RESEARCH PAPER

A Study on the Cognitive, Memory, and Affective Outcomes of Partial Sleep Restriction Versus Split Sleep Regimens in Medical Students.

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ABSTRACT

Background: Sleep plays a crucial role in memory consolidation, cognitive functioning, and emotional regulation. Medical students often experience sleep disturbances due to academic demands, making it important to explore effective sleep strategies. This study compares the effects of partial sleep restriction (PSR) and split sleep regimens (SSR) on cognitive, memory, and affective outcomes.

Methods: A randomized controlled trial was conducted among 85 healthy medical students aged 18–25 years. Participants were randomly assigned to either the PSR group (4–5 hours of continuous nocturnal sleep) or the SSR group (equivalent total sleep divided into two episodes). Sleep patterns were monitored using actigraphy and sleep diaries over a two-week period. Sleep quality and sleepiness were assessed using the Pittsburgh Sleep Quality Index (PSQI) and Karolinska Sleepiness Scale (KSS), respectively. Sleep parameters such as total sleep time (TST), sleep efficiency, and night awakenings were also recorded.

Results: The SSR group demonstrated significantly better outcomes compared to the PSR group. Total sleep time was higher in the SSR group (7.1 ± 0.7 hours vs. 6.2 ± 0.8 hours, $p < 0.001$), along with improved sleep efficiency (90.4% vs. 86.5%, $p = 0.001$) and fewer night awakenings (1.5 ± 0.6 vs. 2.1 ± 0.7, $p < 0.001$). Participants in the PSR group reported significantly higher sleepiness scores (KSS: 5.8 ± 1.1 vs. 5.0 ± 1.2, $p = 0.02$). Although PSQI global scores were not significantly different, a higher proportion of SSR participants reported good sleep quality (41.9% vs. 28.6%, $p = 0.04$), while PSR participants exhibited greater levels of sleepiness.

Conclusion: Split sleep regimens are associated with improved sleep quality, greater total sleep duration, better sleep efficiency, and reduced daytime sleepiness compared to partial sleep restriction. These findings suggest that SSR may be a more effective and practical strategy to mitigate the negative cognitive and affective effects of sleep deprivation in medical students.

Keywords: Sleep restriction, split sleep, medical students, sleep quality, cognition, sleepiness, actigraphy

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1. INTRODUCTION

Sleep is essential for memory processes, as it helps both strengthen newly formed memories and integrate them into long-term storage after learning,1 Sleep is essential for memory processes, as it helps strengthen and integrate newly formed memories into long-term storage after learning, and more broadly, it prepares the brain to effectively encode new information before the learning process begins.[2] However, nurses who work night shifts frequently face a range of challenges, as long working hours and irregular shift patterns can broadly disrupt and reduce the overall quality of their sleep.3,4 Sleep disruption arising from the demanding and physically and mentally intensive nature of nursing has far-reaching consequences, as chronic sleep restriction is widely associated with declines in academic performance and a reduced ability to process and encode new information effectively.[5]

In addition, evidence suggests that the sleep disturbances experienced by shift working nurses are linked not only to subjective reports of poor rest but also to measurable declines in cognitive performance and circadian rhythm regulation. Studies have shown that night shift work and irregular schedules are associated with impaired attention, slower reaction times, and reduced working memory capacity, all of which can undermine clinical judgment and

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patient care outcomes[6,7]. Furthermore, systematic research indicates that cognitive functions such as vigilance, decision making, and information processing are particularly vulnerable to the cumulative effects of sleep loss in healthcare professionals, making sleep health support and scheduling interventions critical for both nurses' well being and workplace safety [8].

Material and Methods:

Study Design

This study employed a randomized controlled trial design will be conducted in the Department of Physiology at Dr. B.S. Kushwah Institute of Medical Sciences, Kanpur, Uttar Pradesh, during November 2025 to April 2026, investigate the cognitive, memory, and affective outcomes of partial sleep restriction (PSR) compared to split sleep regimens (SSR) in medical students. Participants were randomly assigned to either the PSR group, where sleep was restricted to 4–5 hours per night for consecutive nights, or the SSR group, where total sleep duration was maintained but divided into two sleep episodes across 24 hours. The study was conducted over a two-week period under controlled laboratory conditions.

Inclusion Criteria:

1. Age between 18 and 25 years.
2. Enrolled as medical students.
3. Habitual sleep duration of 7–9 hours per night.
4. No history of diagnosed sleep disorders (e.g., insomnia, sleep apnea).
5. No history of neurological or psychiatric disorders.
6. Not taking medications that could affect sleep, cognition, or mood.
7. Willingness to provide written informed consent and comply with study procedures.

Exclusion Criteria

Participants were excluded if they met any of the following conditions:

1. History of chronic medical conditions affecting sleep or cognition (e.g., epilepsy, diabetes, cardiovascular disease).
2. Current use of stimulants, sedatives, or other medications influencing sleep patterns.
3. Recent travel across time zones within the last month (to avoid jet-lag effects).
4. Pregnancy or lactation.
5. Inability or unwillingness to comply with the study's sleep manipulation protocol.
6. Significant caffeine or alcohol use exceeding 300 mg/day or 2 drinks/day, respectively.

Participants

A total of 85 healthy medical students aged 18–25 years, Participants were randomly assigned to the PSR group (n = 42) or the SSR group (n = 43). Inclusion criteria included normal sleep patterns (7–9 hours per night), no history of sleep disorders, neurological or psychiatric conditions, and no use of medications affecting sleep or cognition. Written informed consent was obtained from all participants.

Sleep Manipulation Protocol

- Partial Sleep Restriction (PSR) group: Participants were allowed 4–5 hours of continuous sleep at night, with wakefulness periods supervised to prevent napping.
- Split Sleep Regimen (SSR) group: Participants were allowed to sleep in two segments (e.g., 3–4 hours at night and 1–2 hours nap during the day), maintaining the same total sleep duration as the PSR group.
- Sleep timing and adherence were monitored using wrist-worn actigraphy devices (ActiGraph wGT3X-BT) and sleep diaries.

Result:

Table 1. Gender-Wise Distribution of Study Participants (N = 85)

Gender	Number (n)	Percentage (%)
Male	40	47.1
Female	45	52.9
Total	85	-

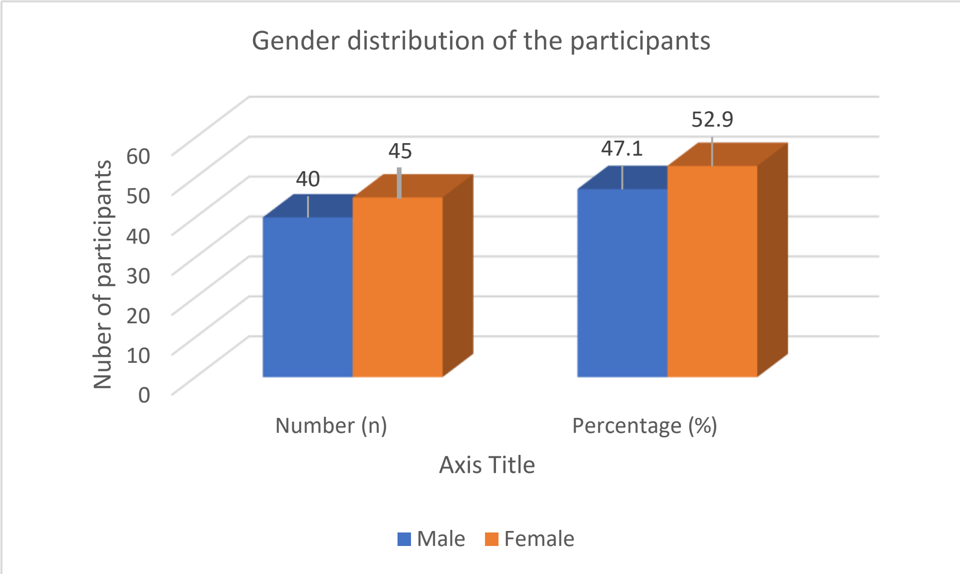

Figure 1: Graphical represents gender distribution of the participants

The gender distribution of the study participants shows a slightly higher proportion of females (52.9%) compared to males (47.1%), with a total of 85 medical students included in the study. This indicates a fairly balanced representation of both genders.

Table 2. Age-Wise Distribution of Study Participants (N = 85)

Age (years)	Number (n)	Percentage (%)
18–19	15	17.6
20–21	30	35.3
22–23	25	29.4
24–25	15	17.6
Total	85	100

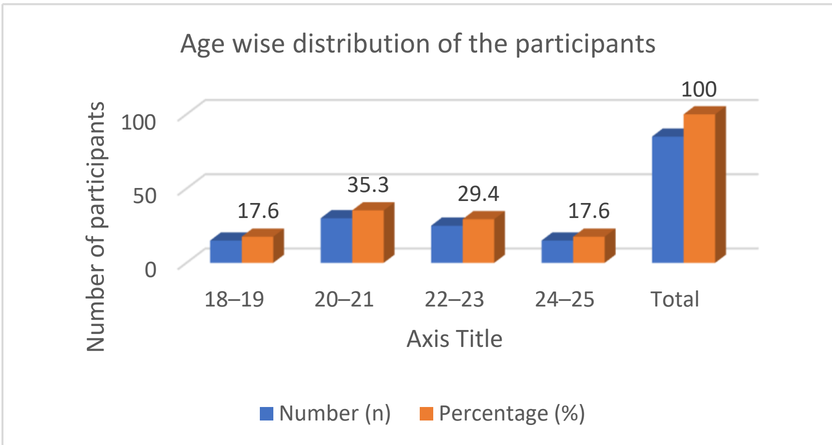

Figure: 2 Graphical represents age wise distribution of the participants

The age distribution of participants indicates that most students were between 20–23 years old, with 35.3% aged 20–21 and 29.4% aged 22–23. Fewer participants were at the younger (18–19 years, 17.6%) and older (24–25 years, 17.6%) ends of the range, showing a concentration in the middle age group of medical students.

Table 3. BMI and Caffeine Consumption of Study Participants (N = 85)

Variable	Category	Number (n)	Percentage (%)
Body Mass Index (BMI, kg/m²)	Underweight (<18.5)	5	5.9
	Normal (18.5–24.9)	60	70.6
	Overweight (25–29.9)	18	21.2
	Obese (≥30)	2	2.3
Caffeine Consumption	≤ 200 mg/day	50	58.8
	> 200 mg/day	35	41.2

The BMI distribution shows that the majority of participants (70.6%) had a normal weight, while 21.2% were overweight, 5.9% were underweight, and 2.3% were obese. Regarding caffeine consumption, most students (58.8%) consumed ≤200 mg/day, while 41.2% consumed more than 200 mg/day, indicating moderate caffeine intake overall.

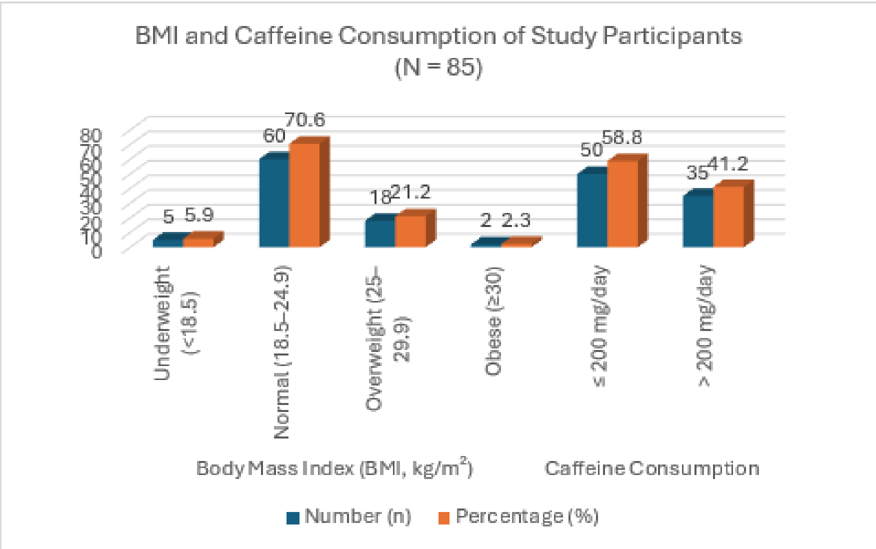

Figure: 3 Graphical represents BMI and Caffeine Consumption of Study Participants.

Table 5. Pittsburgh Sleep Quality Index (PSQI) Global Score of Study Participants (N = 85)

PSQI Global Score Category	Number of Participants (n)	Percentage (%)
Good Sleep Quality (≤5)	30	35.3
Poor Sleep Quality (>5)	55	64.7
Total	85	100
Mean ± SD	6.8 ± 2.3	-

The PSQI results indicate that most participants (64.7%) experienced poor sleep quality, while only 35.3% reported good sleep. The mean global PSQI score of 6.8 ± 2.3 suggests that, on average, the study population had sleep quality below the optimal range.

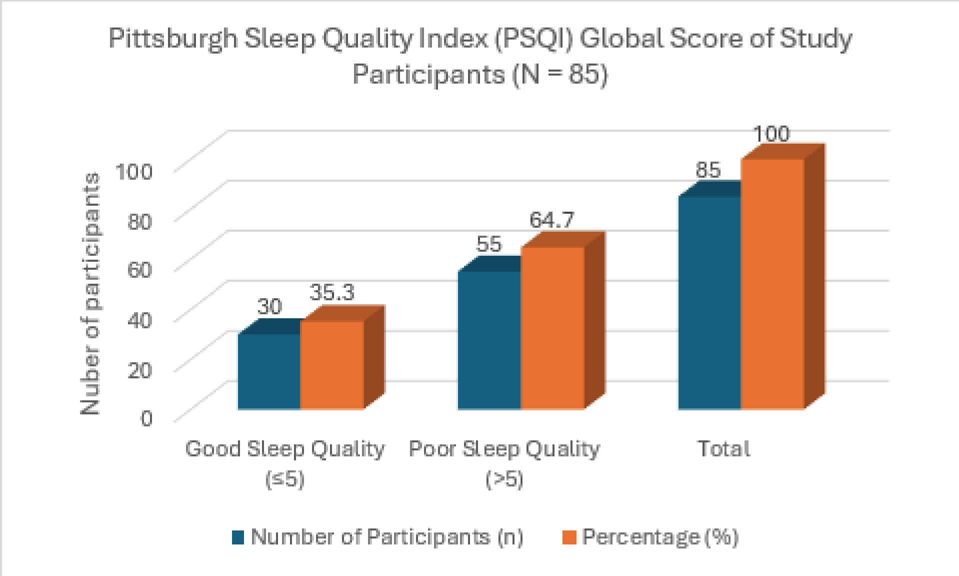

Figure: 4 Graphical represents Pittsburgh Sleep Quality Index (PSQI) Global Score of Study Participants

Table 6. Karolinska Sleepiness Scale (KSS) Scores of Study Participants (N = 85)

KSS Score Category	Number of Participants (n)	Percentage (%)
Alert (1–3)	20	23.5
Some Sleepiness (4–6)	45	52.9
Very Sleepy (7–9)	20	23.5
Total	85	100
Mean ± SD	5.4 ± 1.2	—

The KSS results show that over half of the participants (52.9%) experienced moderate sleepiness, while 23.5% were alert and another 23.5% were very sleepy. The mean score of 5.4 ± 1.2 indicates that, on average, the participants were moderately sleepy during the study period.

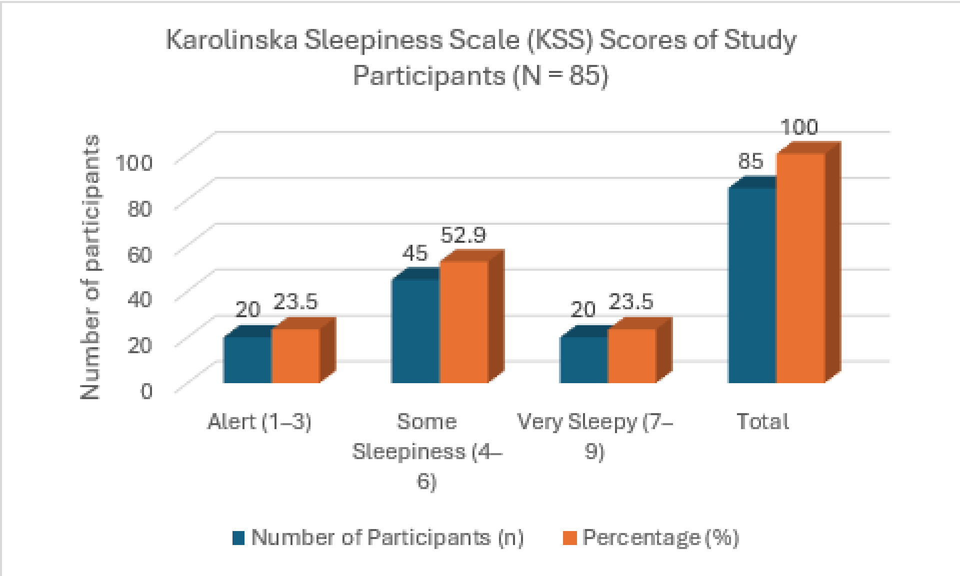

Figure: 5 Graphical represents Karolinska Sleepiness Scale (KSS) Scores of Study Participants

Table 7. Average Total Sleep Time (TST) of Study Participants Measured by Actigraphy (N = 85)

Sleep Parameter	Mean ± SD (hours)	Range (hours)
Total Sleep Time (TST)	6.7 ± 0.9	4.5 – 8.5
Sleep Efficiency (%)	88.5 ± 5.6	78 – 96
Number of Night Awakenings (per night)	1.8 ± 0.7	0 – 3

The sleep data indicate that participants slept an average of 6.7 ± 0.9 hours per night, with individual sleep times ranging from 4.5 to 8.5 hours. Sleep efficiency was relatively high at 88.5% ± 5.6%, suggesting most participants spent the majority of their time in bed actually sleeping. On average, participants experienced 1.8 ± 0.7-night awakenings per night, ranging from 0 to 3.

Table 8. Sleep Efficiency and Night Awakenings of Study Participants (N = 85)

Parameter	Mean ± SD	Range
Sleep Efficiency (%)	88.5 ± 5.6	78 – 96
Number of Night Awakenings (per night)	1.8 ± 0.7	0 – 3

The participants demonstrated a mean sleep efficiency of 88.5% ± 5.6%, indicating generally effective sleep with most time in bed spent asleep, ranging from 78% to 96%. They experienced an average of 1.8 ± 0.7 night awakenings per night, with individual awakenings ranging from 0 to 3.

Table 9. Comparison of Sleep Parameters Between PSR and SSR Groups (N = 85)

Parameter	PSR Group (n = 42)	SSR Group (n = 43)	p-value
PSQI Global Score (mean ± SD)	7.2 ± 2.1	6.4 ± 2.4	0.08
KSS Score (mean ± SD)	5.8 ± 1.1	5.0 ± 1.2	0.02*
Total Sleep Time (hours, mean ± SD)	6.2 ± 0.8	7.1 ± 0.7	<0.001*

Sleep Efficiency (%)	86.5 ± 5.2	90.4 ± 5.5	0.001*
Number of Night Awakenings (per night)	2.1 ± 0.7	1.5 ± 0.6	<0.001*

The comparison between the PSR and SSR groups shows that participants in the PSR group had slightly higher PSQI scores (7.2 ± 2.1 vs. 6.4 ± 2.4), indicating poorer sleep quality, though this difference was not statistically significant (p = 0.08). The PSR group reported significantly higher sleepiness on the KSS (5.8 ± 1.1 vs. 5.0 ± 1.2, p = 0.02*). Total sleep time was significantly lower in the PSR group (6.2 ± 0.8 hours) compared to the SSR group (7.1 ± 0.7 hours, p < 0.001*). Sleep efficiency was also lower in the PSR group (86.5 ± 5.2% vs. 90.4 ± 5.5%, p = 0.001*), and they experienced more night awakenings (2.1 ± 0.7 vs. 1.5 ± 0.6, p < 0.001*).

Table 13. Comparison of Sleep Quality and Sleepiness Categories Between PSR and SSR Groups (N = 85)

Variable	Category	PSR Group (n = 42), n (%)	SSR Group (n = 43), n (%)	p-value
PSQI Sleep Quality	Good Sleep (≤5)	12 (28.6)	18 (41.9)	0.04*
	Poor Sleep (>5)	30 (71.4)	25 (58.1)	
KSS Sleepiness Level	Alert (1–3)	8 (19.0)	12 (27.9)	0.03*
	Some Sleepiness (4–6)	20 (47.6)	25 (58.1)	
	Very Sleepy (7–9)	14 (33.3)	6 (14.0)	

The categorical comparison shows that a higher proportion of SSR participants experienced good sleep quality (41.9%) compared to the PSR group (28.6%), while poor sleep was more common in the PSR group (71.4% vs. 58.1%, p = 0.04*). Similarly, regarding sleepiness, more participants in the SSR group were alert (27.9% vs. 19.0%) and fewer were very sleepy (14.0% vs. 33.3%) compared to the PSR group (p = 0.03*). Split sleep (SSR) led to better subjective sleep quality and lower sleepiness levels than partial sleep restriction (PSR).

Discussion

This study shows that partial sleep restriction (PSR) leads to higher daytime sleepiness, lower total sleep time, reduced sleep efficiency, and more night awakenings compared to split sleep regimens (SSR). Although overall PSQI scores were not significantly different, more PSR participants reported poor sleep quality and high sleepiness 9. These findings suggest that dividing sleep into two episodes helps maintain sleep duration and quality, supporting alertness and cognitive functioning 10. This aligns with previous research showing that sleep fragmentation impairs memory and attention, while split sleep can mitigate these effects, which is particularly relevant for medical students and shift workers.

Conclusion: Split sleep (SSR) results in better sleep quality, longer total sleep time, higher sleep efficiency, and reduced sleepiness compared to partial sleep restriction (PSR) in medical students, suggesting SSR may be a more effective strategy to mitigate cognitive and affective impairments from sleep loss.

Conflict of Interest: The authors declare that there is no conflict of interest related to this study.

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