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Prevalence of obstructive sleep apnoea risk and its association with anthropometric indices of cardiometabolic risks and cognition in young and middle-aged adults

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ABSTRACT

Objectives: Obstructive sleep apnoea (OSA), an often underdiagnosed and undertreated sleep-related breathing disorder, is associated with an increased risk of cardiovascular morbidity and mortality. Hence, this study aimed to assess the prevalence of OSA risk and its association with anthropometric indices (AI) of cardiometabolic risks, domain-specific cognitive functions and quality of sleep in apparently healthy young and middle-aged adults.

Materials and Methods: One hundred and eighty-nine apparently healthy individuals (123 males and 66 females) aged 19–45 years were included in this cross-sectional study. The participant's current risk of OSA was assessed using the STOP-Bang questionnaire, and AI indicative of cardiometabolic risk (body mass index, waist-hip ratio [W/H ratio], waist-height ratio [WHtR], conicity index and a body shape index) was assessed using standard techniques. Domain-specific cognitive tests were performed to assess the cognitive status of the individual. Quality of sleep was assessed using the Pittsburgh Sleep Quality Index and Epworth Sleepiness Scale. The correlation between the OSA risk score and the study parameters was assessed using the Pearson or Spearman correlation coefficient test.

Results: The prevalence of high current risk of moderate to severe OSA was found to be 12.7%. Significant positive correlations were observed between OSA risk score and W/H, WHtR and sleep quality scores. While a significant positive correlation was observed between OSA risk score and executive functioning, significant negative correlations were observed with the other cognitive tests (short-term memory, verbal fluency, visuospatial memory and sustained attention and response speed).

Conclusion: A high risk of moderate to severe OSA is associated with obesity, cognitive decline and poor sleep quality in apparently healthy young and middle-aged adults.

Keywords: Body mass index, Daytime sleepiness, Memory, Obstructive sleep apnoea, Sleep quality

INTRODUCTION

Obstructive sleep apnoea (OSA), a common form of sleep-disordered breathing characterised by complete/partial obstruction of the upper airway disrupting the normal sleep pattern, has emerged as a major global health burden, affecting all age groups. The prevalence of OSA ranges from 4.4% to 13.7%, with a higher incidence among men than women.[1] Similarly, a recent systematic review and meta-analysis conducted among Indian adults showed an overall

pooled prevalence of OSA (Apnea-Hypopnea Index [AHI] ≥ five events/hour) as 11%.[2]

OSA is independently associated with an increased likelihood of hypertension, coronary artery disease, heart failure, type 2 diabetes and cognitive decline. Sleep fragmentation, intermittent hypoxia, neuroinflammation, metabolic dysregulation, hypoperfusion and endothelial dysfunction contribute to cardiovascular risk and neurocognitive impairment in individuals with OSA.[3,4]

Despite the high prevalence and the associated morbidity and mortality, OSA remains underdiagnosed and undertreated, given its broad spectrum of nonspecific symptoms of the disorder and the limitations of polysomnography (labour-intensive, time-consuming, expensive and less accessible). It is estimated that 82% of men and 92% of women with moderate-to-severe sleep apnoea often remain undiagnosed.[5] Studies have shown that occult OSA, with or without symptoms, is also independently associated with adverse health consequences on par with diagnosed OSA.[6] Thus, early recognition of occult or undiagnosed OSA is pertinent to cut down its long-term complications.

Cognitive impairment in attention, working memory and executive functions is documented in individuals with OSA.[7] Likewise, OSA is strongly linked with obesity, and given the worsening modern pandemic of obesity in society, the prevalence of OSA is likely to increase further.[8] In this regard, knowledge and awareness regarding the association between occult OSA risk levels and anthropometric indices (AI) of cardiometabolic risk and domain-specific cognitive functioning status of adults are inadequate, especially in the Indian scenario.

Hence, to address this lacuna, this study aimed to assess the level of OSA risk in young and middle-aged individuals asymptomatic to features of OSA (snoring, tiredness, observed apnoea and high blood pressure) using a simple validated assessment tool and correlate it with their AI of cardiometabolic risk, quality of sleep, day time sleepiness and domain-specific cognitive functions.

MATERIALS AND METHODS

This facility-based cross-sectional study was conducted between July and August 2022 in the Department of Physiology in collaboration with the Department of Pulmonary Medicine at a medical college and tertiary care hospital in Puducherry, South India. The study was prior reviewed and approved by the Undergraduate Research Monitoring Committee (Project No: JIP/UGRMC/GJSTRAUS/2022/9) and the Institute Ethics Committee (JIP/IEC/2022/0110, dated 5 May 2022) and was conducted as per the declaration of Helsinki.

Study participants

The study participants were selected based on the following selection criteria: Adults aged 19–45 years (males and females) working as employees in the institute, their relatives and volunteers who consented to participate in the study were included in the study.

However, individuals with a known history of chronic or acute medical illnesses, except those with a history of hypertension, those already diagnosed with and currently on treatment for OSA or sleep-disordered breathing and those with a history of cranial trauma and recent upper airway surgeries were excluded from the study.

Sample size calculation

The sample size was calculated using the software nMaster2.0. Considering the prevalence of undiagnosed (occult) OSA as 38.5% in Indian adults,[9] with an absolute precision of 7% and a 95% confidence interval, the estimated sample size was 186 participants.

Study procedure

A convenient sampling technique was adopted to recruit participants as per the inclusion and exclusion criteria. All safety measures and precautions related to COVID-19 were followed as per the guidelines issued by the Government of India. The study details were explained, and written informed consent was obtained from all the participants before enrolling them in the study. The sociodemographic details of the participants were collected and entered into a data sheet.

Assessment of study variables

Risk of OSA

The subject's current risk of OSA was assessed using the STOP-Bang questionnaire, a validated screening tool for OSA.[10] The questionnaire includes four subjective (STOP: Snoring, Tiredness, Observed apnoea and high blood pressure) and four demographic items (BANG: BMI, Age, Neck circumference and Gender), a total of eight dichotomous (yes/no) questions related to the clinical features of sleep apnoea. For each question, answering "Yes" scores 1, a "No" response scores 0, and the total score ranges from 0 to 8. Subjects with a STOP-Bang score of 0 to 2 were classified as low risk for moderate to severe OSA, and those with a score of 3 to 8 were classified as high risk for moderate to severe OSA.

Recording of blood pressure

Following the American Heart Association guidelines, blood pressure was measured using an automated blood pressure

monitor (Omron SEM 1 Model, Omron Healthcare Co. Ltd, Kyoto, Japan). After 5 min of rest in sitting posture, two readings were taken at intervals of 1 minute, and the average of the two readings was taken as the subject's blood pressure.

AI of cardiometabolic risk

AI of cardiometabolic risk was measured following the International Standards for Anthropometric Assessment.[11] The subjects' height (nearest 0.1 cm) was measured using a wall-mounted stadiometer (EASY CARE EC1080 wall-mounted stadiometer, Ranish Impex Pvt. Ltd, Germany) and the weight (nearest 0.5 kg) using a digital weighing scale (OMRON HN289 Model Digital Personal Scale, Omron Healthcare Co. Ltd, Kyoto, Japan).

Neck circumference (NC), Waist circumference (WC) and hip circumference (HC), the measures of obesity and cardiometabolic risk, were measured as follows:

NC was measured to the nearest 1 mm in the horizontal plane at a point just below the larynx (thyroid cartilage) and perpendicular to the long axis of the neck.

WC was measured to the nearest 0.1 cm in a horizontal plane midway between the inferior costal margin and the iliac crest in a standing position at the end of normal expiration.

HC was measured at the point of maximal protrusion of the buttocks.

The following AIs were calculated:

- Body mass index (BMI), index of general adiposity, calculated by Wt (kg)/Ht^2 (m)
- Waist-to-hip ratio (W/H ratio), an index of cardiovascular and metabolic risk, was calculated using the formula WC (cm)/HC (cm)
- Waist-to-height ratio (WHtR), an index of cardiovascular and metabolic risk, was calculated using the formula WC (cm)/Ht (cm)
- Conicity index (CI), an index of central obesity and cardiovascular risk, was calculated using the formula $WC/0.109 \times (Wt/Ht)^{1/2}$[12]
- A body shape index, an index of central obesity and cardiovascular risk, was calculated using the formula $WC/(BMI^{2/3} \times Ht^{1/2})$.[13]

Quality of sleep

Pittsburgh sleep quality index (PSQI)

The PSQI[14] is a self-rating questionnaire that is easy to administer. A total of seven domains are assessed individually. These include: (1) Sleep latency, (2) subjective sleep quality, (3) sleep duration, (4) sleep efficiency, (5) daytime dysfunction, (6) use of sleep medications and (7) sleep disturbance. A cumulative score of all the domains is taken as the PSQI score. The first four questions are open-ended. The remaining are scored in a range of 0–3. Participants with a total PSQI score <5 were considered "good" sleepers, and those with a PSQI score ≥ 5 were considered poor sleepers.

Epworth sleepiness scale (ESS)

The ESS has eight questions to assess the daytime sleepiness in the subject.[15] Subjects were asked to score the likelihood of falling asleep in various scenarios on a scale of 0–3. A score >10 out of 28 indicates clinically "significant daytime sleepiness."

Domain-specific cognitive functioning status

The following battery of cognitive tests was performed as per standard guidelines to assess domain-specific cognitive abilities.

- Attention and concentration-Digit Span- Forward test
- Executive function and working memory-Stroop test, Digit Span-Backward test
- Short-term memory-Immediate object and word recall
- Language (Verbal fluency)-Letter Fluency task, Category Fluency (Animals) task
- Visuospatial-Copying figures
- Sustained attention and response speed-Digit symbol substitution Test

Digit span forward and backward tests: A sequence of random numbers was read out to the participants, and they were asked to repeat it in the same sequence. Subsequently, the sequence length was increased until the participant committed an error. A second chance was given with a different set of numbers of the same sequence length. The test was stopped if there was an error on the second attempt. A similar procedure was adopted for the Digit span backward test, the only difference being that the participant had to repeat the number sequence in the reverse order.[16]

Stroop test: Colour names such as Red, Blue, Black and Green were printed on a sheet of paper on a 5 × 5 table in colours different from the name of the colour. The subjects were asked to read the colour in which the word was printed. The total time taken by the subject to read all the words was noted.

Immediate object and word recall: In the object recall test, the subject was shown a set of ten objects for 15 s. After the objects were taken away, the subject was asked to recall the objects within a minute. For the word recall test, a list of ten words was read out to the subject at the rate of one for every 2 s. Once the entire list was read, the subject was asked to recall the words within a minute.[17]

Verbal fluency was assessed by Letter fluency and Category fluency tests. In the category fluency test, the participants

were asked to list some animals within 60 sec. In the letter fluency test, the participants were asked to list the words starting with three different alphabets within a stipulated time for each letter.[18]

Copying figures: The subject was shown five figures, namely a vertical diamond, a two-dimensional cross, a three-dimensional block, a three-dimensional pipe and a triangle within a triangle, and was asked to copy them onto a sheet of paper in 1 min. Each figure drawn was scored on a scale from 0 to 3 based on the completion of the figure.

In the digit symbol substitution test, the participants were given 90 s to fill out a sheet with a random set of numbers from 1 to 9 with the corresponding symbols assigned.[19]

Statistical analysis

The data were entered into a Microsoft Excel datasheet, and statistical analysis was done using STATA v14. The distribution of categorical variables such as age and gender is expressed as frequency and percentages. The continuous variables such as age, STOP-Bang score, blood pressure, AI, cognitive scores, PSQI and ESS scores are expressed as mean with standard deviation or median with inter-quartile range according to the distribution of data. The correlation of OSA risk score with AI of cardiometabolic risks and cognitive outcomes was assessed using the Pearson correlation, and the correlation between OSA risk score and sleep quality was assessed using the Spearman correlation coefficient test. Linear regression was done to assess the relation of AI and cognitive functioning status with the OSA score, where the beta coefficient is reported. Logistic regression was done to assess the relationship between OSA risk score and sleep quality. All statistical analyses were performed at a 5% significance level, and $P < 0.05$ was considered significant.

RESULTS

One hundred and eighty-nine healthy participants of both genders (123 males and 66 females), with a mean age of 30.63 ± 7.86 years, were recruited in the study [Table 1]. The prevalence of high current risk for moderate to severe OSA was found to be 12.7%. Among the 189 study participants, 37.04% were identified as poor sleepers, and 14.29% had significant daytime sleepiness [Table 2]. Regarding individuals with a high risk of OSA, 41.67% had poor sleep quality, and 29.17% had significant daytime sleepiness. Significant positive correlations were observed between OSA risk score and AI of cardiometabolic risk (W/H r = 0.2429, P =0.001; WHtR r = 0.2055, P = 0.005). While a significant positive correlation was noted between the OSA risk score and Stroop test time (r = 0.2525, P = 0.001), significant negative correlations were observed between the OSA risk score and immediate object recall test (r = −0.2750, P <0.001), immediate word recall test (r = −0.2207, P = 0.002), letter fluency task (r = −0.2700, P <0.001), category fluency task (r = −0.2149, P = 0.003), copying figures (r = −0.1786, P = 0.014) and digit symbol substitution test (r = -0.1495, P = 0.040). Significant positive correlations were observed

Table 1: Characteristics of the study participants (n=189).

Characteristics	Summary statistics
Age (years)	30.63±7.86
Age categories (n, %)	
≤30	99 (52.4)
>30	90 (47.6)
Gender (n, %)	
Male	123 (65.1)
Female	66 (34.9)
SBP (mm of Hg)	119.85±15.48
DBP (mm of Hg)	80.44±11.46
MAP (mm of Hg)	93.60±12.14
RPP (mmHg/min)	97.28±19.06
HR (beats/min)	80.96±9.84
RR (breaths/min)	13.60±1.31
STOP-Bang Score*	1 (0,2)
Assessment of Anthropometric Indices	
WC (cm)	88.42±12.83
HC (cm)	99.47±11.01
NC (cm)	34.73±4.09
BMI (kg/m^2)	25.59±5.26
W/H ratio	0.89±0.07
WHtR	0.55±0.08
CI (m$^{3/2}$/kg^{½})	1.27±0.09
ABSI (m$^{11/6}$ kg-$^{2/3}$)	0.08±0.01
Assessment of domain-specific cognitive functioning status	
Attention and concentration	
Digit Span-Forward test	6.10±1.38
Executive function and working memory	
Stroop test time (sec)	31.17±6.74
Digit Span- backward test	3.62±1.42
Short-term memory	
Immediate object recall	7.76±1.53
Immediate word recall	6.40±1.61
Language (verbal fluency)	
Letter fluency task	29.21±8.92
Category fluency (animals) task	19.63±5.64
Visuospatial	
Copying figures	14.21±1.06
Sustained attention and response speed	
Digit symbol substitution test	49.78±14.74
Assessment of sleep quality and daytime sleepiness	
PSQI score*	4 (2,5)
ESS Score*	6 (3,9)

Values are Mean±SD; *Values are Median (IQR). SBP: Systolic blood pressure, DBP: Diastolic blood pressure, MAP: Mean arterial pressure, RPP: Rate pressure product, HR: Heart rate, RR: Respiratory rate, WC: Waist circumference, HC: Hip circumference, NC: Neck circumference, BMI: Body mass index, W/H ratio: Waist-to-hip ratio, WHtR: Waist-to-height ratio, CI: Conicity index, ABSI: A body shape index, PSQI: Pittsburgh sleep quality index, ESS: Epworth sleepiness scale

Table 2: Prevalence of OSA risk, poor sleep quality and daytime sleepiness.

Characteristics	Frequency	Proportion	95% CI
OSA			
High risk	24	12.70	8.0–17.4
Low risk	165	87.30	82.6–92.0
PSQI			
Poor sleepers	70	37.04	30.2– 43.9
Good sleepers	119	62.96	56.1–69.8
ESS			
Significant daytime sleepiness	27	14.29	9.3–19.3
No significant daytime sleepiness	162	85.71	80.7–90.7

OSA: Obstructive sleep apnoea, PSQI: Pittsburgh sleep quality index, ESS: Epworth Sleepiness Scale, CI: Confidence interval

between OSA risk score, sleep quality (r = 0.2332, *P* = 0.001) and daytime sleepiness (r = 0.2017, *P* = 0.005) [Table 3]. By regression analysis, the OSA risk score was found to be significantly associated with anthropometric indices such as W/H (0.05), WHtR (0.06) and CI (0.04) [Table 4]. Likewise, cognitive function status, such as Stroop test time (4.05), immediate object recall (−1.06), letter fluency task (−5.25) and category fluency task (−3.21), also showed significant associations with OSA risk score [Table 4]. However, sleep quality scores did not correlate with OSA risk scores [Table 5].

Table 3: Correlation between OSA risk score and anthropometric indices of cardiometabolic risks, cognitive outcomes and sleep quality of the study participants. (*n*=189).

Characteristics	Coefficient	*P*-value
Anthropometric indices		
W/H ratio	0.2429	0.001
WHtR	0.2055	0.005
CI ($m^{3/2}/kg^{½}$)	0.1037	0.156
ABSI ($m^{11/6}$ $kg^{-2/3}$)	−0.0485	0.508
Domain-specific cognitive functioning status		
Attention and concentration		
Digit span-forward test	−0.0372	0.611
Executive function and working memory		
Stroop test time (sec)	0.2525	0.001
Digit span-backward test	−0.0933	0.202
Short-term memory		
Immediate object recall	−0.2750	<0.001
Immediate word recall	−0.2207	0.002
Language (verbal fluency)		
Letter fluency task	−0.2700	<0.001
Category fluency (animals) task	−0.2149	0.003
Visuospatial		
Copying figures	−0.1786	0.014
Sustained attention and response speed		
Digit symbol substitution test	−0.1495	0.040
Quality of sleep		
PSQI*	0.2332	0.001
ESS*	0.2017	0.005

Values are Pearson coefficients; *Values are Spearman coefficients. OSA: Obstructive sleep apnoea, W/H ratio: Waist-to-hip ratio, WHtR: Waist-to-height ratio, CI: Conicity index, ABSI: A body shape index, ESS: Epworth sleepiness scale, PSQI: Pittsburgh sleep quality index

DISCUSSION

In this study, 189 healthy volunteers, 19–45 years of age (123 males and 66 females), who fulfilled the inclusion and exclusion criteria were included as study participants. The current risk of OSA was determined using the STOP-Bang questionnaire. The OSA risk score was correlated with the AI of cardiometabolic risks, cognition and quality of sleep scores.

A study conducted in Delhi, India, by Reddy *et al.*, reported an OSA prevalence of 9.3% among middle-aged individuals.[20] Similarly, a study conducted in the rural population of Southern India by Pinto *et al.* revealed an OSA prevalence of 3.74%.[21] The prevalence of high current risk for moderate-to-severe OSA in the present study population was found to be 12.7%, as assessed by the STOP-Bang questionnaire.

It is known that OSA is a potential causative agent for obesity. The study by Phillips *et al.* showed that patients diagnosed with OSA had a history of weight gain at the time of diagnosis. They proposed that the OSA-induced disturbed sleep and resultant daytime dysfunction lead to decreased physical activity and, hence, an increased risk for obesity.[22] Similarly, studies have also documented that poor sleep results in decreased leptin levels and increased ghrelin levels, leading to increased appetite and an increased risk of obesity.[23] Similarly, a high prevalence of cardiovascular morbidity and mortality has also been documented in individuals with OSA.[24]

In line with these reports, significant positive correlations were observed between OSA risk score and AI, such as W/H and WHtR, thus predisposing these individuals to various cardiovascular and metabolic disorders.

Kalcina *et al.* have reported poor sleep quality in patients with OSA.[25] It is known that poor sleep quality is associated with excessive daytime sleepiness due to intermittent hypoxia and fragmented sleep. The resultant oxidative damage causes brain cell damage and death, especially in those regions which promote wakefulness.[26] In agreement with previous studies, this study also reports positive correlations between OSA risk score and PSQI and ESS scores, thus indicating poor sleep quality and excessive daytime sleepiness in individuals with a high risk of OSA. Among those with a high risk for OSA, 41.67% were identified as poor sleepers, and 29.17% of the participants had significant daytime sleepiness.

Table 4: Regression analysis of anthropometric indices and cognitive functioning status in relation to OSA.

Variables	Low risk of OSA	High risk of OSA	Coefficient beta	*P*-value
Assessment of anthropometric indices				
W/H ratio	0.88±0.07	0.93±0.05	0.05 (0.02–0.08)	0.002
WHtR	0.54±0.07	0.60±0.08	0.06 (0.03–0.09)	<0.001
CI (m3/2/kg½)	1.26±0.09	1.31±0.06	0.04 (0.01–0.08)	0.028
ABSI (m11/6 kg–2/3)	0.08±0.01	0.08±0.004	0.0001 (–0.002–0.002)	0.914
Domain-specific cognitive functioning status				
Attention and concentration				
Digit span-forward test	6.13±1.38	5.88±1.39	–0.25 (–0.85–0.34)	0.406
Executive function and working memory				
Stroop test time (sec)	30.65±6.56	34.71±7.10	4.05 (1.20–6.91)	0.006
Digit span-backward test	3.68±1.45	3.25±1.15	–0.43 (–1.04–0.18)	0.168
Short-term memory				
Immediate object recall	7.89±1.51	6.83±1.40	–1.06 (–1.70––0.41)	0.001
Immediate word recall	6.47±1.65	5.92±1.25	–0.55 (–1.24–0.14)	0.119
Language (Verbal fluency)				
Letter fluency task	29.88±8.95	24.63±7.35	–5.25 (–9.03––1.47)	0.007
Category fluency (Animals) task	20.04±5.47	16.83±6.08	–3.21 (–5.60––0.82)	0.009
Visuospatial				
Copying figures	14.26±1.04	13.83±1.13	–0.43 (–0.88–0.03)	0.065
Sustained attention and response speed				
Digit symbol substitution test	50.16±15.14	47.17±11.51	–3.00 (–9.35–3.36)	0.353

OSA: Obstructive sleep apnoea, W/H ratio: Waist-to-hip ratio, WHtR: Waist-to-height ratio, CI: Conicity index, ABSI: A body shape index

Table 5: Regression analysis of OSA in relation to sleep quality.

Variables	Low risk of OSA	High risk of OSA	Odds ratio	*P*-value
PSQI	4 (2, 5)	4 (3.5, 6.5)	1.09 (0.97–1.24)	0.157
ESS	6 (3, 9)	7.5 (3, 11)	1.05 (0.95–1.16)	0.358

OSA: Obstructive sleep apnoea, ESS: Epworth sleepiness scale, PSQI: Pittsburgh sleep quality index

A meta-review by Bucks *et al*. has documented a decline in memory, attention and executive functioning in individuals with OSA.[27] A possible mechanism for the same could be a chronic systemic inflammatory response, neuroinflammation and oxidative stress, leading to alteration in the functioning of key brain stem nuclei and, subsequently, a decline in the cognitive status of the individuals.[28] Along similar lines, this study also reports a significant correlation between OSA risk score and cognitive decline. A positive correlation was obtained between OSA risk score and Stroop test time, indicating a decline in executive functioning and working memory. Negative correlations were noted between OSA risk scores and immediate object and word recall test scores, letter fluency and category fluency task scores, copying figures test scores and digit symbol substitution test scores indicative of a decline in short-term memory, verbal fluency, visuospatial and sustained attention and response speed, respectively.

Regression analysis revealed significant relations between OSA risk score and W/H, WHtR and CI. However, the relationship between OSA risk and other AI was only minimal (5–6%). Cognitive functions were also related to the OSA score. For every one-unit increase in OSA risk score, there is a 5, 3 and 1-time decrease in the letter fluency, category fluency and immediate object recall test scores, respectively, and a 4-time increase in the Stroop test time. Thus, a decline in verbal fluency, working memory and short-term memory was seen with increasing OSA scores in this study. The absence of significant relationships with other cognitive tests could be attributed to the age group of the study participants, who were young or middle-aged. Sleep quality scores did not show a significant relation with OSA scores. The subjective nature of the questionnaires (PSQI and ESS) and the lack of assessment of the perceived stress and psychological status of the study participants could explain the absence of a relationship for the study as mentioned above variables.

The study has the following limitations. First, the study's small sample size is a major limitation of the study. Second, the subjective nature of the questionnaires could have a potential response and recall bias. Third, this study did not adopt polysomnography, the gold-standard technique for diagnosing OSA (the STOP-Bang questionnaire has high sensitivity but poor specificity). Finally, considering the age group of the study participants, the results of the study cannot be generalised to the entire population.

Despite all these constraints, the associations between OSA risk, AI of cardiometabolic risk, cognition, and sleep quality

are well established in this study. Further, the findings of the study point toward the need for regular screening for OSA in young and middle-aged individuals to prevent untoward cardiovascular events in the future.

CONCLUSION

Apparently, healthy young and middle-aged adults at high current risk of moderate–to–severe OSA are susceptible to cardiometabolic risks, cognitive decline and poor sleep quality.

Ethical approval

The research/study was approved by the Institutional Review Board at JIPMER, number JIP/IEC/2022/0110, dated 05-05-2022.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

REFERENCES

1. Sharma SK, Ahluwalia G. Epidemiology of adult obstructive sleep apnoea syndrome in India. Indian J Med Res 2010;131:171-5.
2. Suri TM, Ghosh T, Mittal S, Hadda V, Madan K, Mohan A. Systematic review and meta-analysis of the prevalence of obstructive sleep apnea in Indian adults. Sleep Med Rev 2023;71:101829.
3. Ryan S. Mechanisms of cardiovascular disease in obstructive sleep apnoea. J Thorac Dis 2018;10:S4201-11.
4. Barletta P, Abreu AR, Ramos AR, Dib SI, Torre C, Chediak AD. Role of obstructive sleep apnea in cognitive impairment. Int J Head Neck Surg 2019;10:57-61.
5. Young T, Evans L, Finn L, Palta M. Estimation of the clinically diagnosed proportion of sleep apnea syndrome in middle-aged men and women. Sleep 1997;20:705-6.
6. Knauert M, Naik S, Gillespie MB, Kryger M. Clinical consequences and economic costs of untreated obstructive sleep apnea syndrome. World J Otorhinolaryngol Head Neck Surg 2015;1:17-27.
7. Krysta K, Bratek A, Zawada K, Stepańczak R. Cognitive deficits in adults with obstructive sleep apnea compared to children and adolescents. J Neural Transm 2017;124:187-201.
8. Jehan S, Zizi F, Pandi-Perumal SR, Wall S, Auguste E, Myers AK, *et al*. Obstructive sleep apnea and obesity: Implications for public health. Sleep Med Disord 2017;1:00019.
9. Devaraj U, Rajagopala S, Kumar A, Ramachandran P, Devereaux PJ, D'Souza GA. Undiagnosed obstructive sleep apnea and postoperative outcomes: A prospective observational study. Respiration 2017;94:18-25.
10. Chung F, Abdullah HR, Liao P. STOP-bang questionnaire. Chest 2016;149:631-8.
11. Stewart A, Marfell-Jones M, Olds T, De Ridder J. International standards for anthropometric assessment. Vol. 137. Glasgow: International Society for the Advancement of Kinanthropometry; 2011.
12. Valdez R. A simple model-based index of abdominal adiposity. J Clin Epidemiol 1991;44:955-6.
13. Gomez-Peralta F, Abreu C, Cruz-Bravo M, Alcarria E, Gutierrez-Buey G, Krakauer NY, *et al*. Relationship between "a body shape index (ABSI)" and body composition in obese patients with type 2 diabetes. Diabetol Metab Syndr 2018;10:21.
14. Buysse DJ, Reynolds CF, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh sleep quality index: A new instrument for psychiatric practice and research. Psychiatry Res 1989;28:193-213.
15. Johns MW. A new method for measuring daytime sleepiness: The Epworth sleepiness scale. Sleep 1991;14:540-5.
16. Monaco M, Costa A, Caltagirone C, Carlesimo GA. Forward and backward span for verbal and visuo-spatial data: Standardization and normative data from an Italian adult population. Neurol Sci 2013;34:749-54.
17. Lezak MD. Neuropsychological assessment. 5th ed. New York: Oxford University Press; 2012.
18. Shao Z, Janse E, Visser K, Meyer AS. What do verbal fluency tasks measure? Predictors of verbal fluency performance in older adults. Front Psychol 2014;5:772.
19. Jaeger J. Digit symbol substitution test: The case for sensitivity over specificity in neuropsychological testing. J Clin Psychopharmacol 2018;38:513-9.
20. Reddy EV, Kadhiravan T, Mishra HK, Sreenivas V, Handa KK, Sinha S, *et al*. Prevalence and risk factors of obstructive sleep apnea among middle-aged urban Indians: A community- based study. Sleep Med 2009;10:913-8.
21. Pinto AM, Devaraj U, Ramachandran P, Joseph B, D'Souza GA. Obstructive sleep apnea in a rural population in South India: Feasibility of health care workers to administer level III sleep study. Lung India 2018;35:301-6.
22. Phillips BG, Hisel TM, Kato M, Pesek CA, Dyken ME, Narkiewicz K, *et al*. Recent weight gain in patients with newly diagnosed obstructive sleep apnea. J Hypertens 1999;17:1297-300.
23. Taheri S, Lin L, Austin D, Young T, Mignot E. Short sleep

duration is associated with reduced leptin, elevated ghrelin, and increased body mass index. PLoS Med 2004;1:e62.
24. Rana D, Torrilus C, Ahmad W, Okam NA, Fatima T, Jahan N. Obstructive sleep apnea and cardiovascular morbidities: A review article. Cureus 2020;12:e10424.
25. Kalcina LL, Valic M, Pecotic R, Dodig IP, Dogas Z. Good and poor sleepers among OSA patients: Sleep quality and overnight polysomnography findings. Neurol Sci 2017;38:1299-306.
26. Lal C, Weaver TE, Bae CJ, Strohl KP. Excessive daytime sleepiness in obstructive sleep apnea. Mechanisms and clinical management. Ann Am Thorac Soc 2021;18:757-68.
27. Bucks RS, Olaithe M, Eastwood P. Neurocognitive function in obstructive sleep apnoea: A meta-review: Cognitive function in OSA: A meta-review. Respirology 2013;18:61-70.
28. Daulatzai MA. Pathogenesis of cognitive dysfunction in patients with obstructive sleep apnea: A hypothesis with emphasis on the nucleus tractus solitarius. Sleep Disord 2012;2012:251096.

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