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Association of sleep quality with physical and psychological health indicators in overweight and obese rural Indians

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ABSTRACT

Objective: To measure the association of sleep quality with physical (i.e., grip strength, functional mobility, balance) and psychological (depression, anxiety) health indicators in an overweight/obese population.

Methods: Baseline data of 2337 participants (1382 overweight/obese and 955 normal weight) from an aging cohort in rural southern India (CBR-SANSCOG) was analyzed retrospectively. Assessment tools included the Pittsburgh Sleep Quality Index (PSQI) for sleep quality, dynamometry for Hand Grip Strength (HGS), Timed Up-and-Go (TUG) for functional mobility, Chair Stand Test (CST) for lower limb strength, Geriatric Depression scale (GDS-30) for depressive symptoms and Generalized Anxiety Disorder scale (GAD-7) for anxiety symptoms. Linear regression models, adjusted for known confounders, were used to examine the association of sleep quality with the health parameters in overweight/obese and normal-weight groups.

Results: In the fully adjusted model, higher global PSQI score was associated with higher TUG time (β = 0.06, 95 % CI: 0.004,0.12), higher scores on GDS (β = 1.08, 95 % CI: 0.96,1.20) and GAD (β = 0.71, 95 % CI: 0.62,0.79), and lower scores on CST (β = -0.12, 95 % CI: -0.19,-0.06) in overweight/obese individuals. The sleep disturbance sub-component of PSQI was associated with most of the physical (TUG, CST) and psychological (GDS and GAD) health indicators. Sleep duration and use of sleep medication showed no significant association with any of the health indicators.

Conclusion: The concurrent presence of poor sleep quality and overweight/obesity could worsen physical and psychological health in middle-aged and older adults. We highlight the importance of early detection and timely management of sleep problems in this population to reduce physical and psychological morbidities.

1. Introduction

In India, the older population accounts for around 10 % of its total population. This proportion will double, reaching 20.8 % by 2050, wherein India's southern and western regions will have the highest proportion of older adults [1]. Aging is associated with changes in sleep, such as an advanced sleep schedule, decreased duration, increased nocturnal awakenings, and frequent daytime napping [2]. Older adults are at a higher risk for sleep disorders in comparison to young adults due to hormonal changes, comorbidities, polypharmacy, psychosocial stressors, etc. [3].

Sleep plays a critical role in metabolic regulation, tissue growth and repair, and immune functions. Poor sleep has been associated with an increased risk for infectious and non-infectious diseases, multi-morbidity, and mortality [4,5]. Sleep problems have been particularly linked to a higher risk of cardiovascular diseases, metabolic disorders, cancers, etc. [6–8]. Regarding psychological health, poor sleep is related to mood disturbances, decreased cognitive function [9], and increased stress levels [10,11].

The adverse impact of poor sleep on physical and psychological health is likely to be more pronounced among at-risk populations, such as people with obesity. The World Health Organization (WHO) defines overweight and obesity as excessive fat deposition, which poses a health risk [12]. Low- and middle-income countries have witnessed a rapid increase in the prevalence of obesity in the last few decades, and over 70% of overweight or obese individuals reside in LMICs [13,14]. In India, it is estimated that the prevalence of overweight will double and that of obesity will triple during 2010–2040. This rise is expected to be more pronounced in the rural Indian population [15].

Obesity can have a significant negative impact on physical and psychological health. It is associated with an increased risk of cardiovascular disease, diabetes, osteoarthritis, cancer [16], and psychological

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conditions such as depression and anxiety [17]. Furthermore, obesity has been related to a higher risk of frailty, mobility, disability, and poorer quality of life [18,19].

As the impact of sleep problems and obesity is particularly prominent in the middle-aged and older population, their co-existence in this age group can prove to be detrimental to overall health. While the link between sleep quality and obesity is established [20], less is known about how overall sleep quality and its specific components (such as subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleeping medication, and daytime dysfunction) relate to performance on indicators of physical and psychological health among individuals with overweight/obesity, which is the aim of the present study. Many prior studies have focused on the association between sleep and psychological health outcomes. However, it is crucial to understand if sleep quality can impact physical functioning and to specifically examine what aspects of sleep influence physical performance among individuals who are overweight/obese.

This study spotlights a highly underrepresented population in research, namely India's rural, middle-aged and older population. Though rural Indians have been considered to have a healthier lifestyle as compared to urban Indians, recent evidence suggests that they are at a significantly higher risk for obesity [15]. Further, rural Indians, particularly the aging population, form a marginalized and health-disparate population within India, with inadequate access to modern healthcare. Therefore, focused research efforts to understand potential risk factors for adverse physical and psychological health outcomes in this population are crucial to bridge the existing healthcare disparities through developing targeted preventive healthcare strategies.

We hypothesize that among overweight and obese adults from rural India, higher global sleep quality scores and individual sleep component scores on the Pittsburgh Sleep Quality Index, PSQI (indicative of poorer sleep quality) are associated with poorer performance on the physical health measures (HGS, TUG test, CST) as well as psychological health measures (GDS-30, GAD-7).

2. Methods

2.1. Study design and participants

The baseline data of 1382 overweight/obese (Body Mass Index, BMI $\geq$ 23 kg/m^2, as per the Asia-Pacific regional cut-offs [21]) and 955 normal-weight (BMI= 18.5–22.9 kg/m^2) participants from a prospective aging cohort study that is ongoing in the rural areas of Karnataka, India, namely the Centre for Brain Research–Srinivaspura Aging, Neuro-Senescence and COGnition (CBR-SANSCOG) study, was retrospectively analyzed. This data was retrieved from participants recruited between January 2018 and October 2022. The CBR-SANSCOG cohort recruits individuals aged ≥45 years through area sampling from the rural areas of Srinivaspura in southern India. Individuals with dementia, severe psychiatric or medical illnesses, physical or sensory impairments that could preclude the study assessments were excluded from the study. The detailed study protocol of the CBR-SANSCOG study has been published elsewhere [22].

Ethics approval

The CBR-SANSCOG study has been cleared by the Institutional Human Ethics Committee of the Centre for Brain Research. All participants gave written informed consent before being recruited into the study.

2.2. Sleep quality assessment

Pittsburgh Sleep Quality Index (PSQI): This is a widely used self-report measure that assesses sleep quality over the last one-month period and has been validated in the Indian population [23,24]. In our study, the PSQI was administered in the local languages (Kannada and Telugu) by trained doctors/ nurses who were well-versed in the languages and local culture. The PSQI has 19 items, categorized into seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medications, and daytime dysfunction. Each component is scored on a Likert scale from 0 to 3, depending on the severity or frequency of the sleep problem experienced by the participant. The global PSQI score is calculated by adding the scores of the seven individual components and ranges from 0 to 21, wherein a higher score means poorer sleep quality [23].

2.3. Physical assessments

Handgrip strength (HGS): Handgrip strength, an objective measure of upper limb strength and a widely recognized marker of physical frailty, was evaluated using a Camry-EH101 electronic hand dynamometer [25]. The process involved participants seated with their wrists in a neutral, thumb-up position and their arms resting on the chair's arm. They gripped the device with their dominant hand, the thumb over the top and fingers below the handle, while an examiner supported the dynamometer's base. Participants squeezed the handle maximally in two attempts, and the highest reading in kilograms (kg) was recorded as their maximum handgrip strength.

Timed Up-and-Go test (TUG) [26]: TUG is a validated measure of physical performance and functional mobility. It is also a well-recognized tool for evaluating physical frailty. Participants were asked to sit on a sturdy stool, stand up, walk a distance of 3 m at their usual pace, turn around, return, and sit back down. The duration of the

Table 1
Baseline characteristics of the study participants.

Sample Characteristics	Overweight/Obese group, n (%)	Normal-weight group, n (%)	p-value
Sex			0.823
Female	691 (50.00)	482 (50.47)	
Male	691 (50.00)	473 (49.53)	
Age, Mean (SD)	57.09 (9.31)	60.50 (9.75)	<0.001
BMI, Mean (SD)	26.59 (2.90)	20.98 (1.25)	
Tobacco use			<0.001
No	1047 (75.76)	576 (60.31)	
Yes	335 (24.24)	379 (39.69)	
Alcohol usage			0.067
No	1292 (93.49)	910 (95.29)	
Yes	90 (6.51)	45 (4.71)	
Socio-economic status			0.003
Low	255 (18.45)	224 (23.46)	
Middle/upper	1127 (81.55)	731 (76.54)	
Physical activity			0.812
Active	1355 (98.05)	935 (97.91)	
Inactive	27 (1.95)	20 (2.09)	
Education			<0.001
Illiterate	440 (31.84)	449 (47.02)	
Primary/middle	514 (37.19)	335 (35.08)	
High school/diploma	345 (24.96)	140 (14.66)	
Graduate/postgraduate	83 (6.01)	31 (3.25)	
Number of comorbidities			<0.001
None	192 (13.89)	256 (26.81)	
One	559 (40.45)	453 (47.43)	
Two or more	631 (45.66)	246 (25.76)	
HGS, Mean (SD)	24.55 (7.94)	22.34 (6.95)	<0.001
TUG, Mean (SD)	11.00 (2.42)	11.15 (2.50)	0.144
CST, Mean (SD)	11.43 (2.77)	11.41 (2.67)	0.896
GDS, Median (IQR)	2 (6)	2 (7)	0.411
GAD, Median (IQR)	1 (3)	1 (3)	0.346
Global PSQI score, Median (IQR)	2 (3)	2 (3)	0.883

SD-Standard Deviation, IQR-Interquartile Range, HGS- Hand Grip Strength, TUG-Timed Up-and-Go test, CST-Chair Stand Test, GDS- Geriatric Depression Scale, GAD-Generalized Anxiety Disorder Scale, PSQI-Pittsburgh Sleep Quality Index.

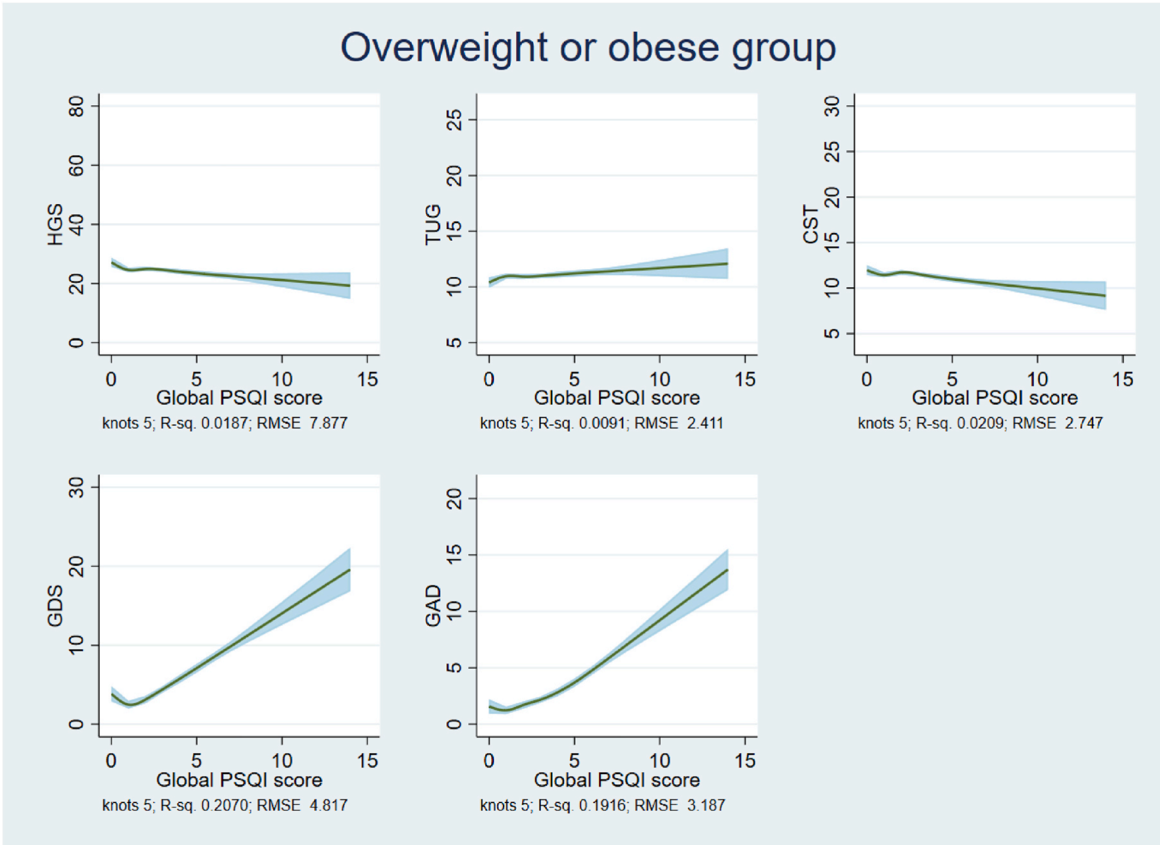

Fig. 1. Restricted cubic spline plots depicting the association of Global PSQI score with health indicators in overweight/obese participants.

entire activity was timed in seconds using a stopwatch, which was their TUG time.

Chair Stand Test (CST) [27]: This parameter assesses lower limb strength. Participants were seated in a chair with a straight back with their feet flat on the ground. With their arms crossed over their chest, they were asked to stand up fully and sit back down. Initially, they did a practice trial, followed by as many complete stands as possible within 30 seconds. The examiner counted the number of correctly completed repetitions, which was their CST score.

2.4. Psychological assessments

Depression: Depression was evaluated using the Geriatric Depression Scale (GDS-30) [28]. The GDS-30 is a well-established, self-reported, screening tool for symptoms of depression among older adults, and has been used widely in southern Indian populations [29]. It consists of 30 straightforward yes/no questions, each contributing one point to a total possible score of 30. A score of 10 or higher indicates the presence of depression.

Anxiety: The Generalized Anxiety Disorder (GAD-7) [30] scale is a self-reported scale to assess anxiety symptoms, and has good sensitivity and specificity to screen for several anxiety disorders, including GAD and panic disorder. There are seven items, and responses are rated on a Likert scale from 0 (not at all) to 3 (almost every day). The maximum score is 21, and a score of ≥10 indicates the presence of anxiety.

3. Statistical analysis

The demographic characteristics were presented in frequency, mean with standard deviation (SD), and median with interquartile range (IQR) for the overweight/obese and normal-weight groups. Linear regression was performed to assess the association between PSQI scores (global score and individual sleep component scores) and the outcome variables such as Hand Grip Strength (HGS), Timed Up-and-Go test (TUG), Chair Stand Test (CST), Geriatric Depression Scale (GDS-30), and Generalized Anxiety Disorder Scale (GAD-7), separately for the overweight/obese and normal-weight groups. We fitted two models separately for each of the groups. Model 1 was unadjusted, and Model 2 was adjusted for age, sex, education, socioeconomic status, BMI, physical activity, tobacco use, alcohol use, and the number of comorbidities. Beta coefficients and 95% confidence intervals (CI) were reported. Additionally, restricted cubic spline plots were used to visualize the relationship between sleep quality and the physical/psychological health indicators for the overweight/obese and normal-weight groups. These plots are useful in modeling non-linear relationships to capture the underlying trend between the predictor and the outcome variables. All statistical analyses were performed using Stata 18.

3.1. Covariates

Sociodemographic data, including age, sex, education (measured in years), socioeconomic status (SES; categorized into 'lower SES' and middle/upper SES'), BMI, physical activity, tobacco use, alcohol use, and the number of comorbidities were used as covariates. The Global Physical Activity Questionnaire (GPAQ) was utilized to evaluate physical activity, and participants were classified as either physically active (≥600 MET-minutes/week) or inactive (<600 MET-minutes/week), based on WHO standards. The current use of tobacco and alcohol were self-reported. The number of medical comorbidities was calculated based on a self-report of hypertension, diabetes mellitus, dyslipidemia, renal disease, respiratory illness, thyroid disease, arthritis, cardiac illness, stroke, transient ischemic attack (TIA), Parkinson's disease, and cancer. The number of comorbidities was then categorized as 'none,' 'one comorbidity,' and 'two or more comorbidities.'

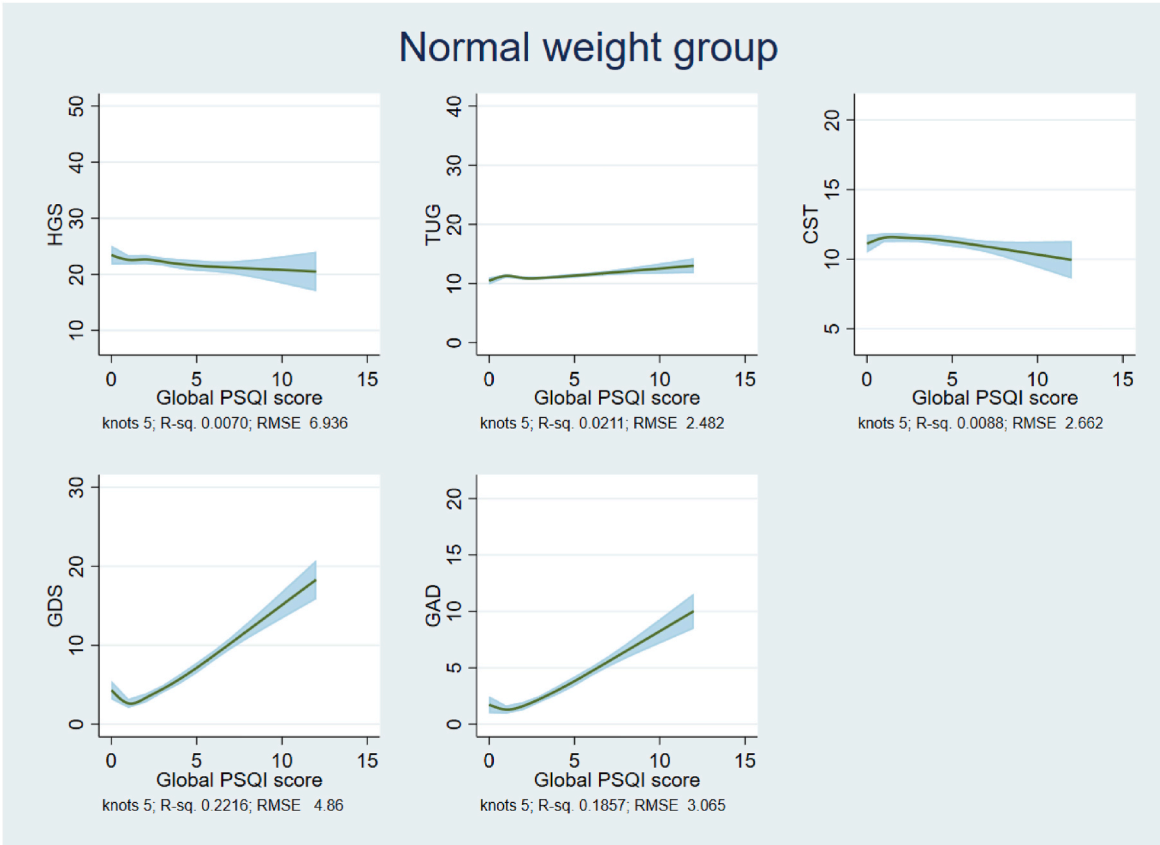

Fig. 2. Restricted cubic spline plots depicting the association of Global PSQI score with health indicators in normal-weight participants.

4. Results

Of the 2337 participants, 1382 belonged to the overweight/obese group and 955 to the normal-weight group. The mean age of the participants was significantly higher in the normal (60.50 ± 9.75 years) compared to the overweight/obese group (57.09 ± 9.31 years), whereas there were no significant sex differences observed between the two groups. The overweight/obese group had a significantly greater proportion of individuals belonging to a middle/upper socioeconomic status, with higher education and having two or more comorbidities. The comparative sample characteristics of the two groups are displayed in Table 1. Further, the overweight/obese group had a significantly higher mean HGS score than the normal-weight group, whereas no significant differences were observed in the mean TUG time, CST, GDS, or GAD scores (Table 1). Figs. 1 and 2 represent the restricted cubic spline plots to visualize the relationship between sleep quality and physical/psychological health indicators in the overweight/obese and normal-weight groups, respectively.

4.1. *Association of overall sleep quality with performance on physical health indicators*

In the linear regression model of sleep quality with HGS, after adjustment with covariates, there was no significant association between overall sleep quality (global PSQI score) and HGS in the overweight/obese and normal-weight participants (Table 2). With regards to the TUG test, one unit of increase in the global PSQI score was associated with a 0.06-s increase in the TUG time in the overweight/obese group (95 % CI: 0.004,0.12; p-value<0.05). On the other hand, in the normal-weight group, one unit of increase in the global PSQI score was associated with a 0.08-s increase in the TUG time (95 % CI: 0.01,0.14; p-value<0.05) (Table 2). Examining the association of overall sleep

Table 2
Association between overall sleep quality and performance in hand grip strength, timed up & go test, chair stand test, geriatric depression scale, generalized anxiety disorder scale.

	Overweight/Obese group		Normal-weight group	
Outcome	Model 1 β (95 % CI)	Model 2 β (95 % CI)	Model 1 β (95 % CI)	Model 2 β (95 % CI)
HGS	-0.45 (-0.65, -0.25)*	-0.07(-0.21, 0.08)	-0.26 (-0.47, -0.05)*	-0.10 (-0.25, 0.05)
TUG	0.10 (0.03, 0.16)*	0.06 (0.004, 0.12)*	0.12 (0.04, 0.19)*	0.08 (0.01, 0.14)*
CST	-0.17 (-0.24, -0.10)*	-0.12 (−0.19, -0.06)*	-0.08 (-0.16, -0.005)*	-0.06 (-0.14, 0.02)
GDS-30	1.12 (1.00, 1.24)*	1.08 (0.96, 1.20)*	1.15 (1.00, 1.30)*	1.13 (0.98, 1.27)*
GAD-7	0.71 (0.63, 0.79)*	0.71 (0.62, 0.79)*	0.67 (0.57, 0.76)*	0.67 (0.57, 0.76)*

HGS- Handgrip strength, TUG-Timed up & go test, CST-Chair stand test, GDS- Geriatric Depression Scale, GAD-Generalized Anxiety Disorder Scale.
Model 1- crude/unadjusted model.
Model 2 adjusted for sex, age, education, socioeconomic status, BMI, physical activity, tobacco use, alcohol use, and number of comorbidities.
* p-value<0.05.

Table 3
PSQI component wise association of sleep quality with hand grip strength (HGS), timed up & go (TUG) test, chair stand test (CST), geriatric depression scale (GDS-30), generalized anxiety disorder scale (GAD-7) in overweight/obese category.

Components	HGS, β (95 % CI)		TUG, β (95 % CI)		CST, β (95 % CI)		GDS-30, β (95 % CI)		GAD-7, β (95 % CI)	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Subjective sleep quality	-1.37(-1.96, -0.77)*	-0.36 (-0.80, 0.07)	0.23 (0.05, 0.41)*	0.13 (-0.04,0.29)	-0.51(-0.72, -0.31)*	-0.37 (-0.58,-0.17)*	2.44 (2.05,2.83)*	2.28 (1.90,2.67)*	1.66 (1.40,1.91)*	1.64 (1.38,1.90)*
Sleep latency	-0.86 (-1.27, -0.45)*	-0.05 (-0.34, 0.25)	0.19 (0.06, 0.31)*	0.11 (-0.00, 0.23)	-0.31 (-0.46, -0.17)*	-0.22 (-0.36,-0.08)*	2.07 (1.81, 2.33)*	1.98 (1.72,2.24)*	1.25 (1.08, 1.42)*	1.25 (1.07, 1.42)*
Sleep duration	0.55 (-0.13, 1.23)	0.08 (-0.41, 0.57)	-0.22 (-0.43, -0.01)*	-0.09 (-0.28, 0.10)	0.12 (-0.11, 0.36)	0.007 (-0.22, 0.24)	-0.04(-0.51, 0.42)	0.13 (-0.33, 0.59)	0.16 (-0.15, 0.46)	0.19 (-0.12, 0.50)
Sleep efficiency	-1.43 (-4.20, 1.32)	-0.97 (-2.95, 1.00)	0.15 (-0.69,0.99)	0.47 (-0.29, 1.24)	-0.44 (-1.40, 0.52)	-0.57 (-1.49, 0.36)	1.64 (-0.23, 3.52)	1.59 (-0.26, 3.44)	1.84 (0.61, 3.07)*	1.70 (0.47, 2.93)*
Sleep disturbance	-1.75 (-2.50,-0.99)*	-0.51 (-1.06,0.04)	0.60 (0.37, 0.83)*	0.34 (0.12,0.55)*	-0.51 (-0.77,-0.24)*	-0.28 (-0.53,-0.02)*	3.79 (3.31, 4.27)*	3.61 (3.14, 4.09)*	1.97 (1.65, 2.30)*	2.00 (1.67, 2.32)*
Use of sleep medication	-0.14 (-1.69, 1.40)	0.51 (-0.59,1.62)	0.18 (-0.29, 0.65)	0.11 (-0.32, 0.53)	-0.15 (-0.69, 0.39)	-0.04 (-0.56, 0.47)	0.45 (-0.60, 1.50)	0.33 (-0.70,1.37)	0.32 (-0.37, 1.01)	0.30 (-0.38,0.99)
Daytime dysfunction	-0.26 (-1.76, 1.25)	0.54 (-0.54,1.62)	-0.05 (-0.51, 0.41)	-0.02 (-0.44,0.40)	-0.49 (-1.01, 0.04)	-0.43 (-0.94, 0.07)	4.41 (3.41, 5.41)*	4.37 (3.39, 5.36)*	3.32(2.67, 3.98)*	3.30 (2.65, 3.95)*

Model 1 – crude/unadjusted model. Model 2 adjusted for sex, age, education, socioeconomic status, physical activity, BMI, tobacco use, alcohol use, and number of comorbidities. *p-value<0.05.

Table 4
PSQI component wise association of sleep quality with hand grip strength, timed up & go test (TUG), chair stand test (CST), geriatric depression scale (GDS-30), generalized anxiety disorder (GAD-7) scale in normal-weight category.

Components	HGS, β (95 % CI)		TUG, β (95 % CI)		CST, β (95 % CI)		GDS-30, β (95 % CI)		GAD-7, β (95 % CI)	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Subjective sleep quality	-1.04 (-1.67, -0.41)*	-0.37 (-0.83,0.08)	0.30 (0.08, 0.53)	0.17 (-0.03,0.38)	-0.37 (-0.61, -0.12)*	-0.27 (-0.50,-0.03)*	2.77 (2.30,3.24)*	2.64 (2.17,3.10)*	1.62 (1.33,1.91)*	1.60 (1.31,1.89)*
Sleep latency	-0.54 (-0.95, -0.12)*	-0.12 (-0.43, 0.18)	0.24 (0.09,0.39)*	0.14 (0.001,0.28)	-0.19 (-0.35, -0.03)*	-0.13 (-0.29, 0.03)	1.88 (1.57, 2.19)*	1.81 (1.50, 2.12)*	1.12 (0.93, 1.32)*	1.13 (0.93, 1.32)*
Sleep duration	0.58(-0.13, 1.28)	0.17 (-0.34, 0.68)	-0.02 (-0.27, 0.24)	0.05 (-0.18, 0.28)	0.20 (-0.07, 0.47)	0.16 (-0.10, 0.43)	0.64 (0.08, 1.20)*	0.74 (0.20, 1.29)*	0.43 (0.09, 0.77)*	0.46 (0.11, 0.80)*
Sleep efficiency	-1.24 (-4.03, 1.55)	-0.96 (-2.97, 1.05)	0.19 (-0.82, 1.20)	0.03 (-0.88, 0.93)	-0.75 (-1.82, 0.32)	-0.67 (-1.72, 0.37)	0.28(-1.93,2.49)	0.37 (-1.81, 2.54)	0.83 (-0.53, 2.19)	0.92 (-0.44, 2.28)
Sleep disturbance	-0.59 (-1.39, 0.20)	-0.22 (-0.80, 0.35)	0.26 (-0.03, 0.54)	0.15 (-0.11, 0.40)	-0.09 (-0.39, 0.22)	-0.02 (-0.32, 0.27)	3.80 (3.22, 4.37)*	3.72 (3.15, 4.29)*	2.18 (1.81, 2.54)*	2.17 (1.81, 2.53)*
Use of sleep medication	-1.86 (-3.90, 0.18)	-0.78 (-2.26, 0.70)	0.23 (-0.51, 0.96)	0.10 (-0.57, 0.77)	-0.17 (-0.96, 0.61)	-0.09 (-0.86, 0.68)	2.11 (0.50, 3.73)*	2.06 (0.46, 3.66)*	-0.21 (-1.20, 0.79)	-0.18 (-1.18, 0.82)
Daytime dysfunction	0.19 (-1.56, 1.95)	-0.98 (-2.25, 0.29)	0.40 (-0.23, 1.03)	0.47 (-0.10, 1.05)	-0.22 (-0.90, 0.45)	-0.33 (-0.99, 0.33)	2.71 (1.33, 4.09)*	3.10 (1.74, 4.46)*	1.25 (0.39, 2.10)*	1.36 (0.50, 2.21)*

Model 1 – crude/unadjusted model. Model 2 adjusted for sex, age, education, socioeconomic status, physical activity, BMI, tobacco use, alcohol use, and number of comorbidities. *p-value<0.05.

quality with CST revealed that one unit of increase in the global PSQI score was associated with a 0.12-unit decrease in the CST score in the overweight/obese (95 % CI: -0.19,-0.06; p-value<0.05). In contrast, there was no significant association between overall sleep quality and CST in the normal-weight group (Table 2).

4.2. Association of overall sleep quality with performance on psychological health indicators

As shown in Table 2, one unit of increase in the global PSQI score was associated with a 1.08-point increase in the GDS score in the overweight/obese group (95 % CI: 0.96,1.20, p-value<0.05). In the normal-weight group, one unit increase in the global PSQI score was associated with a 1.13-point increase in the GDS score (95 % CI: 0.98,1.27, p-value<0.05). Similarly, one unit increase in the global PSQI score was associated with a 0.71-point increase in the GAD score in the overweight/obese group (95 % CI: 0.62,0.79, p-value<0.05), and a 0.67-point increase in the GAD score in the normal-weight group (95 % CI: 0.57,0.76, p-value<0.05).

4.3. Association between individual sleep components and performance on physical and psychological health indicators

Among the individual sleep components, sleep disturbance showed a significant association with the maximum number of parameters, namely TUG time, CST score, GDS-30 and GAD-7 scores in the overweight/obese group (Table 3). In contrast, sleep disturbance did not show a significant association with any physical parameter, but a significant association was seen with GDS-30 and GAD-7 scores in the normal-weight group (Table 4). Subjective sleep quality and sleep latency showed a significant association with CST, GDS-30 and GAD-7 scores in the overweight/obese group (Table 3), whereas significant associations were seen only for GDS-30 and GAD-7 scores in the normal-weight group (Table 4). The daytime dysfunction component showed a significant association with GDS-30 and GAD-7 scores in the overweight/obese and normal-weight groups (Tables 3 and 4). Sleep efficiency showed a significant association with GAD-7 scores in the overweight/obese group (Table 3), whereas use of sleep medication showed a significant association with GDS-30 scores in the normal-weight group (Table 4).

5. Discussion

Our findings indicated that poorer sleep quality was significantly associated with poorer performance on physical (TUG test and CST) as well as psychological (depression and anxiety scores) health indicators among middle-aged and older adults with overweight/obesity, whereas in the normal-weight group, a significant association was seen only with TUG time, depression and anxiety symptoms. Our findings corroborate prior studies that have shown that poor sleep quality is associated with adverse health outcomes, such as poor muscle strength, depression and anxiety in those with excessive weight [31,32].

Excessive adiposity, particularly in older adults can lead to metabolic instability, place a strain on the musculoskeletal system and predispose individuals to physical frailty [33]. Poor sleep quality can further exacerbate metabolic disturbances, cause adverse changes in body composition (such as decreased muscle mass) and thereby, result in muscle weakness and decreased physical functioning [34,35]. In our study, poorer sleep quality was specifically associated with poorer lower limb strength, slower gait speed and balance (as reflected by decreased CST score and increased TUG time). These associations are highly relevant in the older population, due to the potentially increased risk of falls. A recent study among older rural Indians reported that risk of falls increased by 30% for every unit SD increase in BMI [36].

Interestingly, we did not find an association between overall sleep quality or any of the individual components and HGS in either the overweight/obese or normal-weight groups. Prior studies have demonstrated that poor sleep has been negatively associated with HGS in the older population [37–39]; however, no associations have also been reported [40,41]. We speculate that lack of association of sleep quality and HGS could be because our population comprised middle-aged and older adults in contrast to the other studies that have mostly considered older adults. Additionally, majority of our participants are farmers who are engaged in considerable manual labor with their hands, due to which hand muscle strength may not exhibit significant changes in response to the potentially deleterious effects of poor sleep.

Our finding that poor sleep quality was associated with increased depression and anxiety symptoms is important since a prior study found a high proportion of depression and anxiety [42] in this rural population, which was further exacerbated by the recent COVID-19 pandemic [43]. Since these individuals already face considerable financial stressors due to an unstable income (their agricultural income fluctuates substantially depending on weather conditions, choice of crops planted, etc.). Moreover, considering the limited mental health awareness, stigma attached to mental illnesses and poor access to mental healthcare, it is crucial to recognize and promptly manage potentially reversible risk factors such as poor sleep quality that can be associated with deterioration of mental health.

Considering the individual components of sleep quality, we found that sleep disturbance was the only component that showed an independent association with both physical (except for HGS) and psychological health indicators in the overweight/obese group. Past research has found the association of sleep disturbances with mobility and balance [33,44–46], muscle fatigue [47], anxiety [48] and depression [49,50] in middle-aged and older adults. Sleep duration, sleep efficiency, use of sleep medication and daytime dysfunction were not associated with any of the physical health indicators, whereas, sleep duration and use of sleep medication did not show a significant association with any of the physical or psychological health indicators, among overweight/obese individuals. These findings suggest that individual sleep components could have a differential impact on health-related outcomes.

Our findings provide evidence to strengthen the crucial role of sleep in influencing physical and psychological health among overweight and obese, middle-aged and older rural Indians. Ours is one of the first such studies in a rural Indian population that has employed a large sample size and studied the association of overall sleep quality and its individual components with multiple, objective physical and psychological health indicators. We recommend that sleep quality should be routinely assessed among middle-aged and older adults, particularly in those with excessive weight. Further, psychoeducation on the importance of maintaining good sleep hygiene should be provided at the primary care level itself. Some individuals reporting considerable or persistent sleep problems may need a more detailed and objective sleep assessment, such as a polysomnogram. In addition, the choice of specific interventions would depend on the affected sleep components and whether there are any underlying medical conditions. Considering the intricate relationship between sleep, physical health and psychological health, multidomain interventions including lifestyle, behavioural and psychosocial components are likely to yield more benefits than individual interventions alone [51].

Our study has certain limitations, such as the use of a cross-sectional design, implying that causal inferences cannot be made. The use of self-reported questionnaires such as PSQI, GDS-30 and GAD-7 could have introduced reporting bias. Additionally, though we had a control/normal-weight group, the findings on the strength of association between sleep quality and the health parameters cannot be directly compared between the overweight/obese and the normal-weight individuals, as the analyses were done separately for the two groups.

6. Conclusion

In conclusion, the present study highlights the association of overall sleep quality and specific sleep components with performance on physical and psychological health indicators in an overweight and obese population, living in rural areas of southern India. Improving sleep quality in this at-risk group could substantially reduce physical and psychological morbidities. Integrated lifestyle interventions targeting sleep, physical activity and diet could be an effective and scalable approach to reduce the combined adverse impact of poor sleep and excess weight.

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CRediT authorship contribution statement

Sakshi Arora: Writing – review & editing, Writing – original draft, Methodology, Conceptualization. **Pravin Sahadevan:** Formal analysis, Conceptualization. **Jonas S. Sundarakumar:** Writing – review & editing, Supervision, Project administration, Conceptualization, Funding acquisition.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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