function, and systemic physiology [4]. Therefore, poor maintenance of the sleep-wake cycle can lead to a broad spectrum of ailments. Short-term consequences include stress, psychosocial issues, and somatic problems, while long-term consequences include obesity, CVD, type 2 diabetes, and more [4]. Previous studies have also associated poor sleep quality with an elevated risk of developing obesity, dyslipidaemia, diabetes mellitus, atrial fibrillation, and hypertension [4-6], thereby reinforcing the impact of poor sleep on the human body.

With respect to cardiometabolic risk, a Multi-Ethnic Study of Atherosclerosis (MESA), involving over 5,000 individuals free of CVD and followed-up for 7.5 years, revealed that OSA predicted a 2.4-fold increase in mortality and incidence of CVD [7]. Sudden cardiac death was reported in 46% of individuals with OSA due to the development of atrial and ventricular arrhythmias following an apnoeic episode, as demonstrated by a polysomnography study [8,9].

The prevalence of OSA can be highlighted by citing a study that used the American Academy of Sleep Medicine (AASM) 2012 diagnostic criteria and Apnoea-Hypopnoea Index (AHI) threshold values of ≥5 events/hour and ≥15 events/hour. This study estimated that nearly 936 million adults suffer from mild-to-severe OSA, and 425 million suffer from moderate-to-severe OSA globally [10]. Although the Indian population is a major contributor to these statistics [10], a national-level survey is yet to be conducted in the Indian subcontinent. However, it is worth mentioning a cross-sectional study conducted at urban and rural levels in India, which reported a prevalence of 4.6% and 3.7%, respectively, with a male predominance [11].

In developed countries, awareness of SDB as a determinant of cardiovascular risk and poor sleep quality is well established [4,5]. In India, a study was published in this domain but was confined to individuals above the age of 50 [11].

Hence, the present study was conducted to compare cardiometabolic risk and its association with sleep quality among individuals with and without self-reported SDB, aged between 30 and 50 years.

MATERIALS AND METHODS

The present analytical cross-sectional study was conducted at SRM Medical College, Hospital and Research Centre, Chengalpattu, Tamil Nadu, India, over a period of three months from January 2024-April 2024. Ethical approval was obtained from the Institutional Ethics Committee (IEC No: SRMIEC-5T0323-451). Written and verbal informed consent was obtained from all participants prior to recruitment. And the demographic details were obtained using a simple proforma.

Inclusion criteria: Individuals who were aged between 30 to 50 years, of Indian origin, and those who had self-reported SDB.

Exclusion criteria: Individuals who were younger than 30 years and older than 50 years of age, patients with a known history of dyslipidaemia; individuals taking hyperlipidaemic drugs, sedatives or sleep medications were excluded.

Sample size calculation: The sample size was calculated based on the prevalence of SDB in India [11].

Where: Z=1.96; p=4.6%; q=1-p=1-0.046=0.954; d=5%;

$n=(1.96)2\times0.046\times0.954/(0.0025)$

$n=68$

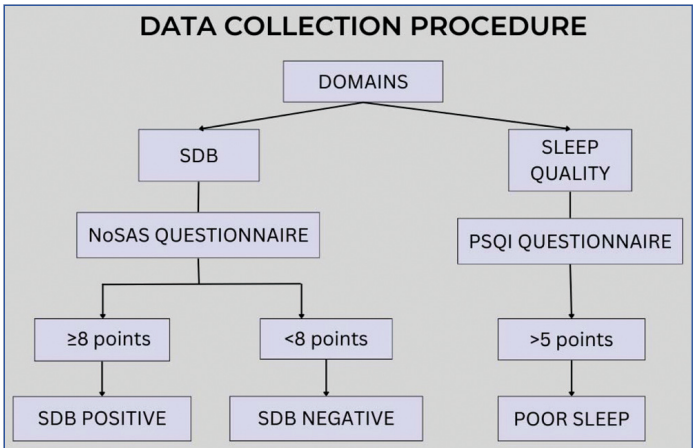
where,

- Z=Z-score for 95% confidence level.
- p=Proportion of the population with the characteristic.
- q=Proportion of the population without the characteristic.
- d=Margin of error.

Study Procedure

The participants were divided into SDB positive and SDB negative groups based on the NoSAS questionnaire, which assessed the likelihood of SDB. A score of ≥8 points was indicative of SDB [12]. The SDB positive group (study group) comprised of 68 participants meeting the criteria as mentioned, while the SDB negative group (control group) comprised of 68 apparently healthy participants (<8 points). A selective sampling technique was employed for recruitment based on inclusion criteria.

Data collection: The two domains were assessed using standard questionnaires [Table/Fig-1].



[Table/Fig-1]: Data collection procedure; the participants were first screened for SDB using the NoSAS score, after which the PSQI questionnaire was administered. SDB: Sleep disorded breathing; PSQI: Pittsburgh sleep quality index; NoSAS: Neck circumference, obesity, snoring, age, and sex score

Assessment of SDB: The SDB was assessed using a simple and efficient screening method, the NoSAS score which included grading for age, gender, NC, obesity, and snoring; ranging from 0 to 17 [12]. A score of ≥8 was considered indicative of SDB. However, the NoSAS scoring was purely subjective, as opposed to polysomnography, which is the gold standard for the diagnosis of Sleep Apnoea. Due to limitations such as lack of manpower, equipment, and various other factors, the NoSAS questionnaire was chosen for this study.

Assessment of sleep quality: The quality of sleep during the previous month was assessed using the PSQI questionnaire. The PSQI is a standardised, quantitative measure of sleep quality with demonstrated high levels of consistency, reliability, and validity [13]. The questionnaire used measured up to seven sleep-related components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction, each scored from 0 to 3. Global PSQI scores greater than five were considered indicative of poor sleep quality. The PSQI has shown excellent validity and acceptable reproducibility in previous studies [14,15].

Anthropometric measurements: Anthropometric measurements such as height (cm), weight (kg), WC and NC were measured using various methodologies, as mentioned below:

- **Height (cm):** Height was measured to the nearest 0.1 cm using a wall-mounted stadiometer, with the participants shoeless and their heads held in the horizontal plane.
- **Body weight (kg):** Weight was measured to the nearest 0.1 kg using a calibrated electronic weighing scale, with participants wearing light clothing.
- **Waist circumference (cm):** WC was measured using a non-stretchable, flexible tape in horizontal position, just above the iliac crest, at the end of normal expiration, in fasting state. The participants were standing erect, looking forward, while the observer sat in front of them.
- **Neck circumference (cm):** NC was measured at the midpoint of the neck, between the mid-cervical spine and the mid-anterior neck, in a standing position using a non-stretchable, flexible tape.
- BMI=weight (kg)/height^2 (m^2).

Evaluation of biochemical parameters: To evaluate the biochemical parameters, blood samples (5 mL) were collected from the participants after a 10-12-hour overnight fast. The parameters assessed included FPG and lipid profile (TC, TGL, HDL-C, and LDL-C), estimated by enzymatic methods using dedicated reagents in the automated chemistry analyser Beckman Coulter AU480. FPG was estimated using Hexokinase method and the reference range for fasting glucose was 70-100 mg/dL [16]. TC was measured using the cholesterol oxidase and peroxidase method; TGL were measured using the enzymatic method; HDL-c was measured using the polymer polyanion method; LDL-c was measured using the LDL direct method.

The cut-off values recommended by Adult Treatment Panel III [17] were used.

1) **Total Cholesterol (TC) (mg/dL):**
   - Desirable: <200
   - Borderline high: 200-239
   - High: ≥240
2) **LDL-c (mg/dL):**
   - Optimal: <100
   - Near or above optimal: 100-129
   - Borderline high: 130-159
   - High: 160-189
   - Very high: >190
3) **HDL-c (mg/dL):**
   - Low: <40
   - High: >60

4) **Triglycerides (TGL) (mg/dL):**
   - Normal: <150
   - Borderline-high: 150-199
   - High TGL s: 200-499
   - Very high TGLs: >500

STATISTICAL ANALYSIS

Descriptive statistics, Student's t-test, Mann-Whitney U test, Spearman's correlation test, Multiple linear regression analysis and Chi-square test were used to study the association of SDB with cardiometabolic risk and sleep quality. Data analysis was performed using Statistical Package for Social Sciences (SPSS) software version 25 (IBM SPSS Statistics 22, SPSS Inc., an IBM Co., Somers, NY). Statistical significance was established when the p-value was <0.05.

RESULTS

The results revealed that the SDB positive group had a higher proportion of males compared to females than the SDB negative group; with a male to female ratio of (40:28); in contrast to (23:45) in the SDB negative group. On average, the SDB positive participants had higher body weight, BMI, WC and NC compared to the SDB negative group. A significant difference was observed in biochemical parameters (FPG, TC, TGL, and LDL-C) between the SDB positive and SDB negative groups, with HDL-C at a significantly lower level in the SDB positive group [Table/Fig-2].

Demographic characteristics	SDB positive (68)	SDB negative (68)	T value	p-value
Age (years)	40.88±6.04	41.20±5.6	0.3236	0.74
Gender distribution (Male: Female)#	40:28	23:45	8.54	0.003*
Height (cm)	162.83±9.81	159.92±9.48	1.7592	0.08
Weight (Kg)	77.03±11.92	65.8±9.65	6.0361	0.0001*
BMI (Kg/m^2)	29.02±3.37	25.79±3.81	5.2153	0.0001*
Waist Circumference (WC) (cm)	98.15± 6.53	86.84±17.33	5.0303	0.0001*
Fasting Plasma Glucose (FPG) (mg/dL)	110.53 ±15.94	95.42±8.69	6.8577	0.0001*
Total Cholesterol (TC) (mg/dL)	192.94±27.65	158.16±15.92	8.988	0.0001*
Triglycerides (TGL) (mg/dL)	144.82±37.27	103.32±28.81	7.263	0.0001*
HDL-C (mg/dL)	42.17±8.69	45.86±7.52	2.6482	0.0091*
LDL-C (mg/dL)	126.47±20.95	96.05±17.63	9.1566	0.0001*

[Table/Fig-2]: Demographic, anthropometric, and biochemical parameters of the study participants.
#Chi-square test: Gender Distribution. Student's t-test: Numerical data are reported as mean±Standard Deviation (SD), with a *p-value <0.05 denoting significance
SDB: Sleep disorded breathing; HDL-C: High density lipoprotein cholesterol; LDL-C: Low density lipoprotein cholesterol; BMI: Body mass index; Units- Kg: Kilogram; Kg/m^2: Kilogram per square metre; cm: Centimetre; mg/dL: Milligram per decilitre

Since some parameters were not normally distributed, they are represented as median and interquartile range. SDB positive participants were observed to have a statistically significant larger NC, higher NoSaS score and poor sleep quality. The Mann-Whitney U test was performed to compare the data [Table/Fig-3]. The sleep quality index (PSQI score) was also higher in the SDB positive group, indicating poorer sleep quality. Correlation of the NoSAS score with anthropometric measures, PSQI score (sleep quality), and biochemical parameters revealed a positive correlation only with BMI and PSQI score [Table/Fig-4].

Demographic characteristics	SDB positive	SDB negative	Z test statistics	p-value
Neck Circumference (NC) (cm)	42 (40-48)	34 (31-40)	-10.08	0.001*
PSQI score	10 (0-16)	4 (0-14)	-4.39	0.001*
NoSAS score	11 (8-13)	3 (0-7)	-10.17	0.001*

[Table/Fig-3]: Neck Circumferencs (NC), SDB and Sleep quality of the study participants.
*p-value <0.05 denoting significance
SDB: Sleep disorded breathing; PSQI: Pittsburgh sleep quality index; NoSAS: Neck circumference, obesity, snoring, age, and sex score; Unit(s)- cm: Centimetre

The sleep quality index (PSQI score) showed significant positive correlation with BMI, fasting plasma glucose and TGL levels [Table/Fig-5]. Multiple linear regression analysis showed that, among the independent variables, only body weight, BMI, and WC had a significant association with poor sleep quality [Table/Fig-6].

DISCUSSION

On average, all the parameters considered negative indicators of health were higher in the SDB positive group. The lipid parameters exhibited a negative trend, with elevated levels of LDL-C, TGL, and TC, as well as lower HDL-C levels. Similar findings of dyslipidaemia were reported in a recent study on newly diagnosed OSA patients [18]. A study conducted in China involving around 2,500 participants found that dyslipidaemia was positively associated with the severity of OSA. It was also observed that non-traditional lipid indices, such as TG/HDL-C, TC/HDL-C, and the atherogenic index, had better predictive power for the risk of severe OSA than other traditional lipid indices [19]. Another study, which used both the NoSAS score and polysomnography to identify OSA, demonstrated that the NoSAS score could be used to predict CVD risk in patients with OSA [20].

The present study showed a positive correlation between the NoSAS score for OSA and BMI. In line with the current study findings, a 10% weight gain in a cohort of 690 Wisconsin residents was associated with a 32% increase in the AHI. The study also demonstrated that weight control was effective in reducing the incidence of SDB [21].

Parameters	BMI		PSQI	
	rho value	p-value	rho value	p-value
NoSAS score	0.462	0.001**	0.249	0.043 *

[Table/Fig-4]: Spearman correlation between NoSAS score, PSQI score and BMI in SDB positive group.
*p value <0.05 is considered significant and **p-value <0.001 is considered highly significant
BMI: Body mass index; PSQI: Pittsburgh sleep quality index; NoSAS: Neck circumference, obesity, snoring, age, and sex score

Components	rho value	p-value
Fasting Plasma Glucose (FPG) (mg/dL)	0.274	0.024*
Total Cholesterol (TC) (mg/dL)	-0.040	0.748
Triglycerides (TGL) (mg/dL)	0.275	0.023*
HDL-C (mg/dL)	-0.035	0.779
LDL-C (mg/dL)	-0.230	0.059
Waist Circumference (WC) (cm)	-0.183	0.134
BMI (Kg/m^2)	0.333	0.005

[Table/Fig-5]: Spearman correlation between PSQI and components of cardio metabolic risk.
*p-value <0.05 is considered significant. HDL-C: High density lipoprotein cholesterol; LDL-C: Low density lipoprotein cholesterol; BMI: Body mass index
Units- Kg/m^2: Kilogram per square metre; cm: Centimetre; mg/dL: Milligram per decilitre

Variables	B	95% CI	β	t	p-value
Weight (Kg)	0.426	0.011-0.842	1.180	2.055	0.045*
BMI (Kg/m^2)	1.562	0.443 -2.68	1.222	2.798	0.007*
Waist Circumference (WC) (cm)	0.788	0.102 -1.474	1.194	2.301	0.025*
Neck Circumference (NC) (cm)	0.103	-0.581-0.786	0.043	0.301	0.765
NoSAS score	0.040	-0.952-1.032	0.014	0.081	0.936
Fasting Plasma Glucose (FPG) (mg/dL)	0.013	-0.054-0.080	0.049	0.392	0.697
Total Cholesterol (TC) (mg/dL)	0.047	-0.038-0.132	0.301	1.102	0.275
Triglycerides (TGL) (mg/dL)	0.014	-0.018-0.047	0.123	0.876	0.385
HDL-C (mg/dL)	0.050	-0.080-0.179	0.100	0.766	0.447
LDL-C (mg/dL)	-0.093	-0.196 – 0.009	-0.454	-1.822	0.074

[Table/Fig-6]: Multiple linear regression analysis with sleep quality (PSQI) as the dependable variable in SDB positive group.
*p-value <0.05 is considered significant. Note: R2=0.337, F (11,56)=2.584 p=0.01 n=68. BMI: Body mass index; NoSAS: Neck circumference, obesity, snoring, age, and sex score; HDL-C: High density lipoprotein cholesterol; LDL-C: Low density lipoprotein cholesterol; Units- Kg: Kilogram; Kg/m^2: Kilogram per square metre; cm: Centimetre; mg/dL: Milligram per decilitre

With respect to anthropometric measures, NC appeared to be an independent predictor of OSA, with a strong correlation with AHI [22]. A higher WC indicates the involvement of central obesity in the pathogenesis of SDB. Studies show that intermittent hypoxaemia in white adipose tissue due to apnoeic episodes causes the tissue to release cytokines, which play a key role in the development of metabolic risk factors [23].

Poor sleep quality was observed in the SDB positive group and showed a positive correlation with the NoSAS score, cardiometabolic risk factors like dysglycaemia and hypertriglyceridemia. Its predictors were body weight, BMI, and WC. Other research aligned with the current study findings of poor sleep quality in OSA [24]. A recent study from South India also identified poor sleep quality and excessive daytime sleepiness among individuals at high risk of OSA, with 41.6% observed to be poor sleepers [25]. Taheri S et al., demonstrated a proportional increase in BMI with a decrease in sleep duration and found dysregulation of leptin and ghrelin in these individuals, explaining that an increase in appetite stimulated by ghrelin possibly contributes to higher BMI [26].

Limitation(s)

The present study was carried out with some limitations. Identification of individuals with SDB was based on the subjective NoSAS score rather than the gold standard in-laboratory polysomnography. Furthermore, due to the cross-sectional nature of the study, the directionality and causality of the associations could not be determined.

CONCLUSION(S)

To conclude, poor sleep quality was more prominent in individuals with SDB. BMI and PSQI correlated strongly with the NoSAS score but were not independent predictors of SDB. Body weight, BMI, and WC were predictors of sleep quality. OSA, body weight, and sleep quality are modifiable factors that can be controlled to some extent, which might protect targeted individuals from CVD. Future studies could focus on exploring the directionality and causality of the said associations.

Acknowledgement

We are ever grateful to the participants of this study. Special thanks to Ms. Kaviya for drafting the proforma and Mr. Afin Matthew for collection of blood samples. We would also like to thank Indian Council of Medical Research (ICMR) for funding this project under Short-term Studentship 2023 (STS-2023) program. The authors gratefully acknowledge the financial support by SRM Medical College and Hospital, Faculty of Medicine and Health Sciences, SRMIST, Kattankulathur for bearing the defrayed costs of publishing this article.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: Apr 06, 2025
- Manual Googling: Aug 23, 2025
- iThenticate Software: Aug 25, 2025 (13%)

ETYMOLOGY: Author Origin

EMENDATIONS: 7

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. NA

Date of Submission: **Mar 21, 2025**
Date of Peer Review: **Jun 12, 2025**
Date of Acceptance: **Aug 27, 2025**
Date of Publishing: **Jan 01, 2026**