

## Association of Poor Sleep Quality with Obesity and Related Behavioral Health Risk Factors in Undergraduate Medical Students: A Cross-Sectional Study

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### Abstract

**Background:** Sleep quality is a core health parameter and modulates metabolic and endocrine functions which may lead to obesity.

**Objectives:** To assess the prevalence of poor sleep quality and determine its association with obesity and related behavioral health risk factors in undergraduate medical students.

**Materials and Methods:** 82 undergraduate medical students (18-25 years) were assessed for sleep quality using the Pittsburgh sleep quality index (PSQI) questionnaire and were grouped into GQS (PSQI score  $\geq 5$ ) and PQS (PSQI score  $> 5$ ). Anthropometric measurements, physical activity, and fruit and vegetable intake were recorded using standard WHO methods. Body composition was assessed using bioelectrical impedance analysis by BODYSTAT quad scan 4000. Binge eating was measured by the Three Factor Eating Questionnaire R-18 (TFEQR-18). The prevalence of poor sleep quality was reported in percentage with 95% Confidence interval (C.I.) The association between various parameters was assessed by ANOVA and chi-square test. A two-sided p-value of  $< 0.05$  was taken as statistically significant.

**Results:** The prevalence of poor sleep quality among 82 study participants (mean age =  $19.2 \pm 1.12$  years, comprising 54 (67%) females and 28 (33%) males) was 67% (55) (PQS group). The mean BMI, WC, WHR, TBW, ICW, ECW, EE score, decreased physical activity, and decreased fruit/vegetable intake was significantly higher in PQS group.

**Conclusion:** Poor sleep quality is positively associated with central obesity, water retention, inadequate physical activity, inadequate fruit, and vegetable intake, and increased emotional eating. Thus, maintenance of sleep hygiene and active dietary and lifestyle changes can lead to larger health benefits for undergraduate medical students.

**Keywords:** Sleep Quality, Physical activity, BMI.

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### Introduction

Medical college life represents one of the critical transitions in a student's life and is characterized by academic growth, higher skill acquisition, and inevitable change in sleep and behavioral patterns. Sleep affects physical growth, emotional development, and metabolic and endocrine changes.

In medical college students, average sleep duration is reduced, and sleep quality is compromised because of high academic demand, peer pressure, and behavioral factors like physical activity, diet, smoking, and alcohol intake.

The sleep quality of medical students deserves particular attention because of the potential impact on their academic performance, and physical and

mental health. [1] Several studies have found a relatively high prevalence of poor sleep-quality complaints, e.g., Inadequate sleep, difficulty falling asleep, early morning awakenings, and daytime sleepiness among college students.[2,3]

Poor sleep quality is known to be associated with increased anthropometric indicators of obesity e.g., BMI, and WHR by altering metabolic and endocrine functions. [4] Certain behavioral factors also appear to be associated with poor sleep quality, like increased smoking and alcohol consumption, inadequate physical activity, inadequate fruit and vegetable intake, and binge eating, [5,6,7]

Hence, keeping in view the potentially harmful effects of poor sleep quality on young students, the present cross-sectional study was conducted to assess the prevalence of poor sleep quality and its association with obesity and related behavioral parameters in undergraduate medical students at a North Indian medical college.

### Materials and Methods

Taking the prevalence of poor sleep quality in medical students in India to be 30.6%, as reported by Giri et al in 2013, the sample size calculated at a 95% confidence interval (C.I.) with 10% precision was 82.3

Ethical approval from the institutional ethical committee was taken before the commencement of the study.

Eighty-two undergraduate medical students between the age groups 18-25 years without any severe medical illnesses like cancer, epilepsy, coronary heart disease, past or present history of any psychiatric illness, known metabolic disorders, PCOD, Diabetes, and thyroid abnormalities were enrolled in the study after obtaining written informed consent.

The sleep quality of the study participants was assessed by the Pittsburgh Sleep Quality (PSQI) questionnaire which assesses the sleep quality of the past month. [8] The PSQI measures seven different aspects of sleep (subjective sleep quality, sleep disturbances, sleep latency, habitual sleep efficiency, use of sleeping medication, daytime dysfunction, and sleep duration). A global PSQI score  $>5$  indicates poor quality sleep and a higher score indicates worsening sleep quality. Accordingly, the study population was grouped into Good-Quality Sleepers (GQS group with PSQI score  $\leq 5$ ) and Poor-Quality Sleepers (PQS group with PSQI score  $> 5$ ).

In both the groups, anthropometric measurements (height in cms, weight in kgs, Hip Circumference in cms, Waist Circumference in cms, Waist Hip Ratio, and BMI in  $\text{kg}/\text{m}^2$ ) were recorded using the standard methods given by WHO. [9]

Body composition parameters like fat weight (kgs), lean weight (kgs), Body Fat Mass Index (BFMI in  $\text{kg}/\text{m}^2$ ), Fat-Free Mass Index (FFMI in  $\text{kg}/\text{m}^2$ ), Extra Cellular Water (ECW in liters), Intra Cellular Water (ICW in liters), and Total Body Water (TBW in liters) were assessed by multi-frequency bio-electrical impedance analysis using BODY STAT, Quad scan 4000 according to the recommendations in the NIH Technology Assessment Statement with impedance values at 5kHz resistance and reactance and Phase Angle at 50 kHz. A specific body stat calibrator (500 ohms) was used daily to confirm the reproducibility of the measurement. The body composition was

performed in a separate room and the study participants were instructed to not have taken meals 4 hrs. before the test and not indulge in severe physical activity 12 hrs. before the test. [10] Behavioral information regarding diet (fruit and vegetable intake), and physical activity was collected using the standard WHO STEPS approach. [11]

Binge eating was assessed using a questionnaire-based tool, the Three-Factor Eating Questionnaire-Revised 18-item (TFEQ-R18) [12] that measures binge eating by three factors namely, Cognitive Restraint (CR- 6 questions), Uncontrolled Eating (UE-9 questions), and Emotional Eating (EE-3 questions). The mean scores of the three factors were computed and compared among the two groups.

The data were reported as frequency and percentage for categorical variables and mean  $\pm$  SD for continuous variables with normal distribution. The prevalence of poor sleep quality in medical students was reported as a percentage with a 95% Confidence interval (C.I.) The association of obesity and behavioral correlates with sleep quality was assessed using an ANOVA test and a chi-square test. A two-sided p-value of  $<0.05$  was taken as statistically significant.

### Results

The sleep quality of the study population ( $n=82$  undergraduate medical students) with a mean age of  $19.25\pm 1.13$  years, comprising 28 males (34.15%), and 54 females (65.85%), was assessed by the PSQI questionnaire (mean PSQI score  $=6.3\pm 2.59$ ). Among them, 27 students had good sleep quality (32.93%) and were grouped as the Good Quality Sleepers (GQS group) and 55 students had poor sleep quality (67.07%) and were grouped as the Poor-Quality Sleepers (PQS group) by PSQI.

The general characteristics (mean age, gender distribution, and mean blood pressure) and familial characteristics (family history of sleep disorders and diabetes mellitus) of both the groups (GQS and PQS groups) were comparable and no significant difference was observed. (Table 1) On comparison of anthropometric and body composition parameters of study groups, the mean values of Body Mass Index (BMI) ( $p=0.04$ ), Waist Circumference (WC) ( $p=0.002$ ), and Waist to Hip Ratio (WHR) ( $p=0.0001$ ), Total Body Water (TBW) ( $p=0.04$ ), Extra Cellular Water (ECW) ( $p=0.02$ ), and Intra Cellular Water (ICW) ( $p=0.05$ ) were significantly higher in the PQS group than in the GQS group. The mean values of lean weight ( $p=0.07$ ), fat weight ( $p=0.5$ ), Body Fat Mass Index (BFMI) ( $p=0.8$ ), Fat-Free Mass Index (FFMI) ( $p=0.07$ ) were higher in the PQS group than in

GQS group but the difference was found to be statistically insignificant. (Table 2)

On comparison of the behavioral health risk factors between the GQS and the PQS groups, the proportion of subjects with inadequate physical activity (METs $\leq$ 600/wk.) (p=0.0004) and inadequate fruit and vegetable intake ( $\leq$ 2 serving/day) (p=0.007) was significantly higher in the PQS group.

While comparing the binge eating scores (as per the TFEQ R-18 questionnaire) between GQS and PQS groups, the mean Emotional Eating score (EE) was significantly higher in the PQS group than in the GQS group (p=0.04), whereas the mean Uncontrolled Eating score (UE) (p=0.34) was higher for PQS group and the mean Cognitive Restraint score (p=0.57) was higher for GQS group

but the difference was found to be statistically insignificant. (Table 3) While comparing the sleep quality components of GQS and PQS groups as assessed by the PSQI questionnaire, the mean scores of daytime dysfunctions, sleep duration, subjective sleep quality, sleep latency, and habitual sleep efficiency were significantly higher in the PQS group than in the GQS group (p= 0.00, 0.0015, 0.002, 0.008, 0.0016 respectively).

The most affected sleep quality components among poor-quality sleepers were daytime dysfunction and sleep duration. Whereas the mean scores of sleep disturbances (p= 0.055) and use of sleeping medication (p= 0.48) component of sleep quality were higher in the PQS group but the difference was found to be statistically insignificant. (Table 4).

**Table 1: Comparison of General and Familial Characteristics in Good Quality Sleeper Group (GQS Group) and Poor Quality Sleeper Group (PQS Group)**

Variables	GQS Group (PSQI score>5) (N=27)	PQS Group (PSQI $\leq$ 5) (N=55)	P- Value	ODD'S Ratio (C.I.)	
The mean age (years)	19.40 $\pm$ 1.11	19.18 $\pm$ 1.14	0.39		
Gender	Male	8 (29.6%)	20(36.3%)	0.72	
	Female	19(70.3%)	35(63.6%)		
Blood Pressure	Mean SBP (mmHg)	113.4 $\pm$ 7.4	112.9 $\pm$ 7.4	0.77	
	Mean DBP (mmHg)	72.3 $\pm$ 5.4	72.7 $\pm$ 6.0	0.77	
Family history of sleep disorders	YES	4	8	1.00	1.02 (0.27-3.74)
	NO	23	47		
Family history of Diabetes Mellitus	YES	8	20	0.72	0.73 (0.27-1.98)
	NO	19	35		

**Table 2: Comparison of Anthropometric and Body Composition Parameters in Study Groups**

Variables	GQS Group N=27	PQS Group N=55	P- Value
BMI (kg/m <sup>2</sup> ) *	20.47 $\pm$ 3.27	22.32 $\pm$ 4.29	0.04
WC (cm)**	68.60 $\pm$ 8.12	77.20 $\pm$ 11.90	0.002
HC (cm)	90.88 $\pm$ 7.20	94.20 $\pm$ 10.88	0.27
WHR**	0.75 $\pm$ 0.06	0.81 $\pm$ 0.06	0.0001
Lean wt. (kg)	43.6 $\pm$ 8.3	48.0 $\pm$ 11.1	0.07
Fat wt. (kg)	11.2 $\pm$ 5.6	12.2 $\pm$ 6.4	0.50
TBW (litres)*	30.9 $\pm$ 5.9	34.1 $\pm$ 6.5	0.04
ECW (litres)*	13.9 $\pm$ 2.0	15.1 $\pm$ 2.2	0.02
ICW (liters)*	16.3 $\pm$ 4.0	18.3 $\pm$ 4.4	0.05
BFMI (kg/m <sup>2</sup> )	4.4 $\pm$ 2.4	4.5 $\pm$ 2.6	0.89
FFMI (kg/m <sup>2</sup> )	16.4 $\pm$ 2.1	17.3 $\pm$ 2.3	0.07

\*p $\leq$ 0.05, \*\*p $\leq$ 0.01

**Table 3: Comparison of Behavioural Characteristics in Study Groups**

Variables	GQS (N=27)	PQS (N=55)	P- Value	ODDS Ratio CI= 95%	
Fruits and vegetable intake**	Adequate (>2 FV serving/day)	20	22	0.007	4.28(C.I.=1.55-11.83)
	Inadequate ( $\leq$ 2 FV serving/day)	7	33		
Physical activity**	Adequate (>600 METS/week)	18	13	0.0004	6.46(C.I.=2.34-17.80)
	Inadequate ( $\leq$ 600 METS/week)	9	42		
Binge eating (by TFEQ R-18)	TFEQ- Uncontrolled eating score	19.2 $\pm$ 4.67	20.3 $\pm$ 5.07	0.34	
	TFEQ- Cognitive restraint score	13.1 $\pm$ 2.94	12.7 $\pm$ 3.5	0.57	
	TFEQ- Emotional eating* score	5.48 $\pm$ 2.48	6.58 $\pm$ 2.25	0.04	

(\*p $\leq$ 0.05, \*\*p $\leq$ 0.01)

**Table 4: Comparison of Sleep Quality Component Scores in Study Groups by PSQI:**

Variables (Sleep Quality Components By PSQI)	GQS Group (N=27) (Mean score)	PQS Group (N=55) (Mean score)	P- Value
Subjective sleep quality**	0.81±0.39	1.25±0.67	0.002
Use of medication	0.00±0.00	0.01±0.13	0.48
Sleep latency**	0.37±0.49	0.90±0.90	0.008
Habitual sleep efficiency**	0.11±0.32	0.65±0.86	0.0016
Sleep disturbances	0.66±0.48	0.90±0.55	0.055
Sleep duration**	0.77±0.57	1.40±0.87	0.0015
Daytime dysfunction**	0.85±0.66	1.89±0.93	0.00

(\*p≤0.05, \*\*p≤0.01)

**Discussion:**

Medical college life represents one of the salient transitions in a student's life and is characterized by an immense pace of growth and erratic sleep patterns. The prevalence of poor sleep quality among undergraduate medical students is on a constant rise and is higher in medical students than in the general population and reportedly affects 22%–73% of medical students. [3] In the present study population (n=82), the prevalence of poor sleep quality among undergraduate medical students was 67%. The reason for this variation worldwide could be attributed to the varied sample size, geographical variations, and peculiar college environments. In the present study, the most affected component of sleep quality was daytime dysfunction (p=0.00) and sleep duration (p-value =0.0015). Similar results were shown in a study conducted by Correa et al in 2017 on 540 medical students in Brazil where the most affected sleep quality component was daytime dysfunction and subjective sleep quality which is attributed to inadequate sleep hygiene among young students including poor social life and late-night eating, internet surfing habits, and increased academic pressure in medical colleges. [13]

The incidence of obesity and its comorbidities are on a constant rise since the past decade, increasing the global burden of NCDs among medical students. [14,15] Sleep quality and quantity changes are known to alter metabolic and endocrine functions including decreased glucose tolerance, decreased insulin sensitivity, increased evening concentrations of cortisol, increased levels of ghrelin, decreased levels of leptin, and increased hunger and appetite contributing directly to obesity [16]. As seen in the present study, the mean values of Body Mass Index (BMI), Waist Circumference (WC), and Waist to Hip Ratio (WHR) were found to be significantly higher in the PQS group, while the hip circumference was insignificantly associated with poor sleep quality, similarly in a study conducted by Yazdanpanah et al in 2021 (n=10,136 adults) in Iran, all the anthropometric indices were significantly higher in those with decreased sleep duration (p-value < 0.001). [17] While comparing the body composition parameters

in the present study population, the mean values of TBW, ECW, and ICW were found to be significantly higher in the PQS group than in the GQS group. The association of poor sleep quality with water retention has been attributed to the role of cortisol in sodium retention and volume expansion as evidenced by earlier studies that changes in sleep duration and quality can delay the recovery of the Hypothalamic pituitary adrenal (HPA) axis from early morning circadian stimulation and thus can alter glucocorticoid feedback regulation accelerating its metabolic consequences causing sodium and water retention. [18,19]

Certain behavioral health risks factors like physical activity, diet, and binge eating are also known to affect sleep quality. Physical activity is known to affect the inhibitory neuromodulator adenosine (sleep-inducing factor) levels which further determine the sleep-wakefulness cycle. [20,21] In the present study, the percentage of subjects with inadequate physical activity was significantly higher in the PQS group (60%) than in the GQS group (25.9%) as reported by a similar study by Wu X et al in 2015 on 4747 college students, concluding that low Physical Activity was significantly associated with an increased risk of poor sleep quality. [22]

The effect of fruit and vegetable consumption on sleep quality can be attributed to their high melatonin, serotonin, and antioxidant content which is known to reduce oxidative stress and thus improve sleep quality. In the present study, inadequate Fruit and vegetable consumption showed a statistically significant association with poor sleep quality (p=0.007). Similarly, in a study conducted by Pengpid et al in 2020 on 21,027 university students from 28 countries, there was a linear decrease in the prevalence of short sleep with increasing Fruits and Vegetable consumption beyond ≥2 servings/day. [23]

Binge eating is also known to affect sleep quality as a study conducted in 2010 by Balbo et al found that higher emotional eating scores were associated with increased indicators of stress such as activation of the hypothalamic-pituitary-adrenal

(HPA) axis and increased cortisol secretion which directly affects the sleep quality. In the present study, the mean score of the emotional eating factor of binge eating was significantly higher in the PQS group than in the GQS group ( $p=0.04$ ). Saleh et al conducted a similar study in 2015 on 150 Iranian female students and reported that students with poor sleep quality had increased emotional eating score and their proportion of calorie intake from fat was higher ( $p<0.05$ ). [24,25]

To conclude, the prevalence of poor sleep quality is high among undergraduate medical students (67% in the present study), which is found to be significantly associated with central obesity, increased water retention, and behavioral factors like inadequate fruit and vegetable intake, inadequate physical activity and higher emotional eating. Therefore, the maintenance of sleep hygiene and active changes in lifestyle can lead to larger health benefits for young students and may decrease the incidence of comorbidities associated with obesity and the global burden of NCDs. Future researchers are recommended to employ a multicentric and multifactorial approach in finding the prevalence and correlates of poor sleep quality.

#### Limitations of the Study:

The present study was aimed at finding the prevalence of poor sleep quality in undergraduate medical students and to establish its correlates. However, there were a few factors that limit the results of this study. Our study was carried out in a select group of students at our own institute which limits the generalizability of our findings. We recommend a multicentric selection of study participants for the future researchers.

The tool used for assessing the sleep quality was questionnaire based and was subjective in nature. More reliable and objective instruments like polysomnography and actigraphy is recommended for the future researchers. The other limitation being that bio electrical impedance used in our study measures the total body fat and lean mass. Segmental bio electrical impedance analysis would be more useful to assess appendicular lean body mass and muscle volume in specific compartment of the body. Such an instrument would be useful in understanding the fat distribution more specifically.

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