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Prevalence of Insufficient Sleep Duration and Excessive Daytime Sleepiness Among Undergraduate Physiotherapy Students: A Cross-Sectional Study

Siddesh Ganesan[1*], N. Vasanth Kumar[1], R. Mukesh Kumar[1] and U. V. Mahisree Bharathi[2]

[1]College of Physiotherapy, School of Health Sciences, Dayananda Sagar University, Ramanagara – 562112, Karnataka, India; Siddesh4544@gmail.com

[2]Vels Institute of Science, Technology and Advanced Studies (VISTAS), Pallavaram, Tambaram – 600117, Tamil Nadu, India

Abstract

Background: Insufficient sleep duration and excessive daytime sleepiness are important concerns among university students because of their potential effects on alertness, cognitive functioning, and daily activities. Undergraduate physiotherapy students may experience academic and clinical demands that affect their sleep patterns. **Objective:** To determine the prevalence of insufficient sleep duration on weeknights and weekends, assess the prevalence and severity of excessive daytime sleepiness, and examine associations between sleep-duration categories, demographic characteristics, daytime napping, and Epworth Sleepiness Scale (ESS) scores among undergraduate physiotherapy students. **Materials and Methods:** A cross-sectional study was conducted among 150 undergraduate physiotherapy students aged 18–24 years at Dayananda Sagar University, Karnataka, India. Participants were recruited using convenience sampling. Data were collected using an online questionnaire covering demographic characteristics, sleep duration, daytime napping, and the ESS. Descriptive statistics and appropriate inferential tests were used to analyse the data. Statistical significance was set at $p < 0.05$. **Results:** The mean age of participants was 19.81 ± 1.62 years, and 73.3% were female. Insufficient sleep duration of less than seven hours was reported by 89.3% of participants on weeknights and 49.3% on weekends. The mean ESS score was 8.53 ± 4.35. Overall, 32.7% of participants had ESS scores above 10, indicating varying degrees of excessive daytime sleepiness. Students who reported daytime napping had significantly higher ESS scores than non-nappers (median 9.0 versus 8.0; $p = 0.037$). No statistically significant differences in ESS scores were reported according to weeknight or weekend sleep duration, gender, academic year, or accommodation status. **Conclusion:** Insufficient sleep duration was common among the participating physiotherapy undergraduates, particularly on weeknights. Approximately one-third had ESS scores indicating excessive daytime sleepiness. Daytime napping was associated with higher ESS scores, although the cross-sectional design does not establish causation. Further multicentre studies incorporating comprehensive sleep assessments and potential contributing factors are warranted.

Major Findings: High prevalence of insufficient sleep duration: A majority of undergraduate physiotherapy students (89.3%) reported insufficient sleep duration (less than 7 hours) on weeknights, compared with 49.3% on weekends. **Excessive daytime sleepiness:** Approximately one-third of participants (32.7%) had ESS scores above 10, indicating excessive daytime sleepiness. **Association with daytime napping:** Students who reported daytime napping had significantly higher ESS scores than non-nappers (median 9.0 vs. 8.0; $p = 0.037$), with a small effect size ($r = -0.212$).

Keywords: Cross-Sectional Study, Daytime Napping, Epworth Sleepiness Scale, Excessive Daytime Sleepiness, Insufficient Sleep Duration, Physiotherapy Students, Sleep Behaviour, Sleep Deprivation, Sleep Duration, University Students

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**Author for correspondence*

1. Introduction

Sleep is an essential physiological process that supports cognitive functioning, metabolic regulation, immune function, and overall health. Adequate sleep duration contributes to alertness, memory consolidation, and the maintenance of normal physiological functions. A joint consensus statement from the American Academy of Sleep Medicine and the Sleep Research Society recommends that adults regularly obtain at least seven hours of sleep per night to promote optimal health[1]. Insufficient sleep duration has been associated with adverse health outcomes, including metabolic disturbances and impaired physiological regulation[2].

Sleep deprivation may result from restricted sleep opportunities, irregular sleep schedules, or disturbances that reduce the duration or continuity of sleep. Persistent sleep restriction can adversely affect attention, executive functioning, reaction time, and decision-making[3]. Sleep deprivation has also been associated with several health-related consequences and alterations in normal physiological functioning[4].

Excessive Daytime Sleepiness (EDS) refers to an increased tendency to fall asleep or difficulty maintaining alertness during waking hours. The ESS, developed by Johns, is a widely used self-report instrument that assesses the likelihood of dozing in eight everyday situations[5]. The ESS has been examined for its reliability and measurement properties and provides a standardised method of quantifying subjective daytime sleepiness[6]. Although it is useful for screening and research, the ESS does not independently establish a clinical diagnosis of a sleep disorder.

University students may be vulnerable to insufficient sleep because of academic workload, examination-related stress, irregular daily routines, social activities, and electronic-device use. Research on adolescents and young adults has identified several behavioural, environmental, and health-related contributors to inadequate sleep[7,8]. University students may also experience stress associated with academic responsibilities and the transition to independent living, potentially affecting their sleep habits[9].

Students enrolled in health science programmes may experience demands associated with practical training, clinical placements, examinations, and professional skill development. Studies among medical and health science students have identified excessive daytime sleepiness and other sleep-related problems, although prevalence estimates vary according to the population, study setting, and assessment instrument[10,11]. Studies have also examined excessive daytime sleepiness among adolescent populations, highlighting the importance of considering age and population-specific characteristics when interpreting sleep-related findings[12]. A systematic review of medical students reported substantial sleep disruption and an association between sleep-related problems and academic performance[11]. These findings highlight the importance of examining sleep duration and daytime sleepiness among students pursuing healthcare-related programmes.

Physiotherapy undergraduates undergo theoretical instruction, practical skill training, and clinical exposure that require sustained attention, physical participation, and effective decision-making. Insufficient sleep and daytime sleepiness may therefore be relevant to their academic functioning and preparation for clinical responsibilities. However, findings from medical students and broader university populations cannot automatically be generalised to physiotherapy students because educational structures and clinical requirements may differ.

Sleep deprivation and insufficient sleep have been associated with a broad range of health concerns, reinforcing the importance of adequate sleep as a public health issue[2,4]. In addition, excessive daytime sleepiness can interfere with learning, daily activities, and overall functioning[10]. The present study aimed to determine the prevalence of insufficient sleep duration on weeknights and weekends, assess the prevalence and severity of excessive daytime sleepiness, and examine associations between sleep-duration categories, demographic characteristics, daytime napping, and ESS scores among undergraduate physiotherapy students.

2. Materials and Methods

2.1 Study Design, Setting and Sample Size

The required sample size was estimated using the single-population proportion formula, $n = Z^2p(1-p)/d^2$, where Z represents the standard normal deviate at a 95% confidence level (1.96), p represents the anticipated prevalence (0.50), and d represents the allowable absolute error (0.10). Substituting these values into the formula yielded a minimum estimated sample size of 96.04,

which was rounded up to 97 participants. A total of 150 undergraduate physiotherapy students aged 18–24 years participated in the study. Convenience sampling was used to recruit eligible students who were available and willing to participate.

2.2 Ethical Considerations

Ethical approval was obtained from the Institutional Scientific Committee of the College of Physiotherapy, Dayananda Sagar University, Bangalore, Karnataka, India (Approval Number: ISC/Intern/DSU/2026/1561; Approval Date: 24 September 2026). Participation was voluntary, and informed consent was obtained from all participants before data collection. Participant confidentiality was maintained throughout the research process.

2.3 Inclusion and Exclusion Criteria

Full-time undergraduate physiotherapy students enrolled during the study period were included in the study. Students with known acute or chronic medical or psychiatric conditions likely to affect sleep, those currently taking medications known to influence sleep (such as hypnotics, stimulants, mood stabilisers, or systemic antihistamines), and students with pre-existing sleep disorders were excluded from the study.

2.4 Procedure, Instruments and Variables Used

Participants reported their usual sleep duration on weeknights and weekends. For analysis, sleep duration was categorised as insufficient sleep duration (<7 hours) and adequate sleep duration (≥7 hours). Excessive daytime sleepiness was assessed using the ESS, a validated self-report instrument developed by Johns, consisting of eight everyday situations in which participants rate their likelihood of dozing from 0 to 3, producing a total score ranging from 0 to 24[5]. Higher scores indicate greater subjective daytime sleepiness. For descriptive analysis, ESS scores were classified as normal (0–10), mild sleepiness (11–12), moderate sleepiness (13–15), and severe sleepiness (16–24). Participants with ESS scores greater than 10 were classified as having EDS.

2.5 Statistical Analysis

Data were analysed using descriptive and inferential statistics. Continuous variables were summarised using means and standard deviations or medians and interquartile ranges, as appropriate. Categorical variables were expressed as frequencies and percentages. The prevalence of insufficient sleep duration on weeknights and weekends was calculated with 95% confidence intervals. The Mann–Whitney U test was used to compare ESS scores between two independent groups, and the Kruskal–Wallis test was used to compare ESS scores across academic years. Associations between categorical variables were examined using chi-square or appropriate exact tests. Effect sizes were reported where available. A two-sided p-value of less than 0.05 was considered statistically significant.

Table 1. Demographic and descriptive characteristics of study participants (N = 150)

Variable	Value
Age (years)	Mean ± SD: 19.81 ± 1.62
Gender	
Male	40 (26.7%)
Female	110 (73.3%)
Year of study	
1st year	40 (26.7%)
2nd year	40 (26.7%)
3rd year	40 (26.7%)
4th year	30 (20.0%)
Accommodation	
Day scholar	100 (66.7%)
Hosteller	50 (33.3%)
Weeknight Sleep Duration	
Insufficient (<7 hours)	134 (89.3%)
Adequate (≥7 hours)	16 (10.7%)
Weekend Sleep Duration	
Insufficient (<7 hours)	74 (49.3%)
Adequate (≥7 hours)	76 (50.7%)
Daytime Napping	
Yes	47 (31.3%)
No	103 (68.7%)
ESS Total Score	Mean ± SD: 8.53 ± 4.35
ESS Severity	
Normal (0–10)	101 (67.3%)
Mild (11–12)	20 (13.3%)
Moderate (13–15)	21 (14.0%)
Severe (16–24)	8 (5.3%)

3. Results

3.1 Demographic and descriptive characteristics

The demographic and descriptive characteristics of the 150 participants are presented in Table 1. The mean age was 19.81 ± 1.62 years, with a higher proportion of female participants (110, 73.3%) than male participants (40, 26.7%). Representation across academic years included 40 students (26.7%) each from the first, second, and third years, and 30 students (20.0%) from the fourth year. Regarding accommodation, 100 participants (66.7%) were day scholars and 50 (33.3%) were hostellers. Sleep patterns revealed that most participants experienced insufficient weeknight sleep of less than seven hours (134, 89.3%), whereas weekend sleep duration was more balanced, with 76 participants (50.7%) reporting adequate sleep and 74 (49.3%) reporting insufficient sleep. Additionally, 47 students (31.3%) reported daytime napping. The mean ESS total score was 8.53 ± 4.35, with 101 participants (67.3%) classified as having normal scores, 20 (13.3%) mild sleepiness, 21 (14.0%) moderate sleepiness, and 8 (5.3%) severe sleepiness.

The distribution of weeknight and weekend sleep-duration categories, along with daytime napping behaviour among the participants, is illustrated in Figure 1.

The distribution of participants according to the severity categories of the Epworth Sleepiness Scale (ESS) is presented in Figure 2.

3.2 Prevalence of Insufficient Sleep

The prevalence of insufficient sleep duration (less than seven hours) on weeknights and weekends, along with the corresponding 95% confidence intervals, is illustrated in Figure 3.

3.3 Association Analysis

From Table 3, The Mann–Whitney U test revealed no statistically significant difference in ESS scores between students with insufficient and adequate weeknight sleep (U = 1004.5, p = 0.682, r = 0.063), indicating a negligible effect size.

From Table 4, The Mann–Whitney U test revealed no statistically significant difference in ESS scores between students with insufficient and adequate weekend sleep (U = 2667, p = 0.586, r = 0.052), indicating a negligible effect size.

The distribution of ESS scores according to weeknight sleep-duration categories, weekend sleep-duration categories, and daytime napping behaviour is presented in Figure 4.

ESS severity category was not significantly associated with weeknight sleep sufficiency.

ESS severity category was not significantly associated with weekend sleep sufficiency.

The percentage distribution of ESS severity categories within each weeknight and weekend sleep-duration group is illustrated in Figure 5

Students who reported daytime naps had significantly higher ESS scores than non-nappers. This association may suggest that daytime napping is a

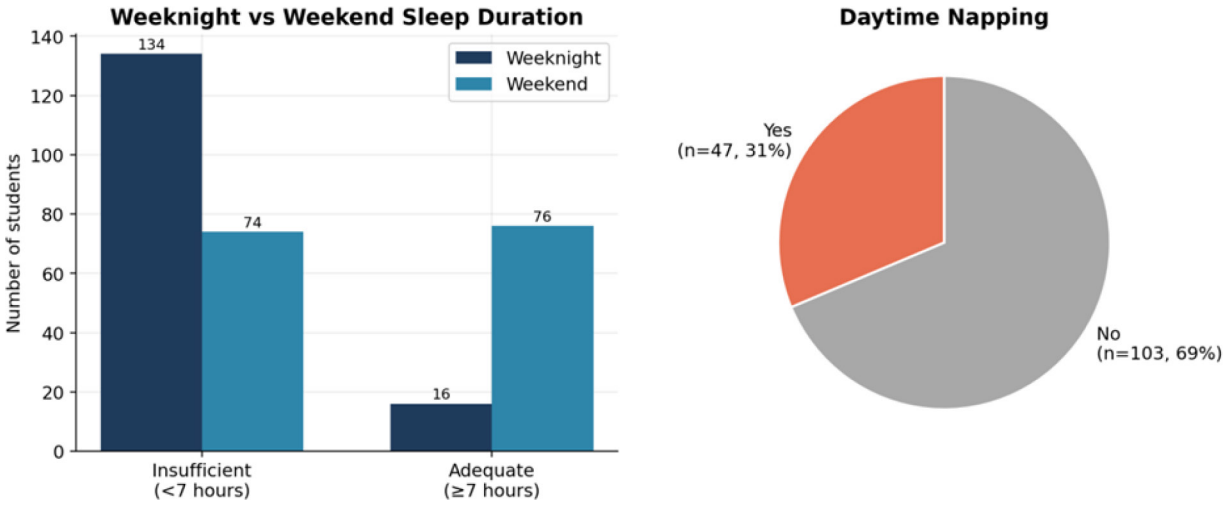

Figure 1. Weeknight vs. weekend sleep duration category, and daytime napping behaviour.

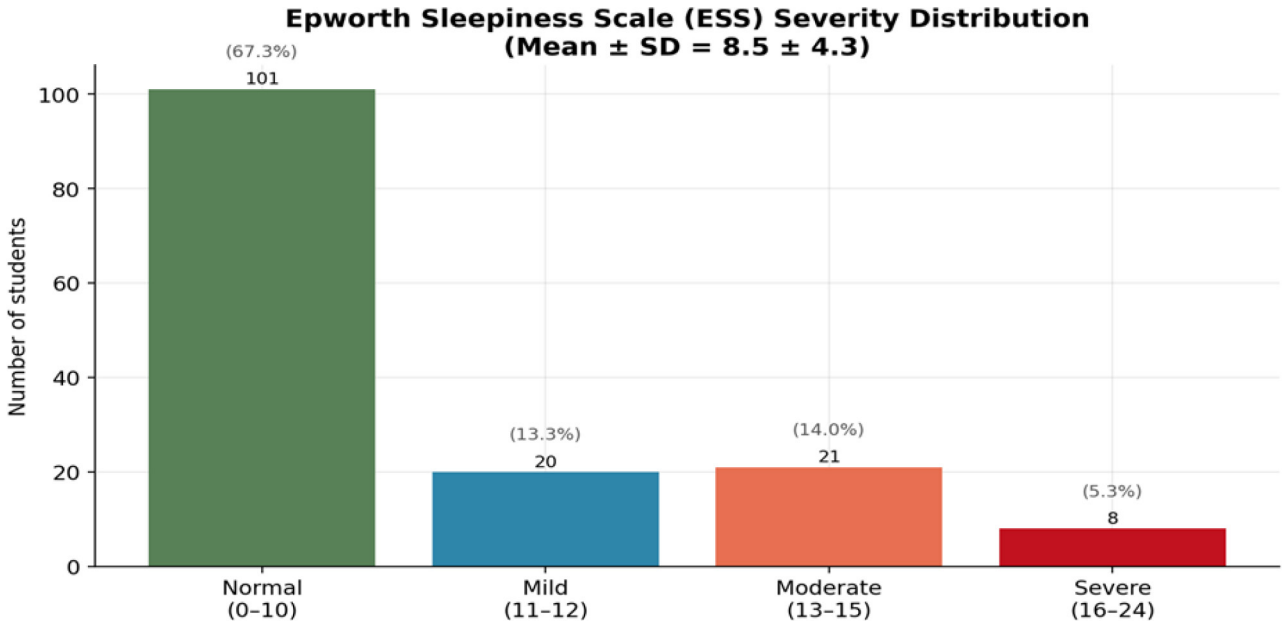

Figure 2. Distribution of Epworth Sleepiness Scale (ESS) severity categories.

Table 2. Prevalence of insufficient sleep (<7 hours) with 95% confidence intervals

Measure	n / N	Prevalence (%)	95% CI (Wilson)
Weeknight insufficient sleep	134 / 150	89.3%	83.4–93.3%
Weekend insufficient sleep	74 / 150	49.3%	41.4–57.3%

Table 3. Comparison of Epworth Sleepiness Scale (ESS) scores between students with insufficient and adequate weeknight sleep duration

Group	N	Median ESS Score	IQR
Insufficient (<7h)	**134**	**8.0**	**6.0-11.*0***
Adequate (>=7h*)*	***16***	**8.*5***	**5.8-13.*0***

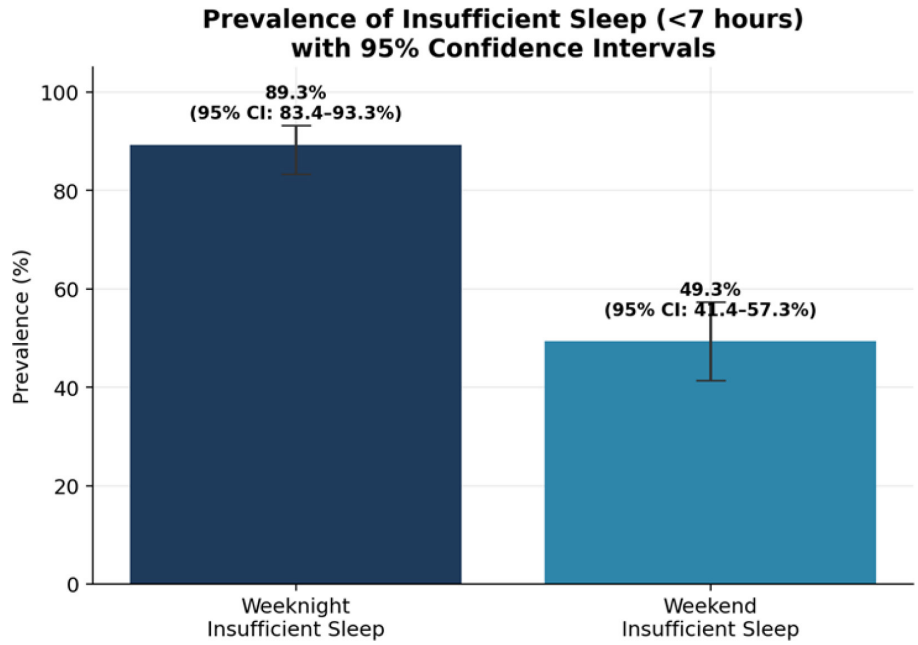

Figure 3. Prevalence of insufficient sleep (<7 hours) on weeknights and weekends, with 95% confidence intervals.

compensatory behaviour among students experiencing daytime sleepiness. However, the cross-sectional design does not establish the direction of this relationship or determine whether napping influences daytime sleepiness.

Weeknight sleep sufficiency did not differ significantly by gender.

Table 4. Comparison of Epworth Sleepiness Scale (ESS) scores between students with insufficient and adequate weekend sleep duration

Group	N	Median ESS Score	IQR
Insufficient (<7h)	**74**	**8.0**	**5.0-10.8**
Adequate (>=7h)	**76**	**8.0**	**6.0-11.0**

ESS score did not differ significantly between male and female students, although females showed a numerically higher median score.

Weeknight sleep sufficiency did not differ significantly across years of study.

ESS score did not differ significantly across years of study, indicating comparable levels of daytime sleepiness regardless of academic year.

Weeknight sleep sufficiency was not significantly associated with accommodation type ($p = 0.076$), although day scholars showed a numerically higher proportion of insufficient sleep than hostellers.

ESS scores did not differ significantly between hostellers and day scholars.

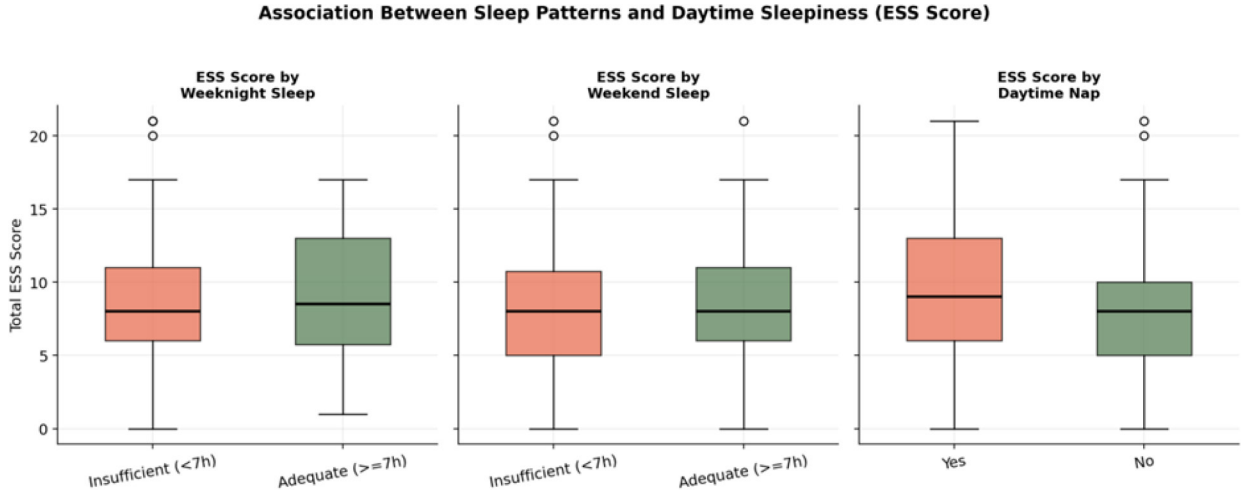

Figure 4. Distribution of ESS score by weeknight sleep category, weekend sleep category, and daytime napping.

Table 5. Association between weeknight sleep-duration categories and Epworth Sleepiness Scale (ESS) severity categories

Sleep Category	Mild Excessive Daytime Sleepiness	Moderate Excessive Daytime Sleepiness	Normal Daytime Sleepiness	Severe Excessive Daytime Sleepiness
Adequate (≥7h)	2	4	9	1
Insufficient (<7h)	18	17	92	7

Chi-square: $\chi^2 = 1.912$, df = 3, p = 0.591 (not statistically significant), Cramér's V = 0.113

Table 6. Association between weekend sleep-duration categories and Epworth Sleepiness Scale (ESS) severity categories

Sleep Category	Mild Excessive Daytime Sleepiness	Moderate Excessive Daytime Sleepiness	Normal Daytime Sleepiness	Severe Excessive Daytime Sleepiness
Adequate (≥7h)	12	13	49	2
Insufficient (<7h)	8	8	52	6

Chi-square: $\chi^2 = 4.054$, df = 3, p = 0.256 (not statistically significant), Cramér's V = 0.164

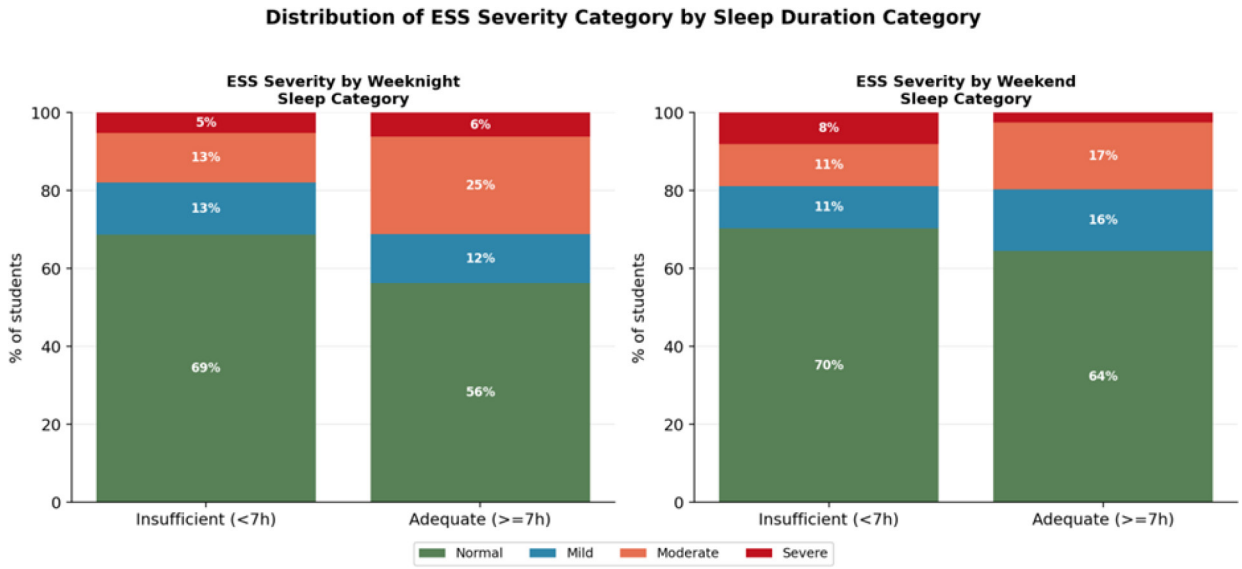

Figure 5. Percentage distribution of ESS severity category within each weeknight and weekend sleep-duration group.

Table 7. Comparison of Epworth Sleepiness Scale (ESS) scores between students who reported daytime napping and those who did not

Group	N	Median ESS Score	IQR
Yes	47	9.0	6.0-13.0
No	103	8.0	5.0-10.0

Mann-Whitney U: U = 2934, p = 0.037 (statistically significant), effect size r = -0.212

Table 8. Association between gender and weeknight sleep-duration categories

Gender	Adequate (≥7h)	Insufficient (<7h)
Female	13	97
Male	3	37

Fisher exact: $\chi^2 = 0.21$, p = 0.561 (not statistically significant), Cramér's V = 0.037

Table 9. Comparison of Epworth Sleepiness Scale (ESS) scores between male and female

Group	N	Median ESS Score	IQR
Male	40	6.0	4.0-11.2
Female	110	8.5	6.0-11.0

Mann-Whitney U: U = 1787, p = 0.079 (not statistically significant), effect size r = 0.188

Table 10. Association between academic year and weeknight sleep-duration categories among undergraduate physiotherapy students

Year	Adequate (≥7h)	Insufficient (<7h)
1st year	4	36
2nd year	7	33
3rd year	3	37
4th year	2	28

Chi-square: $\chi^2 = 2.222$, df = 3, p = 0.528 (not statistically significant), Cramér's V = 0.122

Table 11. Comparison of Epworth Sleepiness Scale (ESS) scores across different academic years

Year of Study	N	Median ESS Score
1st year	40	8.5
2nd year	40	8.5
3rd year	40	8
4th year	30	8

Kruskal-Wallis H: H(3) = 0.476, p = 0.924 (not statistically significant)

Table 12. Association between accommodation status and weeknight sleep-duration categories

Accommodation	Adequate (≥7h)	Insufficient (<7h)
Day Scholar	7	93
Hosteller	9	41

Chi-square: $\chi^2 = 3.157$, df = 1, p = 0.076 (not statistically significant), Cramér's V = 0.145

Table 13. Comparison of Epworth Sleepiness Scale (ESS) scores between day scholars and hostellers

Group	n	Median ESS Score	IQR
Hosteller	50	9.0	6.0-10.8
Day Scholar	100	8.0	5.8-11.0

Mann-Whitney U: U = 2655, p = 0.537 (not statistically significant), effect size r = -0.062

4. Discussion

The present study investigated insufficient sleep duration and excessive daytime sleepiness among 150 undergraduate physiotherapy students. The principal findings were a high prevalence of insufficient weeknight sleep (89.3%), a lower prevalence of insufficient weekend sleep (49.3%), excessive daytime sleepiness in 32.7% of participants based on ESS scores above 10, and a statistically significant association between daytime napping and ESS scores. However, no statistically significant differences in ESS scores were observed according to sleep-duration categories, gender, academic year, or accommodation status.

Insufficient sleep duration was substantially more prevalent on weeknights than on weekends, indicating differences in sleep patterns between academic and non-academic days. This finding suggests that students may have fewer opportunities for adequate sleep during the academic week. Adequate sleep duration is important for maintaining physiological health and cognitive functioning, and insufficient sleep has been associated with adverse health outcomes[1,2]. Previous research has also highlighted the influence of academic and lifestyle-related factors on university students' sleep experiences[9]. However, the specific reasons for the observed differences in weeknight and weekend sleep duration were not investigated in the present study.

The mean ESS score was 8.53 ± 4.35, and 32.7% of participants had scores above 10, indicating elevated subjective daytime sleepiness. Among the participants, 13.3% had mild, 14.0% had moderate, and 5.3% had severe daytime sleepiness. Previous studies among medical and health science students have also reported excessive daytime sleepiness and other sleep-related problems, although prevalence estimates vary according to population characteristics, study settings, and assessment methods[10,11]. These findings highlight the relevance of examining sleep-related outcomes among students pursuing healthcare-related programmes.

Despite the high prevalence of insufficient weeknight sleep, no statistically significant difference in ESS scores was observed between students reporting insufficient and adequate sleep duration (p = 0.682). Similarly, weekend sleep duration was not significantly associated with ESS scores (p = 0.586). These findings indicate that reported sleep duration alone may not adequately explain variations in subjective daytime sleepiness. The absence of statistically significant associations between sleep duration and ESS scores may also be influenced by several potential confounding factors that were not assessed in the present study. Factors such as caffeine consumption, electronic-device use before bedtime, academic workload, clinical training schedules, commuting time, and psychological stress or anxiety may independently or collectively influence sleep patterns and daytime alertness. For instance, caffeine consumption may temporarily influence perceived alertness, while irregular clinical schedules and prolonged screen exposure may affect sleep timing and duration. Similarly, psychological stress may contribute to sleep disturbances and daytime sleepiness independently of reported sleep duration. Since these variables were not measured, their potential influence on the observed associations cannot be determined. Future studies should incorporate these factors to provide a more comprehensive understanding of the relationship between sleep duration and daytime sleepiness among physiotherapy students.

A statistically significant difference in ESS scores was observed between students who reported daytime napping and those who did not. Students who reported daytime naps had a higher median ESS score (9.0) than non-nappers (8.0), with a small effect size (r = −0.212; p = 0.037), indicating a modest difference between the groups. Daytime napping may represent a compensatory behaviour among students experiencing increased daytime sleepiness or insufficient nighttime sleep. However, the cross-sectional design does not establish the direction of this relationship. Furthermore, the frequency, duration, and timing of naps were not assessed, limiting further interpretation of this association.

No statistically significant differences in ESS scores were observed according to gender, academic year, or accommodation status. Similarly, weeknight sleep sufficiency was not significantly associated with gender, academic year, or accommodation type. Although day scholars demonstrated a numerically higher proportion of insufficient weeknight sleep than hostellers, this

difference was not statistically significant (p = 0.076). These findings suggest that sleep-related concerns were observed across different demographic and academic subgroups within the participating population.

Sleep loss has been associated with alterations in brain activity involving networks responsible for attention and cognitive processing, providing a physiological basis for investigating daytime sleepiness in student populations[13]. However, cognitive performance, academic achievement, and clinical performance were not directly assessed in the present study. Therefore, their potential impairment cannot be inferred from the observed sleep-related findings.

Previous research involving physical therapy students has also explored relationships between psychological well-being, sleep quality, and academic performance[14]. This supports the relevance of investigating sleep-related outcomes in physiotherapy education. Physiotherapy undergraduates undergo theoretical instruction, practical skill training, and clinical exposure, which require sustained attention and active participation. The high prevalence of insufficient weeknight sleep and the proportion of students reporting elevated ESS scores highlight the importance of promoting awareness of healthy sleep practices within physiotherapy education. Nevertheless, further research is required to establish how sleep-related factors influence academic and clinical functioning among physiotherapy students.

The findings of the present study are consistent with broader evidence highlighting sleep-related concerns among university students. A systematic review of university students in India reported considerable variations in sleep duration, sleep quality, excessive daytime sleepiness, and chronotype, emphasising the importance of sleep health in this population[15]. Similarly, a systematic review and meta-analysis involving medical students identified a substantial prevalence of insufficient sleep duration and excessive daytime sleepiness, with sleep quality and daytime sleepiness showing associations with academic performance[16]. Previous literature has also highlighted that inadequate sleep and daytime sleepiness may adversely affect learning, memory, mood, and academic functioning among college students[17]. Although the present study did not directly assess academic performance or cognitive functioning, the high prevalence of insufficient weeknight sleep and excessive daytime sleepiness observed among the participants reinforces the importance of addressing sleep health as part of student well-being and academic support programmes.

Overall, the findings highlight insufficient sleep duration and excessive daytime sleepiness as relevant sleep-related concerns among undergraduate physiotherapy students. The observed association between daytime napping and ESS scores further emphasises the importance of considering daytime sleep-related behaviours alongside nighttime sleep duration. These findings support the need for greater awareness of sleep health within physiotherapy education and provide a basis for further investigations incorporating additional behavioural, psychological, and academic factors.

5. Limitations

The present study has certain limitations. Its cross-sectional design assessed sleep duration and daytime sleepiness at a single point in time and therefore does not establish causal relationships. Convenience sampling from a single institutional setting may limit the generalisability of the findings to physiotherapy students in other institutions. Furthermore, sleep duration and daytime napping were self-reported and may be subject to recall or reporting bias. The assessment was limited to reported sleep duration and ESS scores and did not comprehensively evaluate sleep quality, sleep regularity, or objective sleep parameters. Potential confounding variables, including caffeine consumption, screen exposure before bedtime, academic workload, clinical rotation schedules, commuting time, psychological stress, anxiety, and depression, were not assessed. These factors may have influenced sleep duration and daytime sleepiness. Additionally, the frequency, duration, and timing of daytime naps were not recorded. Future studies incorporating these variables and objective sleep assessments may provide a more comprehensive understanding of sleep-related outcomes among physiotherapy students.

6. Recommendations

Future studies should consider recruiting participants from multiple physiotherapy institutions using larger samples to improve generalisability. A more comprehensive assessment of sleep using validated sleep-quality questionnaires, sleep diaries, and objective measures such as actigraphy may provide better insight

into students' sleep patterns. Further research should investigate potential contributing factors, including academic workload, clinical placement schedules, commuting time, psychological stress, anxiety, caffeine consumption, and electronic-device use before bedtime. Longitudinal studies may help examine changes in sleep duration and daytime sleepiness across academic years and clinical training periods. At the institutional level, physiotherapy colleges may consider introducing sleep hygiene awareness programmes and educational workshops to promote healthy sleep habits among students. Academic institutions may also consider reviewing early-morning lecture schedules and clinical rotation timings, where feasible, to support adequate sleep opportunities.

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Author Contribution

Siddesh Ganesan: Study design, methodological support, data verification, manuscript review, critical revision of the article, and final approval of the manuscript. Vasanth

Kumar N: Conceptualization, data collection, statistical analysis, interpretation of results, manuscript drafting, and correspondence with the journal. R. Mukesh Kumar: Supervision, Data verification, Validation, and Writing– Review and Editing. U. V. Mahisree Bharathi Supervision, Validation, and Writing– Review and Editing.

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