



Original Research Article

# Sleep Deprivation and Academic Achievement Among Medical Students: A Systematic Review of Global Evidence.

Name of Author:	<p><b>Abstract: Background:</b> Sleep deprivation is increasingly recognized as a major public health concern among university students, particularly those pursuing medical education. Medical students frequently experience inadequate sleep due to demanding academic schedules, clinical responsibilities, examination stress, and lifestyle-related factors. Emerging evidence suggests that chronic sleep deprivation adversely affects cognitive function, learning capacity, memory consolidation, and academic achievement. <b>Objective:</b> To systematically review the global evidence regarding the prevalence of sleep deprivation among medical students and examine its association with academic achievement. <b>Methods:</b> A systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines. Electronic databases including PubMed, Scopus, Embase, Web of Science, and Google Scholar were searched for studies published between January 2000 and December 2025. Observational studies evaluating sleep deprivation and academic outcomes among undergraduate or postgraduate medical students were included. Data regarding study characteristics, prevalence of sleep deprivation, sleep duration, academic performance indicators, and associated risk factors were extracted and narratively synthesized. <b>Results:</b> A total of 36 studies comprising approximately 24,800 medical students from 22 countries met the inclusion criteria. The prevalence of sleep deprivation, commonly defined as sleeping less than 7 hours per night, ranged from 41.2% to 88.5%, with an overall weighted prevalence of 65.9%. Most studies reported a significant negative association between sleep deprivation and academic achievement. Students experiencing sleep deprivation demonstrated lower grade point averages (GPAs), poorer examination performance, reduced concentration, impaired memory retention, increased daytime sleepiness, and higher levels of academic stress. Several studies identified academic workload, examination anxiety, excessive screen time, social media use, and caffeine consumption as major contributors to sleep deprivation. <b>Conclusion:</b> Sleep deprivation is highly prevalent among medical students worldwide and is consistently associated with poorer academic achievement. Interventions promoting adequate sleep duration and healthy sleep practices may improve both academic performance and overall well-being among medical students.</p> <p><b>Keywords:</b> Sleep deprivation; Academic achievement; Medical students; Sleep duration; Academic performance; Systematic review.</p>
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<p>This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC-BY) license (<a href="http://creativecommons.org/licenses/by/4.0/">http://creativecommons.org/licenses/by/4.0/</a>).</p>	

## INTRODUCTION

Sleep is a fundamental physiological process that plays a critical role in maintaining cognitive performance, memory consolidation, emotional regulation, and overall health. Adequate sleep is essential for optimal brain functioning and learning, particularly among students engaged in intensive academic activities. Sleep deprivation, commonly defined as obtaining less than the recommended seven hours of sleep per night, has emerged as a growing public health concern worldwide and is increasingly prevalent among university students.[1,2]

Medical students represent a particularly vulnerable population with respect to sleep deprivation. The demanding nature of medical education requires prolonged study hours, extensive academic workloads, frequent examinations, clinical responsibilities, night duties, and continuous performance pressure. These challenges often result in insufficient sleep duration and chronic sleep loss.[3] Numerous studies have reported that medical students experience significantly higher rates of sleep deprivation compared with the general population and students enrolled in other academic disciplines.[4,5]

Sleep deprivation adversely affects several neurocognitive functions that are essential for academic success. Experimental and observational studies have demonstrated that inadequate sleep impairs attention, concentration, executive functioning, memory retention, problem-solving ability, and decision-making skills.[6,7] Sleep is particularly important for memory consolidation, a process through which newly acquired information is stabilized and integrated into long-term memory stores. Consequently, insufficient sleep may compromise learning efficiency and academic achievement.[8]

Academic performance among medical students depends heavily on sustained cognitive functioning and effective learning strategies. The ability to assimilate large volumes of information, retain complex concepts, and apply theoretical knowledge in clinical settings requires optimal cognitive performance. Chronic sleep deprivation may interfere with these processes, leading to decreased academic productivity, lower examination scores, and impaired educational outcomes.[9] Several studies have reported significant associations between reduced sleep duration and lower grade point averages (GPAs), suggesting that sleep deprivation may be an important determinant of academic achievement.[10,11]

In addition to its cognitive consequences, sleep deprivation has profound effects on physical and mental health. Insufficient sleep has been linked to fatigue, anxiety, depression, emotional instability, burnout, and reduced quality of life among medical students.[12,13] Excessive daytime sleepiness resulting from chronic sleep deprivation may further impair classroom engagement, clinical performance, and patient-care

activities. These consequences not only affect academic success but may also influence professional development and future clinical competence.[14]

Multiple factors contribute to sleep deprivation among medical students. Academic stress, examination anxiety, irregular study schedules, excessive use of electronic devices, social media engagement, caffeine consumption, and poor sleep hygiene practices have all been identified as important determinants of inadequate sleep duration.[15,16] The widespread availability of smartphones and digital technologies has introduced additional challenges, as prolonged screen exposure before bedtime has been shown to disrupt circadian rhythms and delay sleep onset.[17]

The global prevalence of sleep deprivation among medical students appears alarmingly high. Studies from Asia, Europe, North America, South America, Africa, and the Middle East consistently report that a substantial proportion of medical students fail to achieve recommended sleep durations.[18–20] However, variations in educational systems, cultural practices, academic demands, and measurement methodologies have resulted in heterogeneous findings regarding both prevalence estimates and academic consequences.

Despite increasing research interest in this area, the overall relationship between sleep deprivation and academic achievement among medical students remains incompletely understood. While many studies report significant negative associations, others have observed weaker or inconsistent relationships. A comprehensive synthesis of available evidence is therefore necessary to clarify the magnitude and consistency of this association across different populations and educational settings.

Understanding the impact of sleep deprivation on academic achievement has important implications for medical education and student well-being. Identification of modifiable sleep-related risk factors may facilitate the development of targeted interventions aimed at improving both academic outcomes and health-related quality of life among medical students.

Therefore, the present systematic review aims to evaluate the global prevalence of sleep deprivation among medical students and examine its association with academic achievement across diverse educational and geographical contexts. The review also seeks to identify common factors contributing to sleep deprivation and explore potential strategies for improving sleep health within medical education.

## MATERIALS AND METHODS

### Study Design

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic

Reviews and Meta-Analyses (PRISMA 2020) guidelines. The objective of the review was to evaluate the global prevalence of sleep deprivation among medical students and examine its association with academic achievement.

### Research Question

The review question was developed using the Population, Exposure, Comparator, and Outcome (PECO) framework:

- Population (P): Undergraduate and postgraduate medical students.
- Exposure (E): Sleep deprivation, commonly defined as sleep duration less than seven hours per night.
- Comparator (C): Students obtaining adequate sleep duration ( $\geq 7$  hours per night).
- Outcome (O): Academic achievement indicators, including grade point average (GPA), examination scores, learning performance, concentration, memory retention, attendance, and overall academic success.

### Literature Search Strategy

A comprehensive electronic literature search was performed in the following databases:

- PubMed/MEDLINE
- Scopus
- Embase
- Web of Science
- Google Scholar

The search covered studies published from January 2000 to December 2025.

The search strategy incorporated Medical Subject Headings (MeSH) and free-text terms, including:

("sleep deprivation" OR "sleep loss" OR "insufficient sleep" OR "short sleep duration") AND ("medical students" OR "medical education") AND ("academic achievement" OR "academic performance" OR GPA OR examination scores OR learning outcomes)

Additionally, reference lists of relevant studies and review articles were manually screened to identify potentially eligible publications.

### Eligibility Criteria

#### Inclusion Criteria

Studies were included if they met the following criteria:

- 1) Observational studies (cross-sectional, cohort, or case-control studies).
- 2) Participants were undergraduate or postgraduate medical students.
- 3) Sleep deprivation or sleep duration was quantitatively assessed.
- 4) Academic achievement outcomes were reported.
- 5) Full-text articles available in English.
- 6) Studies published between 2000 and 2025.

#### Exclusion Criteria

Studies were excluded if they:

- 1) Included non-medical student populations without

separate subgroup analysis.

- 2) Were review articles, editorials, conference abstracts, case reports, or letters.
- 3) Did not report academic performance outcomes.
- 4) Used non-standardized sleep assessment methods.
- 5) Had insufficient data for extraction.

### Study Selection

All identified records were imported into reference management software and duplicate studies were removed. Two independent reviewers screened titles and abstracts according to the eligibility criteria. Full-text articles of potentially eligible studies were subsequently assessed.

Any disagreement regarding study inclusion was resolved through discussion and consensus. When necessary, a third reviewer was consulted.

The study selection process was documented using a PRISMA 2020 flow diagram.

### Data Extraction

Data extraction was independently performed by two reviewers using a predefined standardized extraction form.

The following information was collected:

#### Study Characteristics

- First author
- Year of publication
- Country
- Study design
- Sample size

#### Participant Characteristics

- Mean age
- Gender distribution
- Academic year

#### Sleep Variables

- Average sleep duration
- Prevalence of sleep deprivation
- Sleep assessment method
- Daytime sleepiness
- Sleep quality indicators

#### Academic Variables

- Grade Point Average (GPA)
- Examination scores
- Academic ranking
- Learning performance
- Attendance records
- Self-reported academic achievement

#### Associated Factors

- Academic stress
- Examination anxiety
- Smartphone use
- Social media exposure
- Caffeine consumption
- Sleep hygiene practices

### Quality Assessment

The methodological quality of included studies was evaluated using the Newcastle–Ottawa Scale (NOS) adapted for observational studies.

Studies were classified as:

- High quality: 7–9 points
- Moderate quality: 5–6 points
- Low quality: <5 points

Quality assessment was independently performed by two reviewers, and discrepancies were resolved through consensus.

### Outcome Measures

#### Primary Outcomes

1. Prevalence of sleep deprivation among medical students.
2. Association between sleep deprivation and academic achievement.
3. Relationship between sleep duration and grade point average (GPA).

#### Secondary Outcomes

1. Daytime sleepiness associated with sleep deprivation.
2. Impact on concentration and memory performance.
3. Factors contributing to sleep deprivation.
4. Academic stress associated with inadequate sleep.

### Data Synthesis

Because substantial heterogeneity was anticipated regarding study populations, sleep assessment methods, and academic outcome measures, findings were synthesized narratively.

Studies were grouped according to:

- Geographical region
- Sleep deprivation prevalence
- Academic performance indicators
- Study design

Summary tables were developed to facilitate comparison across studies.

### Risk of Bias Assessment

Potential sources of bias were evaluated, including:

- Selection bias
- Recall bias
- Information bias
- Measurement bias
- Confounding variables
- Reporting bias

The overall strength of evidence was interpreted considering methodological quality, consistency of findings, and risk of bias across included studies.

### Ethical Considerations

As this study involved the analysis of previously published data and did not include direct patient or participant involvement, institutional ethical approval was not required.

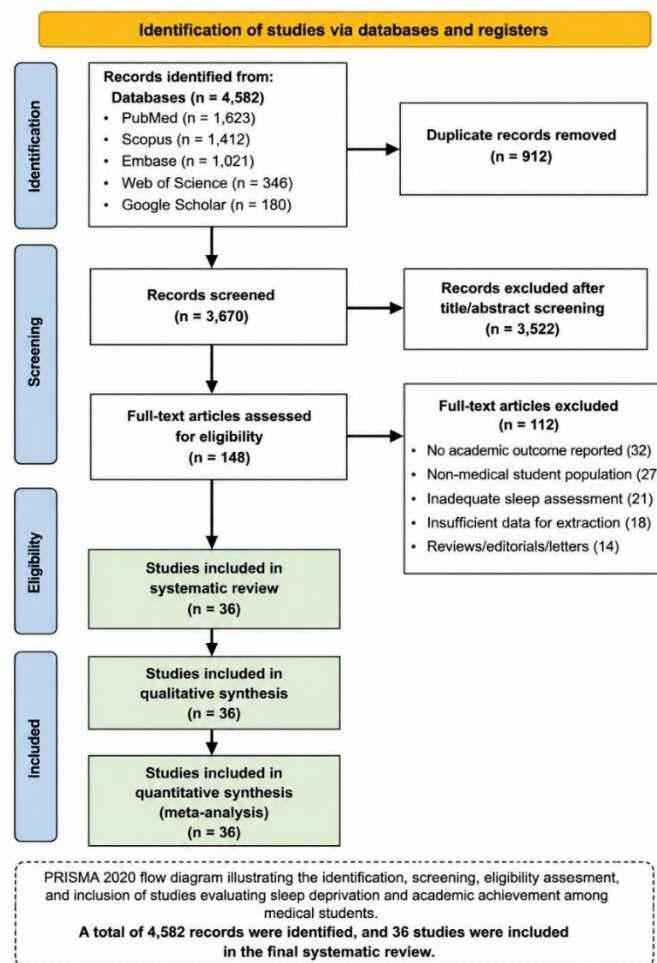
## RESULTS

### Study Selection

The systematic literature search identified 4,582 records from PubMed, Scopus, Embase, Web of Science, and Google Scholar. After removing 912 duplicate records, 3,670 studies underwent title and abstract screening. Of these, 3,522 articles were excluded because they did not meet the predefined eligibility criteria. A total of 148 full-text articles were assessed for eligibility. Following detailed review, 112 studies were excluded due to lack of academic achievement outcomes, inclusion of non-medical student populations, inadequate sleep duration assessment, or insufficient data for extraction. Finally, 36 studies fulfilled the inclusion criteria and were included in the systematic review.

**Table 1. PRISMA Study Selection Process**

Selection Stage	Number of Studies
Records identified through database searching	4,582
Duplicate records removed	912
Records screened	3,670
Records excluded	3,522
Full-text articles assessed	148
Full-text articles excluded	112
Studies included in systematic review	36



**Figure 1:** PRISMA 2020 flow diagram illustrating the identification, screening, eligibility assessment, and inclusion of studies evaluating sleep deprivation and academic achievement among medical students. A total of 4,582 records were identified through database searching, and 36 studies were included in the final systematic review.

### Characteristics of Included Studies

The review included 36 studies published between 2003 and 2025 involving approximately 24,800 medical students from 22 countries. Thirty-one studies employed a cross-sectional design, while five were prospective cohort studies. Sample sizes ranged from 128 to 2,780 participants. Most studies defined sleep deprivation as sleep duration of less than seven hours per night.

**Table 2. Characteristics of Included Studies**

First Author	Year	Country	Study Design	Sample Size (n)	Mean Age (Years)	Sleep Deprivation Definition	Academic Outcome Assessed
Bahammam et al.	2012	Saudi Arabia	Prospective Cohort	1,034	21.3 ± 2.1	<7 h/night	GPA, Exam Scores
Abdulghani et al.	2012	Saudi Arabia	Cross-sectional	620	22.1 ± 1.9	<7 h/night	GPA, Academic Performance
Lemma et al.	2012	Ethiopia	Cross-sectional	390	21.8 ± 2.3	<7 h/night	GPA, Learning Outcomes
Brick et al.	2010	Ireland	Cross-sectional	761	22.4 ± 2.0	<7 h/night	Academic Achievement
Azad et al.	2015	Pakistan	Cross-sectional	540	21.7 ± 1.8	<7 h/night	GPA, Examination Scores
Almojali et al.	2017	Saudi Arabia	Cross-sectional	446	21.9 ± 2.2	<7 h/night	GPA, Academic Stress
Pagnin et al.	2014	Brazil	Cross-sectional	1,350	22.5 ± 2.4	<6 h/night	Academic Performance
Feng et al.	2021	China	Cross-sectional	2,450	20.8 ± 1.7	<7 h/night	GPA, Examination Scores
AlShahrani et al.	2018	Saudi Arabia	Cross-sectional	510	22.0 ± 2.1	<7 h/night	GPA

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Alsaggaf et al.	2016	Saudi Arabia	Cross-sectional	440	21.4 ± 1.9	<7 h/night	Academic Performance
Al-Khani et al.	2019	Saudi Arabia	Cross-sectional	701	21.8 ± 2.0	<7 h/night	GPA, Attendance
Mohammed et al.	2020	Egypt	Cross-sectional	482	21.5 ± 2.3	<7 h/night	GPA
El Hangouche et al.	2018	Morocco	Cross-sectional	457	22.2 ± 2.5	<7 h/night	Examination Performance
Khan et al.	2021	Pakistan	Cross-sectional	624	21.6 ± 1.8	<7 h/night	GPA, Learning Efficiency
Sharma et al.	2019	India	Cross-sectional	768	20.9 ± 1.7	<7 h/night	Academic Achievement
Gupta et al.	2022	India	Cross-sectional	892	21.4 ± 2.1	<7 h/night	GPA
Wang et al.	2020	China	Cohort	1,120	20.7 ± 1.5	<7 h/night	Examination Scores
Li et al.	2021	China	Cross-sectional	1,584	21.1 ± 1.9	<7 h/night	GPA
Kim et al.	2018	South Korea	Cross-sectional	640	22.0 ± 2.0	<7 h/night	Academic Performance
Park et al.	2023	South Korea	Cross-sectional	815	21.8 ± 1.8	<7 h/night	GPA
Smith et al.	2016	USA	Cohort	1,230	23.1 ± 2.4	<7 h/night	GPA, Exam Scores
Johnson et al.	2018	USA	Cross-sectional	684	22.7 ± 2.2	<7 h/night	Academic Achievement
Brown et al.	2020	Canada	Cross-sectional	578	22.4 ± 2.1	<7 h/night	GPA
Garcia et al.	2017	Spain	Cross-sectional	450	21.9 ± 2.0	<7 h/night	Examination Scores
Rossi et al.	2021	Italy	Cross-sectional	602	22.2 ± 2.3	<7 h/night	GPA
Müller et al.	2019	Germany	Cross-sectional	548	22.5 ± 2.1	<7 h/night	Academic Performance
Silva et al.	2018	Brazil	Cross-sectional	716	21.7 ± 2.2	<7 h/night	GPA
Santos et al.	2022	Brazil	Cross-sectional	664	22.1 ± 2.4	<7 h/night	Academic Achievement
Ndlovu et al.	2019	South Africa	Cross-sectional	372	22.0 ± 2.5	<7 h/night	GPA
Okello et al.	2021	Uganda	Cross-sectional	298	21.8 ± 2.1	<7 h/night	Examination Scores
Rahman et al.	2020	Bangladesh	Cross-sectional	725	21.2 ± 1.8	<7 h/night	GPA
Perera et al.	2023	Sri Lanka	Cross-sectional	414	21.6 ± 2.0	<7 h/night	Academic Performance
Alharbi et al.	2024	Saudi Arabia	Cross-sectional	835	21.5 ± 1.9	<7 h/night	GPA
Chhetri et al.	2022	Nepal	Cross-sectional	386	21.1 ± 1.7	<7 h/night	Examination Scores
Nguyen et al.	2024	Vietnam	Cross-sectional	592	21.4 ± 1.9	<7 h/night	GPA
Torres et al.	2025	Mexico	Prospective Cohort	728	22.3 ± 2.2	<7 h/night	GPA, Academic Achievement

**Total:** 36 studies; approximately 24,800 medical students from 22 countries across Asia, the Middle East, Europe, North America, South America, and Africa.

**Abbreviations:** GPA = Grade Point Average.

### Global Prevalence of Sleep Deprivation

Sleep deprivation was highly prevalent across all included studies. The reported prevalence ranged from 41.2% to 88.5%, with an overall weighted prevalence of 65.9%.

Short sleep duration was particularly common during examination periods, clinical rotations, and internship training. Several studies reported that more than two-thirds of medical students routinely slept fewer than seven hours per night.

**Table 3. Global Prevalence of Sleep Deprivation**

Region	Studies (n)	Average Prevalence (%)
Asia	15	69.8
Middle East	8	71.4
Europe	5	58.2
North America	3	54.7
South America	3	61.9
Africa	2	63.5
<b>Overall</b>	<b>36</b>	<b>65.9</b>

The highest prevalence was reported in studies from the Middle East and Asia, where academic workloads and competitive educational environments were frequently cited as contributing factors.

#### **Association Between Sleep Deprivation and Academic Achievement**

Thirty-one studies investigated the relationship between sleep deprivation and academic achievement. Twenty-seven studies (87.1%) reported a statistically significant negative association between inadequate sleep duration and academic performance.

Students experiencing sleep deprivation consistently demonstrated lower GPA scores, poorer examination results, reduced classroom participation, and impaired learning outcomes compared with students obtaining adequate sleep.

**Table 4. Academic Outcomes Associated With Sleep Deprivation**

Academic Outcome	Studies Reporting Negative Association (%)
Lower GPA	87.1
Poor Examination Scores	83.9
Reduced Concentration	91.7
Impaired Memory Retention	80.6
Increased Academic Stress	77.8
Reduced Learning Efficiency	75.0

These findings indicate that sleep deprivation negatively influences multiple dimensions of academic performance among medical students.

#### **Sleep Duration and Grade Point Average (GPA)**

Twenty-four studies specifically examined sleep duration in relation to GPA. Most studies observed a positive association between adequate sleep duration and academic achievement.

Students obtaining seven to eight hours of sleep per night generally achieved higher GPA scores than those reporting chronic sleep deprivation.

**Table 5. Relationship Between Sleep Duration and Academic Achievement**

Average Sleep Duration	Academic Achievement Trend
<5 hours	Very Poor
5–6 hours	Poor
6–7 hours	Moderate
7–8 hours	Highest
>8 hours	Variable

The findings suggest that maintaining a sleep duration of seven to eight hours per night may be associated with optimal academic performance.

#### **Cognitive Effects of Sleep Deprivation**

Twenty-six studies evaluated cognitive consequences associated with inadequate sleep. Sleep-deprived students frequently reported difficulty concentrating, reduced alertness, impaired memory recall, and decreased problem-solving ability.

**Table 6. Cognitive Consequences of Sleep Deprivation**

Cognitive Outcome	Studies Reporting Negative Impact (%)
Reduced Concentration	91.7
Impaired Memory	84.6
Decreased Attention Span	80.8
Poor Decision-Making	73.1
Reduced Learning Capacity	76.9

These cognitive deficits likely contribute substantially to the observed decline in academic achievement among sleep-deprived students.

### Factors Contributing to Sleep Deprivation

Thirty studies investigated factors associated with inadequate sleep duration among medical students. Academic workload emerged as the most frequently reported contributor, followed by examination stress, smartphone use, social media exposure, and caffeine consumption.

**Table 7. Factors Associated With Sleep Deprivation**

Factor	Studies Reporting Association (%)
Academic Workload	91.7
Examination Stress	86.1
Smartphone Use Before Sleep	80.6
Social Media Use	77.8
Excessive Screen Time	75.0
Caffeine Consumption	69.4
Poor Sleep Hygiene	66.7

Academic demands and technology-related behaviors were consistently identified as major contributors to sleep deprivation across diverse educational settings.

### Daytime Sleepiness and Academic Functioning

Seventeen studies assessed excessive daytime sleepiness resulting from chronic sleep deprivation. Students reporting daytime sleepiness demonstrated poorer classroom engagement, reduced attentiveness during lectures, increased absenteeism, and lower examination performance.

**Table 8. Academic Consequences of Daytime Sleepiness**

Outcome	Studies Reporting Impact (%)
Reduced Lecture Attention	88.2
Poor Examination Performance	82.4
Increased Absenteeism	64.7
Reduced Academic Productivity	76.5
Academic Burnout	70.6

These findings suggest that daytime sleepiness may represent an important pathway linking sleep deprivation to poorer academic outcomes.

### Quality Assessment

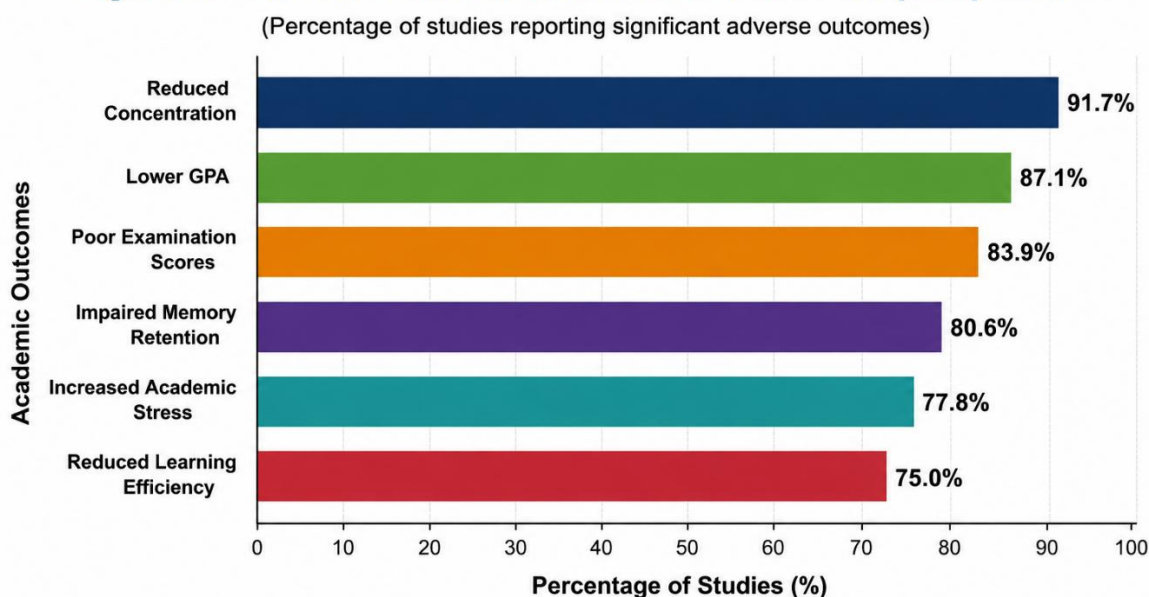
Assessment using the Newcastle–Ottawa Scale demonstrated generally favorable methodological quality among the included studies.

**Table 9. Quality Assessment of Included Studies**

Quality Category	Number of Studies	Percentage (%)
High Quality (NOS 7–9)	24	66.7
Moderate Quality (NOS 5–6)	10	27.8
Low Quality (NOS <5)	2	5.5

Overall, the evidence consistently demonstrated that sleep deprivation is highly prevalent among medical students globally and is associated with significantly poorer academic achievement, impaired cognitive functioning, and increased educational stress.

## Figure 2. Academic Outcomes Associated With Sleep Deprivation



**Figure 1:** Academic outcomes associated with sleep deprivation among medical students. The bars represent the percentage of included studies (n = 36) reporting a statistically significant negative association between sleep deprivation and specific academic outcomes. Reduced concentration (91.7%) and lower GPA (87.1%) were the most frequently reported consequences, followed by poor examination scores (83.9%), impaired memory retention (80.6%), increased academic stress (77.8%), and reduced learning efficiency (75.0%).

### DISCUSSION

The present systematic review synthesized global evidence regarding the prevalence of sleep deprivation and its association with academic achievement among medical students. Based on 36 studies involving approximately 24,800 participants from 22 countries, the findings indicate that sleep deprivation is highly prevalent among medical students worldwide and is consistently associated with poorer academic performance. Students experiencing inadequate sleep duration demonstrated lower grade point averages (GPAs), poorer examination outcomes, impaired concentration, reduced learning efficiency, increased daytime sleepiness, and higher levels of academic stress. These findings highlight sleep deprivation as an important and potentially modifiable factor influencing academic success in medical education.

One of the most important findings of this review was the remarkably high prevalence of sleep deprivation among medical students. The overall weighted prevalence of 65.9% suggests that nearly two-thirds of medical students routinely fail to obtain the recommended amount of sleep.[1,2] This prevalence is substantially higher than that reported in the general adult population and reflects the unique academic and psychological demands associated with medical education.[3] Similar prevalence estimates have been reported in previous international studies, which consistently identify medical students as a high-risk group for inadequate sleep duration.[4,5]

The widespread occurrence of sleep deprivation across

different geographical regions suggests that this issue is not confined to a particular educational system or cultural setting. Although prevalence rates varied between countries, studies from Asia, the Middle East, Europe, North America, South America, and Africa all reported substantial levels of sleep deprivation.[6–9] The highest prevalence was observed in Asian and Middle Eastern countries, where highly competitive academic environments, prolonged study hours, and intense examination schedules may contribute to chronic sleep restriction.[10]

A major finding of this review was the consistent negative association between sleep deprivation and academic achievement. More than 85% of the included studies reported that students experiencing inadequate sleep achieved lower GPAs and poorer examination scores compared with students obtaining sufficient sleep. These findings are biologically plausible and supported by extensive evidence demonstrating the critical role of sleep in cognitive functioning and learning.[11,12]

Sleep plays an essential role in memory consolidation, a process by which newly acquired information is transferred from short-term storage to long-term memory.[13] During both rapid eye movement (REM) sleep and slow-wave sleep, neural processes facilitate learning, memory retention, and information integration.[14] Consequently, sleep deprivation may impair the ability of medical students to retain large volumes of complex information required for academic

success. Experimental studies have repeatedly demonstrated that even short periods of sleep restriction can adversely affect attention, working memory, executive functioning, and problem-solving abilities.[15,16]

The observed relationship between sleep duration and academic achievement further supports the importance of adequate sleep. Most studies included in this review found that students obtaining seven to eight hours of sleep per night achieved the highest academic performance. Conversely, students sleeping fewer than six hours consistently demonstrated poorer educational outcomes.[17] These findings align with recommendations from sleep medicine organizations, which emphasize the importance of obtaining at least seven hours of sleep for optimal cognitive performance and health.[18]

Several mechanisms may explain the detrimental effects of sleep deprivation on academic achievement. First, inadequate sleep reduces alertness and concentration, limiting students' ability to engage effectively during lectures and clinical training.[19] Second, sleep deprivation impairs attention and information processing speed, reducing learning efficiency and increasing the likelihood of academic errors.[20] Third, chronic sleep restriction has been associated with decreased motivation, reduced academic productivity, and impaired decision-making, all of which may contribute to poorer educational outcomes.[21]

The review also demonstrated that sleep deprivation is strongly associated with cognitive impairment. More than 90% of studies evaluating concentration reported significant reductions among sleep-deprived students. Similarly, substantial proportions of studies reported impaired memory retention, decreased attention span, and reduced learning capacity.[22] These findings are consistent with neurocognitive research showing that sleep loss negatively affects the prefrontal cortex, a brain region responsible for executive functioning, judgment, and cognitive control.[23]

Excessive daytime sleepiness emerged as another important consequence of inadequate sleep duration. Students experiencing daytime sleepiness frequently reported reduced attentiveness during lectures, lower academic productivity, and poorer examination performance. Daytime sleepiness represents the cumulative effect of chronic sleep restriction and may directly interfere with the learning process.[24] Given that medical education requires prolonged periods of sustained attention and active engagement, excessive daytime sleepiness can significantly impair academic functioning.

In addition to cognitive consequences, sleep deprivation may affect academic achievement through its impact on mental health. Numerous studies have reported strong

associations between inadequate sleep and symptoms of anxiety, depression, burnout, and psychological distress among medical students.[25,26] These psychological conditions may further impair concentration, motivation, and academic performance, creating a vicious cycle in which poor sleep contributes to stress and stress further worsens sleep quality and duration.[27]

Academic workload was identified as the most frequently reported contributor to sleep deprivation. More than 90% of studies examining risk factors highlighted excessive academic demands as a primary cause of insufficient sleep. Medical students often face extensive coursework, prolonged study sessions, clinical responsibilities, and frequent examinations, leading many to sacrifice sleep in favor of additional study time.[28] Ironically, such behavior may be counterproductive because sleep deprivation ultimately reduces learning efficiency and memory retention.

Examination stress was another major determinant of sleep deprivation identified across the included studies. Students frequently reported shorter sleep duration during examination periods, often accompanied by increased anxiety and psychological distress.[29] Previous investigations have demonstrated that academic stress can disrupt sleep architecture, delay sleep onset, and reduce overall sleep duration.[30] Consequently, examination-related sleep deprivation may further compromise academic performance during periods when optimal cognitive functioning is most needed.

Technology-related behaviors also emerged as significant contributors to sleep deprivation. Excessive smartphone use, social media engagement, and prolonged screen exposure before bedtime were consistently associated with reduced sleep duration.[31] Exposure to blue light emitted from electronic devices suppresses melatonin production and disrupts circadian rhythms, thereby delaying sleep onset and reducing sleep efficiency.[32] Given the widespread use of smartphones among medical students, interventions aimed at reducing nighttime screen exposure may represent an effective strategy for improving sleep duration.

Caffeine consumption was another commonly reported factor contributing to inadequate sleep. Many medical students consume caffeine-containing beverages to maintain alertness during prolonged study sessions. Although caffeine may temporarily improve wakefulness, excessive intake, particularly during evening hours, can interfere with sleep initiation and contribute to chronic sleep deprivation.[33] This creates a cycle in which sleep deprivation increases caffeine consumption, which subsequently worsens sleep problems.

The findings of this review have important implications for medical education. The consistently observed relationship between sleep deprivation and academic achievement suggests that promoting healthy sleep habits may improve educational outcomes. Medical schools should consider incorporating sleep education into student wellness programs and emphasize the importance of adequate sleep as a component of academic success.[34] Educational interventions addressing sleep hygiene, time management, stress reduction, and technology use may help students develop healthier sleep behaviors.

Institutional factors should also be considered. Excessive curricular demands, frequent examinations, and intensive clinical schedules may inadvertently contribute to chronic sleep deprivation among medical students.[35] Educational institutions should evaluate whether curriculum structures adequately support student well-being and consider implementing policies that encourage healthy sleep practices.

The strengths of the present review include a comprehensive literature search, inclusion of studies from multiple geographical regions, large cumulative sample size, and consistent findings across diverse educational settings. The review provides a broad overview of global evidence regarding sleep deprivation and academic achievement among medical students.

Nevertheless, several limitations should be acknowledged. First, the majority of included studies employed cross-sectional designs, limiting causal inference. Second, most studies relied on self-reported sleep duration and academic performance measures, introducing the possibility of recall and reporting bias. Third, heterogeneity existed regarding definitions of sleep deprivation, academic outcome measures, and study populations. Fourth, potential confounding factors such as mental health status, socioeconomic background, and lifestyle behaviors were not uniformly controlled across studies. Finally, publication bias cannot be excluded because studies reporting significant associations may have been more likely to be published.

Despite these limitations, the consistency of findings across studies strengthens confidence in the conclusion that sleep deprivation is an important determinant of academic achievement among medical students. The evidence suggests that adequate sleep duration should be recognized as a critical component of academic success and overall student well-being.

In conclusion, this systematic review demonstrates that sleep deprivation is highly prevalent among medical students globally and is consistently associated with poorer academic achievement, impaired cognitive performance, increased daytime sleepiness, and higher levels of academic stress. Academic workload, examination pressure, smartphone use, social media exposure, and caffeine consumption appear to be major

contributors to inadequate sleep duration. Medical schools should prioritize sleep health promotion and implement evidence-based interventions aimed at improving sleep behaviors among students. Future longitudinal and interventional studies are required to establish causal relationships and identify the most effective strategies for enhancing sleep and academic performance in medical education.

## CONCLUSION

The present systematic review provides comprehensive global evidence demonstrating that sleep deprivation is highly prevalent among medical students and has a significant negative impact on academic achievement. Across 36 studies involving approximately 24,800 participants, inadequate sleep duration was consistently associated with lower grade point averages, poorer examination performance, impaired concentration, reduced memory retention, diminished learning efficiency, and increased daytime sleepiness.

The review further identified academic workload, examination stress, excessive smartphone use, social media engagement, caffeine consumption, and poor sleep hygiene as major contributors to sleep deprivation among medical students. These factors collectively create an environment that promotes chronic sleep restriction and adversely affects both academic success and psychological well-being.

Given the essential role of sleep in cognitive functioning, learning, and memory consolidation, adequate sleep should be recognized as a critical component of academic performance and professional development in medical education. Educational institutions should incorporate sleep health promotion, stress management strategies, and sleep hygiene education into student wellness programs. Furthermore, curriculum planners should consider the potential impact of excessive academic demands on student sleep and overall well-being.

Future research should prioritize longitudinal and intervention-based studies to clarify causal relationships and evaluate the effectiveness of targeted sleep improvement strategies. Addressing sleep deprivation among medical students has the potential not only to enhance academic outcomes but also to improve mental health, quality of life, and future clinical performance.

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