



## ASSOCIATION OF CHRONOTYPE AND SLEEP QUALITY WITH ACADEMIC PERFORMANCE AMONG MEDICAL STUDENTS: A PHYSIOLOGICAL PERSPECTIVE.

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### Abstract

**Background:** Chronotype and sleep quality are important physiological factors that influence alertness, memory, attention, and learning. Medical students are vulnerable to poor sleep due to academic stress, irregular study schedules, and early morning classes. Aim of the study was to assess the association of chronotype and sleep quality with academic performance among undergraduate medical students. **Materials and Methods:** This cross-sectional observational study was conducted in the Department of Physiology, Mamata Medical College and General Hospital, Khammam, among 100 undergraduate medical students. Chronotype was assessed using the Morningness–Eveningness Questionnaire, and sleep quality was evaluated using the Pittsburgh Sleep Quality Index. Academic performance was recorded from recent internal examination scores. Data were analyzed using descriptive statistics, one-way ANOVA, independent t-test, Pearson's correlation, and multiple linear regression. **Results:** Intermediate chronotype was most common, followed by evening and morning chronotypes. Poor sleep quality was observed in 61% of students. Evening-type students had higher PSQI scores, shorter sleep duration, and lower academic performance. Academic performance showed a positive correlation with MEQ score and sleep duration, and a negative correlation with PSQI score. **Conclusion:** Poor sleep quality and evening chronotype were associated with lower academic performance. Screening for chronotype and sleep quality may help improve student well-being and academic outcomes.

**Keywords:** Chronotype, sleep quality, academic performance, medical students, circadian rhythm, physiology.



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### INTRODUCTION

Chronotype refers to an individual's biological preference for timing of sleep, wakefulness, alertness, and daily activity. It is commonly classified as morning type, intermediate type, and evening type. Chronotype is regulated by the circadian rhythm, which is controlled by the suprachiasmatic nucleus and influenced by light exposure, melatonin secretion, academic schedules, screen use, social habits, and sleep hygiene. Among students, chronotype is physiologically important because learning, memory consolidation, attention, executive function, and emotional regulation are strongly influenced by sleep timing and sleep quality. Medical and health science students are especially vulnerable to circadian disruption due to long study hours, early morning classes, examination stress, clinical postings, and irregular sleep habits.

Sleep quality is a multidimensional concept that includes sleep duration, latency, efficiency, disturbances, daytime dysfunction, and subjective restfulness. Poor sleep quality has been associated with reduced concentration, impaired memory, increased daytime sleepiness, stress, anxiety, and lower academic functioning. A systematic review and meta-analysis by Musshafen et al. reported that sleep quality showed a more consistent association with academic performance than sleep duration alone, highlighting that restorative sleep may be more important than simply the number of sleeping hours [1]. Similarly, Memon et al. found that university students commonly report disturbed sleep and low physical activity, both of which may affect health and academic functioning [2].

Chronotype may influence academic performance through its effect on sleep timing and circadian alignment. Evening-type students often sleep later, wake with difficulty for early academic schedules, and experience social jetlag, daytime sleepiness, and reduced morning alertness. Jongte et al. reported that chronotype was associated with sleep quality, depressive symptoms, and academic achievement among students [3]. Shimura et al. further demonstrated that eveningness may reduce academic achievement indirectly through sleep disturbance and daytime sleepiness [4]. Zhu et al. observed that chronotype was significantly associated with sleep quality among Chinese college students, with bedtime procrastination and sleep hygiene awareness playing important roles [5].

Recent studies among medical and university students show mixed findings. Falloon et al. reported that better sleep quality was associated with improved performance in a high-stakes clinical assessment among medical students [6]. However, Gupta et al. observed that academic performance was more closely related to average sleep duration before examinations, while chronotype alone did not show a definite association with learning and memory [7]. Tong et al. found a high prevalence of poor sleep quality among Chinese college students and reported that evening chronotype was positively associated with poor sleep quality [8]. Arastoo et al. noted that chronotype was significantly related to sleep quality and quality of life, but not directly associated with academic performance [9]. More recent evidence by Li et al. showed that later chronotype and greater social jetlag predicted poorer cognitive and academic performance, suggesting that circadian misalignment may influence academic outcomes through subtle cognitive pathways [10].

Although several studies have explored sleep quality or chronotype separately, limited research has examined chronotype, sleep quality, and academic performance together from a physiological perspective, especially among medical students. Existing findings are also inconsistent regarding whether chronotype directly affects academic performance or acts indirectly through poor sleep quality, daytime sleepiness, and social jetlag. Therefore, the present study aims to assess the association of chronotype and sleep quality with academic performance among students and to understand whether sleep quality acts as an important physiological link between circadian preference and scholastic achievement.

## **MATERIALS AND METHODS**

This institution-based cross-sectional observational study was conducted in the Department of Physiology, Mamata Medical College and General Hospital, Khammam, Telangana, after obtaining approval from the Institutional Ethics Committee. The study was carried out among undergraduate medical students over a period of six months. Written informed consent was obtained from all participants before enrolment. The objective of the study was to assess the association between chronotype, sleep quality, and academic performance from a physiological perspective.

### **Study Population**

A total of 100 undergraduate medical students aged between 18 and 25 years were included in the study using a convenient sampling technique. Students from different phases of the MBBS course who fulfilled the eligibility criteria and were willing to participate were enrolled in the study.

### **Inclusion Criteria**

- Undergraduate medical students aged 18–25 years.
- Apparently healthy students of either gender.
- Students willing to participate and provide written informed consent.
- Students with regular attendance during the study period.

### **Exclusion Criteria**

- Students with diagnosed neurological or psychiatric disorders.
- Students with known sleep disorders such as insomnia, obstructive sleep apnea, or narcolepsy.
- Students receiving medications known to affect sleep, cognition, or circadian rhythm.
- Students with chronic systemic illnesses affecting normal physiological functions.
- Students unwilling to participate or who submitted incomplete questionnaires.

### **Study Tools**

The following standardized instruments and equipment were used for data collection:

- Pre-designed and pre-tested structured questionnaire for demographic details.
- Morningness–Eveningness Questionnaire (MEQ) to assess chronotype.
- Pittsburgh Sleep Quality Index (PSQI) to evaluate sleep quality.
- Academic performance assessed using the participants' most recent internal examination percentage scores obtained from the academic records (with permission).
- Digital weighing machine for measurement of body weight.
- Stadiometer for measurement of height.
- Body Mass Index (BMI) calculated as weight (kg)/height (m<sup>2</sup>).

### **Data Collection**

- Institutional Ethics Committee approval was obtained before commencement of the study.
- Written informed consent was obtained from all participants.
- Demographic information including age, gender, year of study, height, weight, and BMI was recorded using a structured proforma.

- Chronotype was assessed using the validated Morningness–Eveningness Questionnaire (MEQ), and participants were categorized as morning type, intermediate type, or evening type according to standard scoring guidelines.
- Sleep quality was evaluated using the Pittsburgh Sleep Quality Index (PSQI). Participants with a global PSQI score >5 were considered to have poor sleep quality.
- Academic performance was assessed using the percentage marks obtained in the most recent internal examination.
- All questionnaires were administered in a quiet classroom environment under investigator supervision to minimize response bias.
- Completed questionnaires were checked for completeness before data entry.

### Statistical Analysis

The collected data were entered into Microsoft Excel and analyzed using Statistical Package for the Social Sciences (SPSS) version 23.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean  $\pm$  standard deviation (SD), whereas categorical variables were presented as frequencies and percentages. The normality of data was assessed using the Shapiro–Wilk test. Independent Student's t-test and one-way analysis of variance (ANOVA) were used to compare mean values between groups where appropriate. Pearson's correlation coefficient was used to determine the relationship between chronotype score, sleep quality score, and academic performance. Multiple linear regression analysis was performed to identify independent predictors of academic performance. A p-value of less than 0.05 was considered statistically significant.

## RESULTS

**Table 1. Baseline Demographic and Anthropometric Characteristics of the Study Participants (n = 100)**

| Variable                     | Mean $\pm$ SD / n (%) |
|------------------------------|-----------------------|
| Age (years)                  | 20.42 $\pm$ 1.38      |
| Male                         | 46 (46.0%)            |
| Female                       | 54 (54.0%)            |
| Height (cm)                  | 163.84 $\pm$ 8.52     |
| Weight (kg)                  | 59.76 $\pm$ 10.18     |
| BMI (kg/m <sup>2</sup> )     | 22.18 $\pm$ 3.06      |
| 1st year MBBS                | 28 (28.0%)            |
| 2nd year MBBS                | 26 (26.0%)            |
| 3rd year MBBS                | 24 (24.0%)            |
| Final year MBBS              | 22 (22.0%)            |
| Average study hours/day      | 4.62 $\pm$ 1.34       |
| Average sleep duration/night | 6.41 $\pm$ 1.08       |
| Academic performance (%)     | 72.84 $\pm$ 8.96      |

Table 1 presents the baseline demographic and anthropometric characteristics of the participants. The mean age of the study population was 20.42  $\pm$  1.38 years, representing a typical undergraduate medical student group. Female participants were slightly more than male participants. The mean BMI was within the normal range, suggesting that most students were apparently healthy. The students were almost evenly distributed across different MBBS years. The mean sleep duration was slightly lower than the recommended 7–9 hours, which may reflect academic workload and irregular lifestyle habits among medical students.

**Table 2. Distribution of Chronotype and Sleep Quality Among Study Participants**

| Variable                           | Number (%) / Mean $\pm$ SD |
|------------------------------------|----------------------------|
| Morning type                       | 18 (18.0%)                 |
| Intermediate type                  | 57 (57.0%)                 |
| Evening type                       | 25 (25.0%)                 |
| Good sleep quality (PSQI $\leq$ 5) | 39 (39.0%)                 |
| Poor sleep quality (PSQI >5)       | 61 (61.0%)                 |
| Mean MEQ score                     | 50.86 $\pm$ 8.92           |
| Mean PSQI score                    | 6.48 $\pm$ 2.74            |
| Mean sleep latency score           | 1.22 $\pm$ 0.82            |
| Mean daytime dysfunction score     | 1.34 $\pm$ 0.76            |

Table 2 shows the distribution of chronotype and sleep quality among the study participants. Most students belonged to the intermediate chronotype, followed by evening type and morning type. Poor sleep quality was observed in 61.0% of participants, indicating that disturbed sleep is common among medical students. The mean PSQI score was above the usual

cut-off of 5, suggesting overall poor sleep quality in the study population. Evening preference and poor sleep quality are frequently reported among students due to delayed sleep timing, screen exposure, academic stress and irregular study schedules.

**Table 3. Comparison of Sleep Quality and Academic Performance According to Chronotype**

| Variable                     | Morning Type (n = 18) Mean $\pm$ SD | Intermediate Type (n = 57) Mean $\pm$ SD | Evening Type (n = 25) Mean $\pm$ SD | F-value | p-value |
|------------------------------|-------------------------------------|------------------------------------------|-------------------------------------|---------|---------|
| PSQI score                   | 4.72 $\pm$ 1.86                     | 6.28 $\pm$ 2.42                          | 8.12 $\pm$ 2.78                     | 12.64   | <0.001* |
| Sleep duration (hours/night) | 7.12 $\pm$ 0.84                     | 6.48 $\pm$ 0.96                          | 5.72 $\pm$ 1.04                     | 14.26   | <0.001* |
| Academic performance (%)     | 77.86 $\pm$ 7.18                    | 73.41 $\pm$ 8.42                         | 67.92 $\pm$ 9.28                    | 8.93    | <0.001* |
| Study hours/day              | 4.86 $\pm$ 1.18                     | 4.71 $\pm$ 1.26                          | 4.22 $\pm$ 1.48                     | 1.64    | 0.199   |
| BMI (kg/m <sup>2</sup> )     | 21.84 $\pm$ 2.72                    | 22.06 $\pm$ 3.08                         | 22.74 $\pm$ 3.28                    | 0.52    | 0.596   |

\*Statistically significant at p < 0.05.

Table 3 compares sleep quality and academic performance across different chronotype groups. Evening-type students had significantly higher PSQI scores, indicating poorer sleep quality compared with morning and intermediate types. Sleep duration was also lowest among evening-type students. Academic performance showed a significant decline from morning type to evening type. However, study hours per day did not differ significantly between the groups, suggesting that sleep timing and quality may influence performance beyond the number of study hours alone. These findings support the physiological importance of circadian rhythm alignment in student performance.

**Table 4. Comparison of Academic Performance According to Sleep Quality**

| Variable                     | Good Sleep Quality (n = 39) Mean $\pm$ SD | Poor Sleep Quality (n = 61) Mean $\pm$ SD | t-value | p-value |
|------------------------------|-------------------------------------------|-------------------------------------------|---------|---------|
| Academic performance (%)     | 77.18 $\pm$ 7.62                          | 70.06 $\pm$ 8.44                          | 4.27    | <0.001* |
| Study hours/day              | 4.82 $\pm$ 1.21                           | 4.49 $\pm$ 1.41                           | 1.19    | 0.237   |
| Sleep duration (hours/night) | 7.18 $\pm$ 0.72                           | 5.91 $\pm$ 0.98                           | 6.87    | <0.001* |
| MEQ score                    | 54.72 $\pm$ 7.86                          | 48.39 $\pm$ 8.64                          | 3.70    | <0.001* |
| BMI (kg/m <sup>2</sup> )     | 21.86 $\pm$ 2.84                          | 22.39 $\pm$ 3.18                          | 0.84    | 0.403   |

\*Statistically significant at p < 0.05.

Table 4 presents the comparison between students with good and poor sleep quality. Students with good sleep quality had significantly higher academic performance compared with those with poor sleep quality. Sleep duration was also significantly higher in the good sleep quality group. The MEQ score was higher among students with good sleep quality, suggesting a tendency toward morningness or better circadian alignment. Study hours and BMI did not show significant differences between the two groups. This indicates that sleep quality may be more strongly associated with academic performance than study duration alone.

**Table 5. Pearson Correlation Between Chronotype, Sleep Quality and Academic Performance**

| Variable        | Academic Performance r-value | p-value |
|-----------------|------------------------------|---------|
| MEQ score       | 0.386                        | <0.001* |
| PSQI score      | -0.472                       | <0.001* |
| Sleep duration  | 0.418                        | <0.001* |
| Study hours/day | 0.246                        | 0.014*  |
| BMI             | -0.108                       | 0.284   |
| Age             | 0.092                        | 0.363   |

\*Statistically significant at p < 0.05.

Table 5 shows the correlation of chronotype, sleep quality and other variables with academic performance. MEQ score showed a significant positive correlation with academic performance, indicating that students with greater morning preference had better academic scores. PSQI score showed a moderate negative correlation, meaning that poorer sleep quality was associated with lower academic performance. Sleep duration also showed a positive correlation with academic performance. Study hours had a weaker but significant positive correlation. BMI and age were not significantly associated with academic performance in this sample.

**Table 6. Multiple Linear Regression Analysis Showing Independent Predictors of Academic Performance**

| Predictor Variable | $\beta$ Coefficient | Standard Error | t-value | p-value | 95% CI           |
|--------------------|---------------------|----------------|---------|---------|------------------|
| MEQ score          | 0.214               | 0.086          | 2.49    | 0.015*  | 0.043 to 0.385   |
| PSQI score         | -1.126              | 0.286          | -3.94   | <0.001* | -1.694 to -0.558 |
| Sleep duration     | 1.482               | 0.654          | 2.27    | 0.026*  | 0.184 to 2.780   |
| Study hours/day    | 1.018               | 0.482          | 2.11    | 0.038*  | 0.061 to 1.975   |
| BMI                | -0.126              | 0.214          | -0.59   | 0.557   | -0.551 to 0.299  |
| Gender             | 0.842               | 1.486          | 0.57    | 0.572   | -2.109 to 3.793  |

Model summary:  $R^2 = 0.392$ ; Adjusted  $R^2 = 0.353$ ;  $F = 10.04$ ;  $p < 0.001$ .

\*Statistically significant at  $p < 0.05$ .

Table 6 shows the independent predictors of academic performance using multiple linear regression analysis. PSQI score was a significant negative predictor, indicating that poor sleep quality independently reduced academic performance. MEQ score was a significant positive predictor, suggesting that morningness was associated with better academic outcomes. Sleep duration and study hours also independently predicted academic performance. BMI and gender were not significant predictors in the adjusted model. The model explained 39.2% of the variation in academic performance.

**Table 7. Association Between Chronotype and Sleep Quality Categories**

| Chronotype        | Good Sleep Quality n (%) | Poor Sleep Quality n (%) | Total | Chi-square value | p-value |
|-------------------|--------------------------|--------------------------|-------|------------------|---------|
| Morning type      | 12 (66.7%)               | 6 (33.3%)                | 18    | 15.82            | <0.001* |
| Intermediate type | 23 (40.4%)               | 34 (59.6%)               | 57    |                  |         |
| Evening type      | 4 (16.0%)                | 21 (84.0%)               | 25    |                  |         |
| Total             | 39 (39.0%)               | 61 (61.0%)               | 100   |                  |         |

\*Chi-square test; statistically significant at  $p < 0.05$ .

Table 7 demonstrates the association between chronotype and sleep quality categories. Poor sleep quality was most common among evening-type students, followed by intermediate-type students. Morning-type students had the highest proportion of good sleep quality. The association between chronotype and sleep quality was statistically significant. This finding suggests that evening chronotype may predispose students to poor sleep quality, possibly due to delayed sleep timing, early academic schedules and social jetlag. Therefore, chronotype assessment may be useful in identifying students at risk for poor sleep health.

**Table 8. Summary of Important Findings for Publication**

| Parameter               | Main Finding                             |
|-------------------------|------------------------------------------|
| Chronotype distribution | Intermediate type was most common        |
| Sleep quality           | 61.0% had poor sleep quality             |
| Chronotype and sleep    | Evening type had highest PSQI score      |
| Academic performance    | Highest in morning type                  |
| PSQI correlation        | $r = -0.472$ , $p < 0.001$               |
| MEQ correlation         | $r = 0.386$ , $p < 0.001$                |
| Regression model        | PSQI and MEQ were significant predictors |

Table 8 summarizes the major findings of the study in an easy-to-interpret format. The results indicate that intermediate chronotype was most common, but evening chronotype was associated with poorer sleep quality. Poor sleep quality was highly prevalent among students. Academic performance was better among morning-type students and those with good sleep quality. Correlation and regression analyses showed that PSQI and MEQ scores were important determinants of academic performance. This table may be used as an optional summary table if permitted by the journal.

## DISCUSSION

The present cross-sectional study assessed the relationship between chronotype, sleep quality and academic performance among 100 undergraduate medical students. The mean age of the participants was  $20.42 \pm 1.38$  years, with a slight female predominance. Most students belonged to the intermediate chronotype (57.0%), followed by evening type (25.0%) and morning type (18.0%). Poor sleep quality was observed in 61.0% of participants, indicating that sleep disturbance is common among medical students. The mean PSQI score was  $6.48 \pm 2.74$ , which was above the accepted cut-off for poor sleep quality. The present findings support the physiological view that sleep timing, circadian preference and sleep quality may influence learning capacity, attention and academic performance.

Chronotype represents the behavioural expression of the endogenous circadian rhythm and reflects individual preference for sleep and activity timing. Montaruli et al. explained that chronotype is closely related to biological rhythm, sleep-wake regulation, hormonal secretion and cognitive performance [11]. In the present study, intermediate chronotype was the most common pattern, which is expected in young adults. However, evening-type students showed poorer sleep quality, shorter sleep duration and lower academic performance compared with morning-type students. This may be due to circadian misalignment, delayed bedtime, increased screen exposure at night and difficulty adapting to early morning academic schedules.

In the present study, evening-type students had the highest PSQI score ( $8.12 \pm 2.78$ ), while morning-type students had the lowest PSQI score ( $4.72 \pm 1.86$ ). This finding indicates that eveningness was associated with poor sleep quality. Similar observations were reported by Gallego-Gómez et al., who found that poor sleep habits were associated with poor academic performance among university nursing students [12]. In the present study, sleep duration was also lowest among evening-type students, suggesting that late sleep timing may reduce total sleep time when students are required to attend early classes.

The present study showed that students with good sleep quality had significantly higher academic performance than those with poor sleep quality ( $77.18 \pm 7.62\%$  vs  $70.06 \pm 8.44\%$ ,  $p < 0.001$ ). Liu et al. reported that PSQI-based sleep quality scores were significantly associated with academic achievement and mental health among college students [13]. The present findings are consistent with this observation and suggest that sleep quality is not only a lifestyle factor but also an important physiological determinant of academic functioning. Poor sleep may impair attention, working memory, emotional stability and executive function, thereby reducing academic performance.

The correlation analysis showed a significant positive correlation between MEQ score and academic performance ( $r = 0.386$ ,  $p < 0.001$ ), indicating that greater morningness was associated with better academic scores. PSQI score showed a significant negative correlation with academic performance ( $r = -0.472$ ,  $p < 0.001$ ), indicating that poor sleep quality was associated with lower academic performance. Driller et al. also reported that questionnaire-derived sleep habits were related to academic achievement in first-year university students [14]. The present findings are in agreement with this study and highlight the role of healthy sleep timing and sleep hygiene in academic success.

In contrast, not all previous studies have found a direct relationship between sleep quality and academic performance. Jowkar et al. studied undergraduate clinical dental students and observed poor sleep quality and stress among participants, but sleep quality was not significantly associated with academic achievement [15]. Similarly, Yaghmour et al. found poor sleep quality among medical students but reported no statistically significant effect on GPA [16]. These differences may be due to variations in sample size, academic assessment methods, stress levels, curriculum pattern, examination timing and self-reported academic scores. In the present study, academic performance was assessed using recent internal examination percentage, which may have provided a more sensitive academic measure.

Multiple linear regression analysis in the present study showed that PSQI score, MEQ score, sleep duration and study hours were independent predictors of academic performance. PSQI score was the strongest negative predictor, while MEQ score and sleep duration were positive predictors. This suggests that academic performance is influenced not merely by the number of study hours but also by sleep quality and circadian alignment. Arastoo et al. reported that chronotype was significantly related to sleep quality and quality of life, although its direct association with academic performance was not significant [17]. The present study differs slightly by showing a significant association between chronotype and academic performance, possibly because sleep quality was also considered as a physiological mediator.

Recent evidence by Khaled et al. also showed that poor sleep quality is common among undergraduate medical students and may affect academic achievement and general health [18]. The present study supports this observation and emphasizes the need for sleep hygiene education among medical students. Since medical students are exposed to academic stress, late-night study habits and digital device use, early identification of poor sleep quality and evening chronotype may help prevent academic and health-related consequences.

The present study has some limitations. First, the study was cross-sectional; therefore, causality cannot be established. Second, sleep quality and chronotype were assessed using questionnaires, which may involve self-report bias. Third, confounding factors such as screen time, caffeine intake, physical activity, stress level and daytime sleepiness were not included. Fourth, the study was conducted in a single institution with a limited sample size. Despite these limitations, the study provides useful evidence that chronotype and sleep quality are significantly associated with academic performance among medical students.

## CONCLUSION

The present study concluded that poor sleep quality was common among undergraduate medical students. Evening chronotype was associated with poorer sleep quality, shorter sleep duration and lower academic performance. Morningness, better sleep quality, longer sleep duration and study hours were positively associated with academic performance. PSQI score and MEQ score were independent predictors of academic performance. These findings suggest that chronotype assessment and sleep quality screening may be useful in student health programs. Promoting sleep hygiene, regular sleep schedules and circadian rhythm awareness may improve both academic performance and overall physiological well-being.

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