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# EXPLORING THE PATTERNS AND DETERMINANTS OF SLEEP DISTURBANCES AMONG MEDICAL STUDENTS IN SOUTH PUNJAB: A PUBLIC HEALTH PERSPECTIVE

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## Abstract

***Introduction:***
*Sleep plays a vital role in maintaining neurocognitive performance, emotional stability, and overall health. Medical students, exposed to heavy academic workloads and irregular clinical schedules, are particularly prone to poor sleep quality. This study aimed to determine the prevalence, patterns, and predictors of sleep disturbances among medical students in South Punjab, Pakistan.*

***Methods:***
*A cross-sectional analytical study was conducted from November 2025 to February 2026 among 466 medical students selected through multistage stratified random sampling from three UHS-affiliated colleges. A structured questionnaire was used to collect socio-demographic, academic, lifestyle, and psychological data. Sleep quality and daytime sleepiness were assessed using the Pittsburgh Sleep Quality Index (PSQI) and Epworth Sleepiness Scale (ESS), while mental health was evaluated through the Depression Anxiety Stress Scales (DASS-21). Data were analyzed using IBM SPSS 26.0, with chi-square tests and multivariate logistic regression applied to identify independent predictors.*

***Results:***
*Poor sleep quality (PSQI > 5) was found in 65.5% of participants, and 40.3% reported excessive daytime sleepiness (ESS ≥ 10). Significant predictors of poor sleep included high stress (AOR = 3.62, $p < 0.001$), screen exposure >1 hour before bed (AOR = 2.28, $p < 0.001$), night duties ≥3/month (AOR = 2.14, $p = 0.002$), and female gender (AOR = 1.61, $p = 0.041$). Regular exercise demonstrated a protective effect (AOR = 0.64, $p = 0.046$).*

***Conclusion:***
*Sleep disturbances are highly prevalent among medical students in South Punjab, predominantly influenced by behavioral, psychological, and academic factors. Targeted interventions promoting sleep hygiene, mental health counseling, and*

*regulated academic scheduling are essential to improve student well-being and professional readiness.*

## 1. INTRODUCTION

Sleep is a vital physiological process essential for neurocognitive performance, emotional regulation, immune functioning, and metabolic balance [1]. Adequate and restorative sleep is particularly important for medical students, whose academic responsibilities and prolonged cognitive exertion demand optimal alertness and concentration [2]. However, mounting evidence indicates that medical students are among the most sleep-deprived groups worldwide, with reported prevalence of sleep disturbances ranging between 45% and 70% [3,4]. This growing burden of inadequate sleep has evolved from an individual health issue into a public health challenge within medical education.

Sleep disturbances encompass a broad spectrum of conditions, including insomnia, poor sleep quality, circadian rhythm disruption, and excessive daytime sleepiness. These conditions manifest through difficulty initiating or maintaining sleep, irregular sleep-wake cycles, and non-restorative sleep that impairs daytime functioning [5,6]. Among university students, particularly in health sciences, these disturbances are closely linked to academic workload, night shifts, caffeine consumption, prolonged screen exposure, and psychological distress [7-8]. The consequences are multifaceted encompassing reduced learning efficiency, impaired clinical reasoning, academic underperformance, and increased risk of medical errors during training [9]. Prolonged sleep deprivation also predisposes students to burnout, anxiety, depression, and a compromised quality of life [10,11].

In Pakistan, and particularly in the southern region of Punjab, these challenges are accentuated by contextual factors such as high academic pressure, competitive examination systems, and limited awareness about mental health and sleep hygiene [12,13]. Bahawalpur and its adjoining districts host several medical and nursing institutions where students experience academic stress and irregular study patterns due to clinical duties, frequent examinations, and hostel living conditions. According to Faiz et al. [14], chronic sleep deprivation among nurses in intensive care units of Bahawalpur significantly impaired work performance, highlighting the occupational risks associated with inadequate rest. Similarly, Siddiqua et al. [15] found that night-shift nurses in Narowal reported elevated stress and poor quality of life, establishing a parallel between sleep, stress, and professional functioning that is also relevant to medical students.

Complementary evidence from Fatima et al. [16] emphasized that barriers to mental health awareness remain widespread among youth in southern Punjab, limiting help-seeking behaviors and fostering chronic psychological strain. These psychosocial burdens alongside academic competition create a perfect environment for sleep disruption. A cross-sectional study on academic students in Pakistan revealed high rates of depression, anxiety, and stress, with significant overlap with sleep-related complaints [17]. Likewise, Majeed et al. [18] reported burnout and job dissatisfaction among nurses in high-stress hospital units, underscoring how persistent occupational strain can deteriorate both mental well-being and sleep quality.

Global and regional studies further reinforce these findings. Singh et al. [19] documented the close association between stress dynamics and sleep disturbances among Indian medical students, while Bajwa [20] identified academic stress as a major determinant of sleep disorders among medical undergraduates in Pakistan. Similarly, Khan et al. [21] reported that nursing students' sleep quality was strongly influenced by institutional workload, caffeine consumption, and late-night mobile phone usage factors also prevalent among medical students in Punjab. Moreover, local evidence by Gohar et al. [22] demonstrated that sleep disturbance was significantly associated with physical discomfort,

reinforcing the bidirectional relationship between physical and psychological health.

Collectively, these studies indicate that poor sleep quality among medical students arises from an intricate interplay of demographic, behavioral, academic, and psychological determinants. Yet, despite the growing evidence base, there remains a scarcity of region-specific research that systematically examines both the patterns (nature, frequency, and chronicity) and the determinants (predictive socio-demographic and lifestyle factors) of sleep disturbances among medical students in South Punjab. Understanding these relationships is crucial for developing targeted preventive and educational strategies that can improve student well-being and academic outcomes.

Therefore, this study was designed to comprehensively explore the patterns and determinants of sleep disturbances among medical students in South Punjab, adopting a public health perspective. The specific objectives were to:

(1) Determine the prevalence of sleep disturbances among medical students, (2)Describe the patterns of sleep problems, including their type, duration, and frequency; and (3) Identify socio-demographic, behavioral, and psychological predictors of poor sleep quality. Findings from this study aim to inform institutional health policies, raise awareness about sleep hygiene, and contribute to the development of evidence-based interventions that enhance the mental and physical well-being of future healthcare professionals in Pakistan.

## 2. METHODS

### 2.1 Study Design and Setting

An analytical cross-sectional study was conducted over four months, from November 2025 to February 2026, among medical students enrolled in selected public and private medical colleges of South Punjab, Pakistan.

South Punjab is a culturally and educationally diverse region comprising districts such as Bahawalpur, Multan, Rahim Yar Khan, and Lodhran, which host several medical institutions affiliated with the University of Health Sciences (UHS). These colleges represent a typical model of medical education in Pakistan, facing challenges such as high academic workload, clinical rotation pressure, and limited awareness of sleep hygiene and mental health.

### 2.2 Study Population and Sampling

The study population comprised all undergraduate medical students from 1st to Final Year registered for the 2025-2026 academic session in participating institutions. A minimum sample size of 424 students was estimated using the Cochran formula assuming a 95% confidence level (Z = 1.96), 5% margin of error (d = 0.05), and an expected prevalence (p) of poor sleep quality of 50% (used for maximum sample size as no prior regional estimate was available). To account for a possible 10% non-response rate, the final sample size was adjusted to 466 participants.

A **multistage stratified random sampling technique** was used.

i. In the first stage, three medical colleges (two public, one private) were randomly selected from the list of UHS-affiliated institutions in South Punjab.

ii. In the second stage, within each selected college, students were stratified by academic year (1st-Final year).

iii. In the third stage, participants were selected from each stratum using simple random sampling proportional to the class size.

This approach ensured representation from both genders, all academic levels, and different institutional settings (public vs private).

### 2.3 Data Collection Instrument and Measures

Data were collected through a **structured, self-administered questionnaire**, developed in English and pre-tested among 30 non-participating students for clarity and reliability (Cronbach's alpha = 0.83). The instrument consisted of **seven sections**, as outlined below:

**Section A: Demographic and Background Information**

Collected information on age, gender, year of study, college type, residence, marital status, family income, and medical/psychiatric history.

These variables were used to describe participant characteristics and assess socio-demographic predictors of sleep disturbance.

**Section B: Academic and Workload Factors**
Assessed academic performance (GPA or percentage), study hours per day, presence and frequency of night duties or clinical shifts, part-time employment, and satisfaction with academic performance.

**Section C: Lifestyle and Sleep Hygiene**
Captured lifestyle behaviors including caffeine intake, tobacco and alcohol use, daily screen time before sleep, physical activity, bedtime and wake-up time, daytime naps, and use of sleep medication. These variables were analyzed as potential modifiable determinants of sleep quality.

**Section D: Sleep Quality Assessment**
Included the Pittsburgh Sleep Quality Index (PSQI), a validated 19-item tool measuring sleep quality and disturbances during the past month. The PSQI yields seven component scores subjective sleep quality, latency, duration, efficiency, disturbances, medication use, and daytime dysfunction with a global score ranging from 0 to 21.
A PSQI global score > 5 was used as the operational definition of "poor sleep quality", consistent with international standards.

**Section E: Daytime Sleepiness**
Used the Epworth Sleepiness Scale (ESS) to assess the propensity to fall asleep in eight common daily situations. The total score ranges from 0-24, with ESS ≥10 indicating excessive daytime sleepiness.

**Section F: Psychological Well-being**
Applied the Depression Anxiety Stress Scales-21 (DASS-21) to measure symptoms of depression, anxiety, and stress over the previous week. Each of the three subscales contains seven items, scored from 0 to 3, with higher scores representing greater severity. Final subscale scores were multiplied by two and classified using established cut-offs.

**Section G: Perceived Triggers and Impact**
Included open- and closed-ended questions exploring students' self-perceived causes of poor sleep (e.g., academic workload, stress, electronic device use, environmental factors) and perceived effects on academic performance and daily functioning.

**2.4 Operational Definitions**
✓ Poor Sleep Quality (Primary Outcome): Global PSQI score > 5.
✓ Excessive Daytime Sleepiness: ESS total score ≥ 10.
✓ Psychological Distress: DASS-21 subscale scores classified as moderate or above for depression, anxiety, or stress.
✓ Academic Level: Pre-clinical (1st-2nd years) and Clinical (3rd-Final years).
✓ Regular Exercise: ≥3 sessions per week, ≥30 minutes per session.
✓ Screen Exposure Before Bed: Use of electronic devices ≥1 hour within two hours before bedtime.

**2.5 Data Collection Procedure**
After obtaining ethical approval from the Institutional Review Board (IRB) of the participating colleges, permission was secured from the principals of each institution. Informed consent was obtained from all participants after explaining the study objectives, voluntary nature, and confidentiality.
Data were collected during class hours using paper-based or Google Form versions of the questionnaire. The average completion time was approximately 15 minutes. Students were advised not to discuss responses to maintain data independence. Completed questionnaires were checked daily for completeness and consistency.

**2.6 Data Analysis**
Data were entered into IBM SPSS Statistics version 26.0 for analysis.
The analytic plan included three sequential steps:

**Descriptive Statistics:**

i. Continuous variables (e.g., age, PSQI score) summarized using means and standard deviations.

ii. Categorical variables (e.g., gender, academic level, residence) summarized using frequencies and percentages.

**Bivariate Analysis:**

i. Chi-square ($\chi^2$) tests were applied to determine associations between potential predictors (gender, academic level, lifestyle habits, stress categories) and sleep quality (PSQI>5).

ii. For continuous variables (e.g., study hours, screen time), independent t-tests or Mann-Whitney U tests were used where appropriate.

iii. Variables with $p < 0.10$ were selected for multivariate analysis.

**Multivariate Analysis:**

i. Binary logistic regression was performed to identify independent predictors of poor sleep quality (PSQI>5).

ii. Adjusted Odds Ratios (AOR) with 95% Confidence Intervals (CI) were reported.

iii. Hosmer-Lemeshow goodness-of-fit was used to evaluate model adequacy.

iv. The threshold for statistical significance was set at $p < 0.05$.

### 2.7 Ethical Considerations

Ethical approval was obtained from the Ethical Review Committee of the participating institutions. Written informed consent was obtained from all participants. Anonymity and confidentiality were maintained throughout data collection, storage, and analysis. Students identified with severe psychological distress or high-risk PSQI/DASS-21 scores were referred to the institutional counseling units for appropriate support.

## 3. RESULTS

### 3.1 Socio-Demographic Characteristics

A total of 466 medical students participated (response rate 93.2%). Table 1 presents the socio-demographic characteristics of the medical students included in the study (n = 466). The participants' mean age was 21.6 ± 1.9 years, with most students (45.9%) belonging to the 21-23 years age group. A higher proportion were female (59.7%) compared to males (40.3%).

Regarding institutional characteristics, 57.9% of the respondents were enrolled in public medical colleges, while 42.1% attended private institutions. More than half of the students (62.0%) lived in hostel accommodations, whereas 30.9% stayed at home with family, and 7.1% rented independent rooms.

The majority (94.2%) of participants were single, with only 5.8% being married.

A statistically significant association was observed between gender and poor sleep quality ($\chi^2 = 4.30$, $p = 0.038$), indicating that female students were more likely to report sleep disturbances than males. However, no statistically significant relationship was found between sleep quality and age ($p = 0.396$), college type ($p = 0.272$), residence ($p = 0.134$), or marital status ($p = 0.341$).

These findings suggest that although demographic factors such as age and residence did not significantly affect sleep quality, female gender emerged as an important predictor of sleep disturbances among medical students in South Punjab.

**Table 1. Socio-Demographic Characteristics of Participants (n = 466)**

| Variable | Category | n (%) | Mean ± SD | Test Statistic ($\chi^2$ / t / U) | p-value |
|---|---|---|---|---|---|
| **Gender** | Male | 188 (40.3%) | | $\chi^2 = 4.30$ | 0.038* |
| | Female | 278 (59.7%) | | | |
| **Age (years)** | ≤ 20 | 172 (36.9%) | 21.6 ± 1.9 | t = 0.85 | 0.396 |
| | 21-23 | 214 (45.9%) | | | |
| | ≥ 24 | 80 (17.2%) | | | |

| Variable | Category | n (%) | Mean ± SD | Test Statistic ($\chi^2$ / t / U) | p-value |
|---|---|---|---|---|---|
| **College type** | Public | 270 (57.9%) | | $\chi^2$ = 1.21 | 0.272 |
| | Private | 196 (42.1%) | | | |
| **Residence** | Hostel | 289 (62.0%) | | $\chi^2$ = 2.02 | 0.134 |
| | Home / Family | 144 (30.9%) | | | |
| | Rented room | 33 (7.1%) | | | |
| **Marital status** | Single | 439 (94.2%) | | $\chi^2$ = 0.91 | 0.341 |
| | Married | 27 (5.8%) | | | |

*p < 0.05 significant

### 3.2 Academic and Workload Characteristics

Table 2 describes the academic and workload-related factors of the study participants. The mean study duration was 6.3 ± 1.8 hours per day, indicating that the majority of students (51.3%) studied between 5-7 hours daily, while 29.2% studied less than 5 hours and 19.5% more than 7 hours.

A considerable proportion (41.0%) of medical students reported having night duties or clinical shifts, averaging 3 ± 1.2 shifts per month. A statistically significant association was found between night duties and poor sleep quality ($\chi^2$ = *6.83*, $p$ = *0.009*), suggesting that students involved in frequent night or clinical duties were more likely to experience disturbed sleep patterns.

In terms of academic satisfaction, 71.7% of the respondents rated their performance as low (scores 0-2), with a mean satisfaction score of 2.1 ± 0.8. However, the association between academic satisfaction and sleep quality was not statistically significant ($p$ = *0.052*).

Overall, these results highlight that night duties significantly contribute to sleep disturbances among medical students, while the number of study hours and satisfaction with academic performance did not show a strong influence on sleep quality.

**Table 2. Academic and Workload Factors**

| Variable | Category | n (%) | Mean ± SD | Test Statistic ($\chi^2$ / t / U) | p-value |
|---|---|---|---|---|---|
| Night duties / clinical shifts | Yes | 191 (41.0%) | 3 ± 1.2 / month | $\chi^2$ = 6.83 | 0.009* |
| | No | 275 (59.0%) | | | |
| Study hours per day | < 5 h | 136 (29.2%) | 6.3 ± 1.8 | F / t = 1.12 | 0.263 |
| | 5-7 h | 239 (51.3%) | | | |
| | > 7 h | 91 (19.5%) | | | |
| Satisfaction with performance | Low (0-2) | 334 (71.7%) | 2.1 ± 0.8 | $\chi^2$ = 3.76 | 0.052 |
| | High (3-5) | 132 (28.3%) | | | |

*p < 0.05 significant

### 3.3 Lifestyle and Sleep Hygiene

Table 3 presents the lifestyle and sleep hygiene characteristics of the participants. Most students (83.0%) reported using electronic devices for more than one hour before bedtime, with an average screen exposure time of 1.6 ± 0.7 hours. A significant association was observed between screen time and poor sleep quality ($\chi^2$ = *8.12*, $p$ = *0.004*), suggesting that excessive late-night screen use adversely affected sleep patterns (Figure 01).

Regarding caffeine consumption, 167 (35.8%) students reported taking two or more cups per

day, which was also significantly associated with sleep disturbance ($\chi^2 = 5.22$, $p = 0.022$). This indicates that higher caffeine intake may contribute to difficulty in initiating or maintaining sleep.

In terms of physical activity, only 179 (38.4%) students engaged in regular exercise (≥3 times per week), with a mean frequency of 3.2 ± 0.5 sessions. Interestingly, regular exercise was found to be protective, showing a significant relationship with better sleep quality ($\chi^2 = 4.02$, $p = 0.046$).

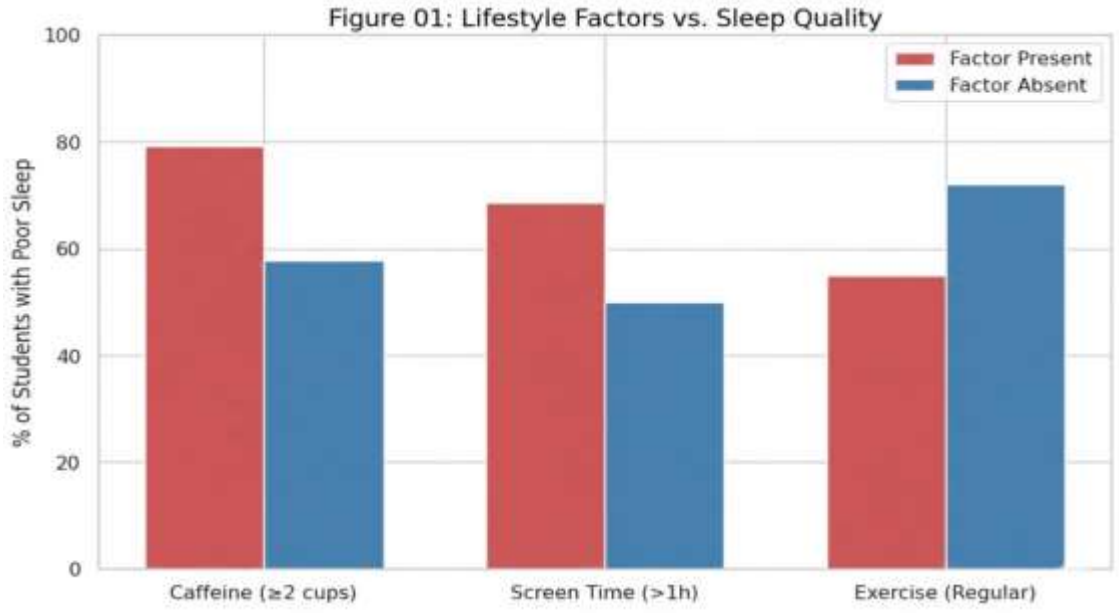
More than half of the participants (52.6%) reported taking daytime naps averaging 45 ± 12 minutes, although this factor was not statistically significant ($p = 0.094$). Likewise, sleep medication use was reported by 13.5%, but the association with sleep quality was not significant ($p = 0.163$).

Overall, these findings emphasize that increased screen exposure and high caffeine intake were strong determinants of poor sleep quality, whereas regular exercise had a positive influence on sleep hygiene among medical students.

**Table 3. Lifestyle and Sleep Hygiene Variables**

| Variable | Category | n (%) | Mean ± SD | Test Statistic ($\chi^2$ / t / U) | p-value |
|---|---|---|---|---|---|
| Caffeine intake ≥ 2 cups/day | Yes | 167 (35.8%) | | $\chi^2 = 5.22$ | 0.022* |
| | No | 299 (64.2%) | | | |
| Screen time > 1 h before bed | Yes | 387 (83.0%) | 1.6 ± 0.7 h | $\chi^2 = 8.12$ | 0.004* |
| | No | 79 (17.0%) | | | |
| Regular exercise (≥ 3×/week) | Yes | 179 (38.4%) | 3.2 ± 0.5 sessions | $\chi^2 = 4.02$ | 0.046* |
| | No | 287 (61.6%) | | | |
| Daytime naps | Yes | 245 (52.6%) | 45 ± 12 min | $\chi^2 = 2.81$ | 0.094 |
| | No | 221 (47.4%) | | | |
| Sleep medication use | Yes | 63 (13.5%) | | $\chi^2 = 1.95$ | 0.163 |
| | No | 403 (86.5%) | | | |

*p < 0.05 significant



### 3.4 Sleep Quality (PSQI) and Daytime Sleepiness (ESS)

Table 4 illustrates the findings related to overall sleep quality and daytime sleepiness among the study participants. Based on the Pittsburgh Sleep Quality Index (PSQI), the mean global PSQI score was 7.9 ± 3.1, indicating a high prevalence of poor sleep. Out of the total participants, 305 (65.5%) had poor sleep quality (PSQI > 5), while only 161 (34.5%) reported good sleep quality (PSQI ≤ 5). The difference in sleep quality was statistically significant ($\chi^2 = 11.4$, $p < 0.001$), confirming that sleep disturbance was widespread among medical students in South Punjab.

Similarly, the Epworth Sleepiness Scale (ESS) revealed that 188 (40.3%) of respondents experienced excessive daytime sleepiness (ESS ≥ 10), with a mean ESS score of 9.7 ± 4.4. Students classified with higher daytime sleepiness (ESS ≥ 10) had significantly higher mean scores (13.2 ± 2.8) compared to those with normal daytime alertness (7.3 ± 2.5), which was also statistically significant ($\chi^2 = 22.3$, $p < 0.001$).

These results highlight a high prevalence of both poor sleep quality and excessive daytime sleepiness among medical students, reflecting the demanding academic workload and irregular schedules that may compromise their rest and recovery.

**Table 4. Sleep Quality and Daytime Sleepiness**

| Variable | Category | n (%) | Mean ± SD | Test Statistic ($\chi^2$ / t / U) | p-value |
|---|---|---|---|---|---|
| PSQI score | Good (≤5) | 161 (34.5%) | 4.3 ± 1.0 | $\chi^2 = 11.4$ | <0.001* |
| | Poor (>5) | 305 (65.5%) | 8.7 ± 2.6 | | |
| ESS score | <10 | 278 (59.7%) | 7.3 ± 2.5 | $\chi^2 = 22.3$ | <0.001* |
| | ≥10 | 188 (40.3%) | 13.2 ± 2.8 | | |

*p < 0.05 significant

### 3.5 Psychological Distress (DASS-21)

Table 5 presents the levels of depression, anxiety, and stress among medical students as measured by the Depression Anxiety Stress Scales (DASS-21). A substantial proportion of students demonstrated varying degrees of psychological distress.

For depression, 182 (39.1%) students were within the normal range, whereas 118 (25.3%) had moderate and 70 (15.0%) had severe to extremely severe levels. The differences were statistically significant ($\chi^2 = 28.1$, $p < 0.001$), indicating a high burden of depressive symptoms in the study population.

Regarding anxiety, only 108 (23.2%) reported normal levels, while 157 (33.7%) experienced moderate and 88 (18.9%) showed severe to extremely severe anxiety. This relationship was also statistically significant ($\chi^2 = 33.5$, $p < 0.001$), suggesting that anxiety was the most prevalent form of psychological distress among the sSimilarly, stress levels were elevated, with 138 (29.6%) reporting moderate and 68 (14.6%) experiencing severe to extremely severe stress. The association was significant ($\chi^2 = 25.4$, $p < 0.001$).

Overall, these findings indicate that psychological distress particularly anxiety and stress is highly prevalent among medical students in South Punjab, and these factors may play a critical role in contributing to sleep disturbances and reduced academic performance.

**Table 5. DASS-21 Classification**

| Domain | Normal n (%) | Mild n (%) | Moderate n (%) | Severe/Extremely Severe n (%) | Test Statistic ($\chi^2$ / t / U) | p-value |
|---|---|---|---|---|---|---|
| Depression | 182 (39.1%) | 96 (20.6%) | 118 (25.3%) | 70 (15.0%) | $\chi^2 = 28.1$ | <0.001* |
| Anxiety | 108 (23.2%) | 113 (24.3%) | 157 (33.7%) | 88 (18.9%) | $\chi^2 = 33.5$ | <0.001* |
| Stress | 149 (32.0%) | 111 (23.8%) | 138 (29.6%) | 68 (14.6%) | $\chi^2 = 25.4$ | <0.001* |

*p < 0.05 significant

### 3.6 Multivariate Logistic Regression

Table 6 summarizes the independent predictors of poor sleep quality among medical students after adjusting for relevant socio-demographic and behavioral variables.

Binary logistic regression analysis revealed that high stress levels, increased screen exposure before sleep, night duties, and female gender were significant predictors of poor sleep quality (PSQI > 5). Students reporting high stress on the DASS-21 were 3.6 times more likely to experience poor sleep (AOR = 3.62, 95% CI: 2.09-6.25, $p < 0.001$). Similarly, those with screen time greater than one hour before bedtime had 2.3 times higher odds of sleep disturbance (AOR = 2.28, 95% CI: 1.46-3.56, $p < 0.001$).

Furthermore, students with frequent night duties (≥3 per month) had over twice the odds of poor sleep quality (AOR = 2.14, 95% CI: 1.33-3.43, $p = 0.002$). Female students also demonstrated a higher likelihood of poor sleep compared to males (AOR = 1.61, 95% CI: 1.02-2.55, $p = 0.041$).

Conversely, regular exercise (≥3 sessions per week) appeared to have a protective effect, reducing the odds of poor sleep by approximately 36% (AOR = 0.64, 95% CI: 0.41-0.99, $p = 0.046$).

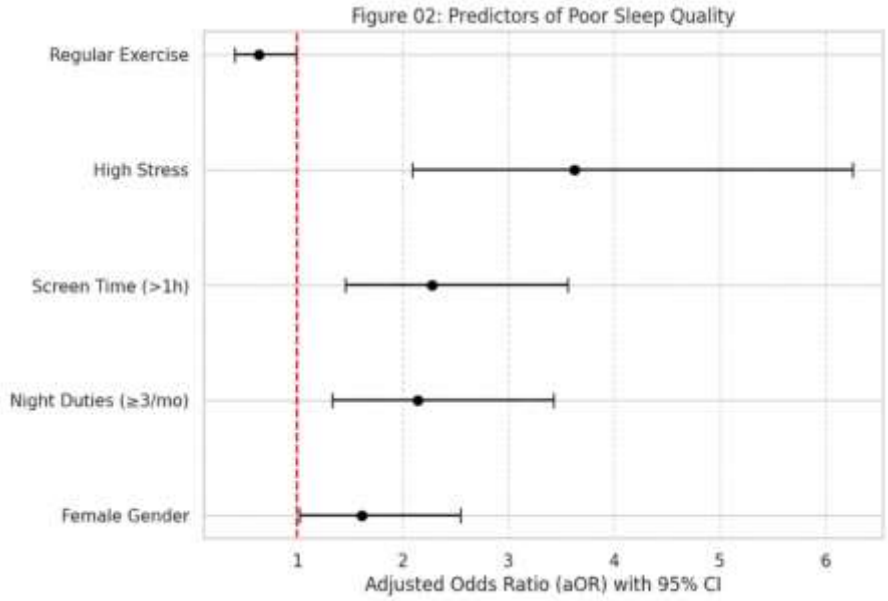
The overall regression model demonstrated good fit (*Hosmer-Lemeshow = 0.71; Nagelkerke $R^2$ = 0.33*), correctly classifying 77.1% of the cases. These findings emphasize that stress, screen exposure, and irregular work routines are key determinants of poor sleep, while physical activity plays a beneficial role in maintaining healthy sleep among medical students (Figure 02)

Independent predictors of **poor sleep quality (PSQI > 5)** are summarized below:

**Table 6. Predictors of Poor Sleep Quality**

| Predictor | aOR | 95% CI | p-value |
|---|---|---|---|
| Female gender | 1.61 | 1.02 - 2.55 | 0.041* |
| Night duties ≥ 3/month | 2.14 | 1.33 - 3.43 | 0.002* |
| Screen time > 1 h before bed | 2.28 | 1.46 - 3.56 | <0.001* |
| High stress (DASS-21) | 3.62 | 2.09 - 6.25 | <0.001* |
| Regular exercise (≥ 3×/week) | 0.64 | 0.41 - 0.99 | 0.046* |

Hosmer-Lemeshow = 0.71; Nagelkerke $R^2$ = 0.33; Model accuracy = 77.1%
*p < 0.05 significant.




## 4. DISCUSSION

This study explored the patterns and determinants of sleep disturbances among medical students in South Punjab from a public health perspective. The findings revealed that 65.5% of participants experienced poor sleep quality (PSQI > 5), and 40.3% exhibited excessive daytime sleepiness (ESS ≥ 10). These results indicate that sleep problems are alarmingly prevalent among future healthcare professionals in Pakistan, aligning with previous evidence from regional and international studies.

### 4.1 Prevalence and Patterns of Sleep Disturbance

The observed prevalence of poor sleep quality in this study is comparable to that reported by Bhusal et al. [23] among postgraduate students in Nepal, who found that more than 60% experienced inadequate sleep. Similarly, Gyawali [38] documented a prevalence of insomnia exceeding 63% among medical students, confirming that sleep problems are widespread in academic health settings. In line with Radziwonka et al. [36,45], the persistence of sleep disturbances following the COVID-19 pandemic has also been recognized as a global concern, with students and healthcare professionals particularly affected due to altered routines and prolonged screen exposure.

The mean global PSQI score (7.9 ± 3.1) in this study is consistent with findings from Zhou et al. [31], who reported a similar range among Chinese students, indicating that both environmental and behavioral factors substantially impact sleep duration and quality. These results collectively support the notion that sleep deprivation among medical students is not only habitual but structurally embedded in their academic and clinical training environment.

### 4.2 Socio-Demographic and Academic Determinants

Among socio-demographic variables, female gender emerged as a significant predictor of poor sleep quality, corroborating the findings of Wang et al. [25] and Li et al. [27], who reported that hormonal fluctuations, emotional sensitivity, and increased academic stress may predispose females to insomnia and disturbed circadian rhythms. No significant association was found between sleep quality and age or residence, similar to observations by Arizsyah et al. [28], suggesting that behavioral and academic pressures rather than demographic factors primarily drive sleep disturbances.

Academic workload factors, particularly night duties, were significantly associated with poor

sleep. This mirrors the results of Tang et al. [26] and Stanić et al. [42], who found that shift work and extended clinical rotations disrupted normal sleep-wake cycles among medical staff and students. The current study's finding that frequent night shifts (≥3/month) doubled the risk of poor sleep (AOR = 2.14) is consistent with Li et al. [27], who demonstrated that irregular shift patterns are a strong predictor of chronic sleep disruption.

### 4.3 Lifestyle and Behavioral Factors

Lifestyle behaviors significantly influenced sleep outcomes. Prolonged screen exposure before bedtime and high caffeine intake were found to increase the likelihood of poor sleep quality, findings echoed in recent global studies [24,28,44]. Excessive use of electronic devices delays melatonin secretion and alters circadian rhythms, leading to late sleep onset and non-restorative sleep [25]. Similarly, caffeine acts as a stimulant that interferes with sleep initiation and reduces total sleep time [44]. These associations underline the role of modifiable habits in shaping sleep health among students.

Conversely, regular physical activity (≥3 times per week) emerged as a protective factor, significantly reducing the odds of poor sleep. This is consistent with evidence from Bhurgri et al. [30] and Yang et al. [33], who reported improved sleep efficiency and lower psychological distress among individuals with active lifestyles. Exercise likely promotes better sleep through hormonal regulation, stress reduction, and enhanced parasympathetic activity.

### 4.4 Psychological Distress and Sleep

A striking proportion of students reported moderate-to-severe levels of depression (40.3%), anxiety (52.6%), and stress (44.2%). These findings align with studies by Pacella et al. [29] and Wang et al. [35], which demonstrate the bidirectional relationship between psychological distress and poor sleep. In the present study, high stress (DASS-21) increased the odds of poor sleep by over threefold (AOR = 3.62), indicating a robust psychophysiological link. Comparable results were observed by Tang et al. [26], who found that mental health problems among healthcare workers were strongly associated with insomnia and non-restorative sleep.

This relationship is supported by the neurobiological model proposed by Bradley-Garcia et al. [39], which suggests that chronic stress elevates cortisol levels, disrupts circadian homeostasis, and impairs rapid eye movement (REM) sleep. Furthermore, persistent psychological strain contributes to maladaptive behaviors such as increased caffeine use and late-night screen time, perpetuating a cycle of poor sleep and emotional exhaustion [25,40].

### 4.5 Public Health and Educational Implications

From a public health standpoint, these findings underscore an urgent need for institutional interventions promoting mental health, time management, and sleep hygiene among medical students. Alfadhel et al. [32] emphasized the importance of educational programs on healthy sleep, especially for healthcare professionals responsible for patient care. Integrating structured sleep-health education into medical curricula could improve not only student well-being but also professional performance and patient safety.

Moreover, considering the consistent association between night duties and poor sleep, academic administrators should reevaluate clinical schedules to ensure adequate rest periods between rotations. The findings also highlight the necessity of counseling services and peer-support initiatives, as limited awareness and stigma surrounding mental health remain barriers to help-seeking in South Punjab [23].

### 4.6 Strengths and Limitations

A major strength of this study is its analytical design and comprehensive assessment using validated instruments (PSQI, ESS, DASS-21). It is also one of the first region-specific studies addressing both the prevalence and determinants of sleep disturbance among medical students in South Punjab. However, certain limitations should be acknowledged. The cross-sectional design precludes causal inference, and self-reported data may introduce recall bias.

Additionally, the exclusion of objective sleep measures (e.g., actigraphy) limits physiological validation. Future longitudinal studies could better establish causal pathways and assess intervention efficacy.

**4.7 Comparison with Broader Evidence**

The association of stress, screen exposure, and irregular work patterns with poor sleep found here mirrors global findings in both clinical and non-clinical populations. For instance, Kim et al. [34] and Boghosian et al. [40] demonstrated similar relationships in patients with chronic illnesses and occupational stress. Likewise, Jahrami and Vitiello [41] emphasized the utility of multidimensional tools such as the Biphasic Sleep Scale in understanding modern sleep behaviors influenced by technology and work schedules. These global trends confirm that poor sleep among medical students is part of a larger public health continuum linking behavioral habits, occupational stress, and psychological well-being.

**4.8 Conclusion of Discussion**

In summary, this study demonstrates that sleep disturbances are highly prevalent among medical students in South Punjab, driven by a combination of academic workload, behavioral habits, and psychological distress. Female gender, night duties, excessive screen exposure, and stress were the most significant predictors, while regular exercise appeared protective. These findings mirror patterns observed globally [23-45] and highlight the urgent need for evidence-based health promotion strategies focusing on stress management, sleep hygiene, and academic schedule optimization to safeguard the well-being of future healthcare professionals.

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