

To Study the Effect of Sleep Deprivation on the Academic Performance and Cognitive Behaviour on Medical Students of Jammu Region

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ABSTRACT

Background: Sleep deprivation is widespread among undergraduate medical students and has been implicated in impaired cognition and poorer academic outcomes, yet the magnitude of this relationship varies across populations. Region-specific data from North India, including the Jammu region, have been lacking. **Aim:** To assess the effect of sleep deprivation on academic performance and on cognitive function among undergraduate medical students. **Methods:** This cross-sectional study was conducted in the Department of Physiology, Government Medical College (GMC), Jammu, over one year (2021-2022) on 179 consenting medical students. Sleep quality and duration were assessed using the Pittsburgh Sleep Quality Index (PSQI), and cognitive performance using the Mini-Mental State Examination (MMSE). Academic performance was graded from internal assessment marks (good $\geq 50\%$, poor $< 50\%$). Data were analysed in IBM SPSS Statistics-26 using the chi-square test and Pearson correlation, with $p < 0.05$ taken as significant. **Results:** The mean age of participants was 19.35 ± 0.93 years; 51.4% were male and 48.6% female. The mean PSQI score was 6.43 ± 2.86 and the mean MMSE score was 27.40 ± 1.96 . Poor sleep quality (PSQI ≥ 5) was present in 76.5% of students, while 93.9% had normal cognition on MMSE. Neither sleep quality nor sleep difficulty showed a statistically significant association with academic performance ($p = 0.292$ and $p = 0.819$, respectively) or with cognition ($p = 0.299$ and $p = 0.205$, respectively). Pearson correlation showed weak negative correlations of PSQI score with cognition ($r = -0.039$, $p = 0.601$) and with academic performance ($r = -0.066$, $p = 0.384$). The odds ratio for good academic performance among students with good sleep quality was 1.97 (95% CI 0.55-7.03), and the odds ratio for normal cognition among students with good sleep quality was 0.512 (95% CI 0.142-1.841). **Conclusion:** Poor sleep quality was highly prevalent among the medical students studied, but no statistically significant association with academic performance or cognitive function was demonstrated in this cohort. Given the consistent adverse associations reported in the wider literature, institution-level screening and sleep-hygiene education remain warranted.

Keywords: Sleep deprivation; Pittsburgh Sleep Quality Index; Mini-Mental State Examination; academic performance; cognition; medical students.

INTRODUCTION

Sleep is classically described as a state of altered consciousness from which an individual can be aroused by sensory or other stimuli, and it is organised into two principal types that alternate through the night: rapid eye movement (REM) sleep and non-REM (NREM), or slow-wave, sleep. REM sleep occupies approximately one-quarter of total sleep time in young adults and recurs in cycles of about ninety minutes; it is not physiologically restful and is closely linked to vivid dreaming, whereas NREM sleep constitutes the

greater part of the night and provides the deep, restorative sleep that predominates in the first hours after sleep onset.¹

Sleep is a fundamental biological requirement for maintaining physical and psychological health, and although individual requirements vary, most healthy adults need between seven and eight hours of sleep each night to function optimally.² Sleep of adequate quality and duration is essential for memory consolidation and learning; it supports concentration, higher cognitive functions, sensorimotor integration,

and information processing.³ During sleep, the brain consolidates newly acquired information and integrates it into pre-existing knowledge networks for long-term storage, while simultaneously restoring the capacity for further learning; both nocturnal and daytime sleep episodes of varying duration have been shown to benefit memory processing.⁴ At a cellular level, sleep is thought to orchestrate a global downscaling of non-essential synaptic connections while selectively strengthening task-relevant synapses; long-term potentiation, a key substrate of synaptic plasticity, is facilitated by regular sleep and attenuated after prolonged wakefulness.⁵ Sleep deprivation, whether acute or chronic, is consistently associated with measurable decrements in cognitive performance, including attention, working memory and executive function.⁶ Neuroimaging studies further indicate that sleep loss alters task-associated cerebral blood flow and reduces cortical neurovascular coupling, providing a physiological correlate for the cognitive impairment observed after sleep restriction.⁷

Sleep disorder refers to a persistent alteration in an individual's usual sleep pattern; more than 30% of the general population is estimated to experience some form of sleep disruption arising from lifestyle, environmental, or medical factors, broadly manifesting as an inability to obtain sufficient sleep, failure to maintain sleep continuity, or abnormal events occurring during sleep.⁸ Sleep deprivation itself has been defined as obtaining inadequate sleep to sustain adequate daytime alertness.⁹ Sleep deprivation impairs cognitive performance by disrupting the brain regions that govern higher-order functions such as language and creativity,¹⁰ and even a single night of inadequate sleep can compromise elementary aspects of cognition, including alertness, sustained attention, and psychomotor vigilance. Cognitive control - the capacity to switch flexibly between rule sets and to filter out irrelevant or distracting information - is particularly vulnerable to sleep loss, a deficit with obvious implications for tasks demanding divided attention, such as driving.¹¹ Investigations among military personnel have quantified this effect, reporting that a single night of sleep deprivation reduces cognitive performance by 30-40%, while two consecutive nights of sleep loss can produce declines of 60-70%.¹² More broadly, prolonged wakefulness is associated with a progressive deterioration of thought processes and, in extreme cases, abnormal behaviour or irritability, underscoring the role of sleep in restoring both the overall level and the internal balance of central nervous system activity.¹ Sleep deprivation is widespread among adolescents and young adults. Survey data indicate that a substantial majority of students obtain fewer than eight hours of sleep on school nights, with older students reporting the shortest sleep durations; because subjective reports tend to overestimate sleep duration relative to

objective measures such as actigraphy, the true prevalence of sleep deprivation in this population may be even greater than survey-based estimates suggest.¹³ Insufficient sleep in this age group has also been linked to poorer mood, impaired emotional regulation, and adverse changes in appetite-regulating hormones such as leptin and ghrelin, which may in turn contribute to weight gain.¹³ Medical education is widely regarded as one of the most demanding pathways in higher learning, and poor sleep quality is correspondingly common among medical students. A systematic review and meta-analysis estimated that more than half of medical students worldwide experience poor sleep quality,¹⁴ and comparable findings have been reported across diverse educational and cultural settings, confirming that disturbed sleep among medical trainees is a global phenomenon rather than one confined to a particular region or curriculum.¹⁵ Indeed, the prevalence of sleep deprivation among medical students has been reported to be roughly twice that of the general population, a disparity attributed to the unique combination of academic and clinical demands placed on this group.¹⁶ Medical students are particularly vulnerable to sleep disruption because demanding academic and clinical schedules coincide with lifestyle changes such as relocation away from family, unfamiliar or inadequate accommodation, and a tendency to sacrifice sleep for additional study time, since sleep is often not regarded as a priority relative to academic obligations.¹⁷ When students are sleep deprived, the resulting disruption of normal sleep architecture impairs the ability to concentrate, and has been associated with lower grade point averages, an increased risk of academic failure, compromised learning, and impaired mood.¹⁸ Because of the well-established relationship between sleep and mental health, and the recognised potential for the academic demands of medical training to generate significant stress, sleep disturbance in undergraduate medical students has attracted particular research interest; studies conducted in a range of countries have consistently found that both the academic performance and general health status of medical students are influenced by sleep deprivation.¹⁹ Despite this global body of evidence, no comparable study evaluating the relationship between sleep deprivation, academic performance and cognitive function had previously been undertaken among medical students in the Jammu region of North India. The present study was therefore designed to address this gap and to generate locally relevant evidence that could inform strategies to safeguard the cognitive skills and academic performance of medical students in this setting.

Aims and Objectives

1. To assess the effect of sleep deprivation on academic performance among undergraduate medical students.

2. To assess the effect of sleep deprivation on cognitive function among undergraduate medical students.

MATERIALS AND METHODS

The present study was conducted in the Department of Physiology, Government Medical College (GMC), Jammu, over a period of one year (2021-2022). Institutional Ethical Committee approval was obtained from Government Medical College, Jammu (IEC/GMC/2022/871, dated 10 February 2022), and written informed consent was obtained from every participant prior to enrolment.

Study population

A total of 179 undergraduate medical students of either sex, enrolled at GMC, Jammu, were recruited for the study.

Inclusion Criteria

Healthy male and female medical students of GMC, Jammu, who provided informed consent for participation.

Exclusion Criteria

Students were excluded if they had a diagnosed psychiatric illness; a history of any chronic disease; were receiving psychotropic medication, including antipsychotics, antidepressants or sedatives; or declined to give consent.

Data collection

Following a detailed explanation of the purpose and methodology of the study, each participant was interviewed individually by the investigator. Demographic details (age, gender, and place of residence), relevant past or present medical history, and smoking habits were recorded on a pre-designed proforma. Internal assessment marks for each student were compiled to evaluate academic performance, which was graded as “poor” for a score of <50% and “good” for a score of ≥50%.

Assessment of sleep quality and duration:

Sleep quality and duration were assessed using the Pittsburgh Sleep Quality Index (PSQI).²⁰ The PSQI is

a self-administered, validated questionnaire comprising 19 self-rated items grouped into seven components: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbance, use of sleep medication, and daytime dysfunction. Each component is scored on a 0–3 scale, and the seven component scores are summed to yield a global PSQI score ranging from 0 to 21, with lower scores indicating better sleep quality. A PSQI score of <5 was taken to denote good sleep quality and a score of ≥5 was taken to denote poor sleep quality, in accordance with the standard scoring instructions for the instrument.

Assessment of cognitive performance:

Cognitive function was assessed using the Mini-Mental State Examination (MMSE), originally described by Folstein and colleagues for the brief quantitative assessment of cognitive status²¹ and since established as the most widely used bedside and research instrument for this purpose. The MMSE is an eleven-item measure evaluating five cognitive domains: orientation (10 points), registration (3 points), attention and calculation (5 points), recall (3 points), and language and praxis (9 points) – yielding a maximum possible score of 30. Each participant was tested individually by the investigator, and responses were scored according to the standard MMSE scoring key. Scores of 24–30 were classified as no cognitive impairment, 18–23 as mild cognitive impairment, and 0–17 as severe cognitive impairment; for analysis, participants were dichotomised into “normal cognition” (≥24) and “impaired cognition” (<24).

Statistical Analysis

Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics, version 26. Quantitative variables were expressed as mean ± standard deviation, and qualitative variables as frequencies and percentages. The chi-square test was used to assess associations between categorical variables, and Pearson correlation was used to examine relationships between continuous variables. A two-tailed p-value of <0.05 was considered statistically significant.

RESULTS

The majority of participants were 19 years of age (78; 43.6%), followed by 20 years (54; 30.2%), 18 years (28; 15.6%), 21 years (14; 7.8%), 22 years (4; 2.2%) and 17 years (1; 0.6%).

Table 1. Age distribution of subjects studied

Age (years)	Males, n (%)	Females, n (%)	Total, n (%)
17	0 (0)	1 (1.2)	1 (0.6)
18	13 (14.1)	15 (17.2)	28 (15.6)
19	31 (33.7)	47 (54.0)	78 (43.6)
20	35 (38.0)	19 (21.8)	54 (30.2)

Age (years)	Males, n (%)	Females, n (%)	Total, n (%)
21	9 (9.8)	5 (5.8)	14 (7.8)
22	4 (4.4)	0 (0)	4 (2.2)
Total	92 (100)	87 (100)	179 (100)

Table 2. Gender-wise distribution of subjects studied

Gender	Frequency (n)	Percent (%)
Female	87	48.6
Male	92	51.4
Total	179	100.0

The study group comprised 92 (51.4%) male and 87 (48.6%) female participants.

Table 3. Distribution of subjects studied with respect to residence

Residence	Frequency (n)	Percent (%)
Rural	114	63.7
Urban	65	36.3
Total	179	100.0

A total of 114 (63.7%) participants resided in rural areas and 65 (36.3%) in urban areas.

Table 4. Distribution of parameters among subjects studied

Parameter	N	Minimum	Maximum	Mean	SD
Age (years)	179	17.00	22.00	19.35	0.93
PSQI score	179	0	15.00	6.43	2.86
MMSE score	179	20.00	30.00	27.40	1.96
Academic performance (%)	179	13.00	83.00	62.53	13.26

The mean age of participants was 19.35 ± 0.93 years (range 17–22 years). The mean PSQI score was 6.43 ± 2.86 , the mean MMSE score was 27.40 ± 1.96 , and the mean academic percentage was 62.53 ± 13.26 .

Table 5. Statistical parameters of sleep-quality component scores (PSQI)

Component	N	Minimum	Maximum	Mean	SD
Subjective sleep quality	179	0	3.00	1.11	0.69
Sleep latency	179	0	3.00	1.15	0.96
Sleep duration	179	0	3.00	1.24	0.86
Habitual sleep efficiency	179	0	2.00	0.29	0.51
Sleep disturbance	179	0	2.00	0.96	0.51
Use of sleep medication	179	0	3.00	0.06	0.35
Daytime dysfunction	179	0	3.00	1.58	1.08
Global PSQI score	179	0	15.00	6.43	2.86

Among the seven PSQI components, daytime dysfunction had the highest mean score (1.58 ± 1.08), followed by sleep duration (1.24 ± 0.86), sleep latency (1.15 ± 0.96) and subjective sleep quality (1.11 ± 0.69), while use of sleep medication had the lowest mean score (0.06 ± 0.35).

Table 6. Distribution of subjects based on sleep duration

Sleep duration	Frequency (n)	Percent (%)
>7 hours	40	22.3
6–7 hours	66	36.9
5–6 hours	63	35.2
<5 hours	10	5.6

Most participants (66; 36.9%) slept 6–7 hours per night, followed by 63 (35.2%) who slept 5–6 hours, 40 (22.3%) who slept more than 7 hours, and 10 (5.6%) who slept less than 5 hours.

Table 7. Distribution of subjects based on PSQI score

PSQI group	N	Percent (%)
Good sleep quality (<5)	42	23.5
Poor sleep quality (≥ 5)	137	76.5
Total	179	100

Poor sleep quality was present in 76.5% (137/179) of participants, while 23.5% (42/179) had good sleep quality.

Table 8. Distribution of subjects based on MMSE score

MMSE group	N	Percent (%)
Normal cognition (≥ 24)	168	93.9
Impaired cognition (<24)	11	6.1
Total	179	100

Based on MMSE scores, 93.9% (168/179) of participants had normal cognition and 6.1% (11/179) had impaired cognition.

Table 9. Comparison of study parameters by residence

Parameter	Residence	N	Mean	SD	t-value	p-value
PSQI score	Urban	65	6.38	2.42	-0.160	0.873
	Rural	114	6.45	3.10		
MMSE score	Urban	65	27.75	1.73	1.793	0.075
	Rural	114	27.21	2.06		
Academic %	Urban	65	64.41	14.63	1.435	0.153
	Rural	114	61.46	12.35		

No statistically significant differences were observed between urban and rural participants for PSQI score ($p=0.873$), MMSE score ($p=0.075$) or academic percentage ($p=0.153$).

Table 10. Comparison of study parameters by gender

Parameter	Gender	N	Mean	SD	t-value	p-value
PSQI score	Male	92	6.30	3.12	-0.603	0.547

Parameter	Gender	N	Mean	SD	t-value	p-value
	Female	87	6.56	2.57		
MMSE score	Male	92	27.43	1.85	0.113	0.911
	Female	87	27.39	2.07		
Academic %	Male	92	61.39	13.56	-1.189	0.236
	Female	87	63.74	12.90		

No statistically significant differences were observed between male and female participants for PSQI score ($p=0.547$), MMSE score ($p=0.911$) or academic percentage ($p=0.236$).

Table 11. Association of cognition with sleep quality (PSQI)

Sleep quality	Normal cognition, n (%)	Impaired cognition, n (%)	Total, n (%)	OR (95% CI)	χ^2	p-value
Good (<5)	38 (21.3)	4 (2.2)	42 (23.5)	0.512 (0.142–1.841)	1.086	0.299
Poor (≥ 5)	130 (72.6)	7 (3.9)	137 (76.5)			
Total	168 (93.9)	11 (6.1)	179 (100)			

No statistically significant association was found between sleep quality and cognition ($p=0.299$). Although not significant, the odds ratio (0.512, 95% CI 0.142–1.841) suggested a possible protective trend, whereby good sleep quality was associated with normal cognition.

Table 12. Association of academic performance with sleep quality (PSQI)

Sleep quality	Good performance ($\geq 50\%$), n (%)	Poor performance (<50%), n (%)	Total, n (%)	OR (95% CI)	χ^2	p-value
Good (<5)	39 (21.8)	3 (1.7)	42 (23.5)	1.97 (0.55–7.03)	1.116	0.292
Poor (≥ 5)	119 (66.5)	18 (10.0)	137 (76.5)			
Total	158 (88.3)	21 (11.7)	179 (100)			

No statistically significant association was found between sleep quality and academic performance ($p=0.292$). Students with good sleep quality had approximately twice the odds of good academic performance compared with those with poor sleep quality (OR=1.97, 95% CI 0.55–7.03), although this difference did not reach statistical significance.

Table 13. Association of cognition with sleep difficulty (PSQI-derived)

Sleep difficulty	Normal cognition, n (%)	Impaired cognition, n (%)	Total, n (%)	OR (95% CI)	χ^2	p-value
No difficulty (0)	1 (0.5)	0 (0)	1 (0.5)	0.211 (0.026–1.69)*	1.61	0.205
Mild (1–7)	113 (63.2)	10 (5.6)	123 (68.8)			
Moderate (8–14)	53 (29.7)	1 (0.5)	54 (30.2)			
Severe (15–21)	1 (0.5)	0 (0)	1 (0.5)			
Total	168 (93.9)	11 (6.1)	179 (100)			

*For calculation of the odds ratio, the “no difficulty” and “mild” categories were combined, and the “moderate” and “severe” categories were combined.

No statistically significant association was found between sleep difficulty and cognition ($p=0.205$); students with no/mild sleep difficulty tended to have normal cognition ($OR=0.211$, 95% CI 0.026–1.69).

Table 14. Association of academic performance with sleep difficulty (PSQI-derived)

Sleep difficulty	Good performance, n (%)	Poor performance, n (%)	Total, n (%)	OR (95% CI)	χ^2	P-value
No difficulty (0)	1 (0.5)	0 (0)	1 (0.5)	0.89 (0.33–2.43)*	0.052	0.819
Mild (1–7)	108 (60.4)	15 (8.4)	123 (68.8)			
Moderate (8–14)	48 (26.8)	6 (3.4)	54 (30.2)			
Severe (15–21)	1 (0.5)	0 (0)	1 (0.5)			
Total	158 (88.3)	21 (11.7)	179 (100)			

No statistically significant association was found between sleep difficulty and academic performance ($p=0.819$); students with no/mild sleep difficulty tended to have good academic performance ($OR=0.89$, 95% CI 0.33–2.43).

Table 15. Pearson correlation of cognition and academic performance with PSQI score

Parameter	N	Pearson correlation (r)	p-value
Cognition (MMSE)	179	-0.039	0.601
Academic performance (%)	179	-0.066	0.384

A weak, statistically non-significant negative correlation was observed between PSQI score and both cognition ($r=-0.039$, $p=0.601$) and academic performance ($r=-0.066$, $p=0.384$), indicating that higher (worse) PSQI scores were only marginally associated with lower MMSE scores and lower academic percentages in this cohort

DISCUSSION

Medicine remains among the most academically demanding and highly respected professional disciplines worldwide, requiring sustained dedication and vigilance to master the complexity of human structure and function. Medical students, as a discrete population, are especially susceptible to sleep deprivation because they must simultaneously contend with intense academic pressure, social adjustment, unfamiliar environments, erratic timetables, financial strain and broader lifestyle change. Since more than seven hours of sleep per night is generally regarded as necessary for optimal adult health and well-being, the present study was undertaken to examine the effect of sleep deprivation on academic performance and cognitive function in a cohort of undergraduate medical students.

The 179 participants had a mean age of 19.35 ± 0.93 years, comparable to the mean age of 20.63 years reported by Al-Humairi in a similar study of medical students.²² The near-equal gender distribution observed in the present cohort (51.4% male, 48.6% female) mirrors that reported by Wondie et al. (53.8% male, 45.2% female), although it contrasts with the markedly female-predominant sample (79% female) described by Krishna et al., a difference likely attributable to

variation in institutional gender ratios across settings.^{16,23}

Poor sleep quality ($PSQI \geq 5$) was observed in 76.5% of participants, a proportion closely comparable to the 74.2% reported by Siddiqui et al. among Saudi medical students.²⁴ Our findings, however, differed from those of Kalyani et al., who reported that only 46.4% of their participants had a PSQI score of ≥ 5 ; this discrepancy may reflect differences in sample composition, as that study enrolled students across all years of the MBBS curriculum and had a substantially larger sample size ($n=278$), whereas the present study was restricted to first-year students with a comparatively smaller sample ($n=179$).²⁵

No statistically significant difference in PSQI score was observed between male (6.30 ± 3.12) and female (6.56 ± 2.57) participants ($p=0.547$). This finding is consistent with Awasthi et al., who likewise found no significant gender difference in PSQI scores (males 5.76, females 5.92), and with Kalyani et al., who reported comparable results ($p=0.140$).^{25,26} In contrast, Ercan et al. reported a positive association between male gender and higher PSQI scores, a difference that may be explained by their considerably larger sample size ($n=1007$).²⁷

Similarly, PSQI scores did not differ significantly between rural (6.45 ± 3.10) and urban (6.38 ± 2.42)

participants ($p=0.873$), a result concordant with Awasthi et al., who also found no significant relationship between sleep quality and the demographic characteristics of their study population.²⁶ Sleep deprivation is a well-recognised occurrence among medical students; by curtailing their own sleep, students not only heighten daytime sleepiness but also compromise their capacity to sustain attention in the classroom, which may adversely affect academic performance.^{28,29} In our cohort, only 22.3% of participants obtained more than seven hours of sleep, while the remainder reported six hours or less, confirming that habitual short sleep duration is widespread in this population.

Academic performance may be defined as the extent to which a student achieves short- or long-term educational goals, and most previous research indicates that sleep deprivation affects both academic achievement and cognitive ability in students.^{17,23} In the present study, 88.3% of participants demonstrated good academic performance and 11.7% poor academic performance, a distribution broadly comparable to that reported by Datta et al. (92% good, 8% poor).¹⁹

No statistically significant association was found between PSQI-defined sleep quality and academic performance ($p=0.292$); among students with good sleep quality, 92.9% (39/42) had good academic performance, compared with 86.9% (119/137) among those with poor sleep quality. This absence of a statistically significant association is consistent with the findings of Jalali et al. and Thomas and Sundar, both of whom similarly reported no significant relationship between PSQI-assessed sleep quality and academic performance.^{30,31} Conversely, Maheshwari and Shaikat found that poor sleep quality had a demonstrably negative effect on the academic performance of medical students, and Abdulghani et al. likewise reported a significant inverse relationship between sleep disturbance and academic achievement.^{3,32} Chen et al. have noted that intrusive light, noise, and other features of the sleep environment can materially affect sleep quality, a consideration that may be particularly relevant for students residing in hostel accommodation away from home; nevertheless, academic achievement is also shaped by factors independent of sleep, such as class attendance, concentration, motivation, and time-management skills, which vary considerably between individuals and may account for the lack of a statistically significant association observed in the present study.³³ Notably, despite the absence of statistical significance, students with good sleep quality had an odds ratio of 1.97 (95% CI 0.55–7.03) for good academic performance relative to those with poor sleep quality, suggesting a possible, if modest and non-significant, protective trend broadly in keeping with the direction of effect reported by Gaultney and by Gomes et al. in their respective studies of sleep and

undergraduate academic performance.^{34,35} Similarly, Rathakrishnan et al. reported a positive, though not always statistically robust, association between quality of sleep and academic performance among undergraduate students in Malaysia.³⁶

The mean academic percentage did not differ significantly between male (61.39 ± 13.56) and female (63.74 ± 12.90) participants ($p=0.236$). This is at variance with the findings of Thomas and Sundar, who reported a significant gender difference favouring female medical students.³¹

Sleep plays an integral role in learning and the consolidation of memory, enabling the recall of previously learned information; Curcio et al. have highlighted the essential contribution of sleep to memory and learning capacity, while Adelantado-Renau et al. observed that, during adolescence – a critical period for the acquisition of academic and cognitive skills – sleep is likely to play a key role in memory consolidation, brain plasticity, and overall cognitive functioning.^{37,38} Longitudinal evidence also links shorter sleep duration to accelerated cognitive decline over time.³⁹

Based on MMSE scores, 93.9% of participants demonstrated normal cognition and 6.1% demonstrated impaired cognition, with no significant difference in mean MMSE score between male (27.43 ± 1.85) and female (27.39 ± 2.07) participants ($p=0.911$).

No statistically significant association was observed between PSQI-defined sleep quality and cognitive performance ($p=0.299$); among students with good sleep quality, 90.5% (38/42) had normal cognition, compared with 94.9% (130/137) among those with poor sleep quality. This finding is consistent with Leman et al., who similarly found no significant association between sleep quality and cognitive function among medical students in Indonesia, and with Krishna et al., who reported a comparable non-significant relationship.^{23,40} Notably, the odds ratio for normal cognition among students with good sleep quality was 0.512 (95% CI 0.142–1.841), a value below unity that, while statistically non-significant, is directionally consistent with data reported by Okano et al. and Zavec et al., both of whom described a positive relationship between better subjective sleep quality/consistency and cognitive performance in student and young-adult populations.^{41,42}

The broader literature on sleep deprivation and cognition in student and clinical trainee populations is considerably more consistent than the present findings might suggest. Patrick et al. demonstrated measurable decrements in both cognitive and physical performance following sleep restriction in university students, Perez-Olmos and Ibanez-Pinilla documented impaired attention performance among medical students exposed to night-shift-related sleep deprivation, and Robbins and Gottlieb, in an early

study of internal medicine house staff, reported clear deficits in cognitive testing after sleep loss.⁴³⁻⁴⁵ Pilcher and Walters similarly demonstrated that college students frequently underestimate the extent to which sleep deprivation impairs their capacity to complete cognitive tasks, retain information, and achieve academically.⁴⁶ Together with the observation that inadequate sleep in college students is also associated with adverse behavioural outcomes such as increased substance use and motor vehicle accidents, and that daytime napping may partially offset the effects of shortened nocturnal sleep, the weight of published evidence supports a genuine, if sometimes modest, adverse effect of sleep deprivation on cognition, even though this relationship did not reach statistical significance within the present, relatively small, single-centre cohort.^{47,48}

Strengths and Limitations

A major strength of this study is the use of standardized and validated instruments, including the Pittsburgh Sleep Quality Index (PSQI) for assessment of sleep quality and the Mini-Mental State Examination (MMSE) for evaluation of cognitive function. The study also assessed sleep quality, sleep duration, academic performance, and cognitive function within the same cohort, allowing a comprehensive evaluation of these parameters among undergraduate medical students.

The study has several limitations. First, it was conducted at a single government tertiary-care teaching hospital, which may limit the generalizability of the findings to medical students in other institutions and settings. Second, the sample size was relatively modest and may have limited the statistical power to detect small associations. Third, sleep quality and sleep-related variables were assessed using self-reported measures, which may be subject to recall and response bias. Finally, the observational cross-sectional design does not permit establishment of causal relationships between sleep characteristics, academic performance, and cognitive function.

CONCLUSION

The present study confirms that poor sleep quality and short sleep duration are highly prevalent among undergraduate medical students in this setting, affecting more than three-quarters of the cohort. Although the observed associations between sleep quality and both academic performance and cognitive function did not reach statistical significance, the direction of the odds ratios was broadly consistent with the wider literature, and the high prevalence of poor sleep quality in this population is, in itself, a matter of considerable public health and educational concern. Screening students for preventable and treatable causes of sleep deprivation and excessive daytime sleepiness therefore remains a reasonable and potentially valuable

strategy for safeguarding academic performance, cognitive function, and overall well-being.

DECLARATIONS

Ethics Approval and Consent to Participate

The study was conducted in accordance with the ethical principles applicable to research involving human participants. Ethical approval was obtained from the Institutional Ethics Committee, Government Medical College, Jammu (Approval No. IEC/GMC/2022/867, dated 10 February 2022). Written informed consent was obtained from all participants before their inclusion in the study.

Consent for Publication

Written informed consent was obtained from the participants for publication of the study findings. No individually identifiable information is presented in this manuscript.

Availability of Data and Materials

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request, subject to applicable ethical and institutional restrictions.

Competing Interests

The authors declare that they have no competing interests.

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Authors' Contributions

All authors contributed to the conception and design of the study, data collection, analysis and interpretation of the findings, and drafting and critical revision of the manuscript. All authors approved the final version of the manuscript and agreed to be accountable for all aspects of the work.

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