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Original Article

Poor Sleep Quality and Daytime Dysfunction Among Senior High School Students in Sorowako, Indonesia: A Cross-Sectional Study

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ABSTRACT

Introduction: Poor sleep is common during adolescence and may impair daytime functioning, learning, and overall well-being. Evidence from Indonesian adolescents living outside major urban centers remains limited. *This study aims to* determine the prevalence of poor sleep quality and daytime dysfunction among senior high school students in Sorowako, Indonesia, and to identify the factors associated with these outcomes.

Methods: This cross-sectional study included 618 senior high school students. Sleep quality and daytime dysfunction were assessed using the Indonesian version of the Pittsburgh Sleep Quality Index (PSQI); a global score >5 indicated poor sleep quality. Nutritional status was classified using the Centers for Disease Control and Prevention body mass index (BMI)-for-age percentiles. Late-night academic activity was defined as usually completing school assignments after 9:00 PM. Associations were examined using the chi-square test, crude odds ratios (ORs), and multivariate logistic regression.

Results: Poor sleep quality was identified in 280 students (45.3%), and 460 (74.4%) reported experiencing daytime dysfunction. Poor sleep quality was more frequent among female than male students (50.4% vs. 38.8%; OR 1.60, 95%

confidence interval [CI] 1.16–2.21; p = 0.004) and among students who completed assignments after 9:00 PM (54.4% vs. 39.2%; OR 1.85, 95% CI 1.34–2.57; p < 0.001). Late-night academic activity was also associated with daytime dysfunction (81.5% vs. 69.7%; OR 1.91, 95% CI 1.29–2.81; p = 0.001). Nutritional status was not associated with sleep quality (P = 0.335). After adjusting for age, female sex (AOR 1.55, 95% confidence interval [CI], 1.09–2.20; p = 0.015) and late-night academic activity (AOR 1.78, 95% CI, 1.23–2.57; p = 0.002) remained independently associated with poor sleep quality.

Conclusion: Nearly half of the senior high school students in Sorowako had poor sleep quality, and three-fourths reported daytime dysfunction. Female sex and late-night academic activity were associated with poor sleep outcomes, whereas nutritional status was not. School-based sleep health education and attention to evening academic workload may be warranted.

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1. INTRODUCTION

Adolescence is a critical developmental period characterized by rapid physical, cognitive, emotional, and social changes. During this period, maturational changes in sleep regulation shift the timing of sleep later, whereas school schedules remain early; together with increasing academic and social demands, this mismatch produces short and poorly timed sleep in many adolescents.[1] The American Academy of Sleep Medicine recommends 8 to 10 hours of sleep per 24 hours for adolescents aged 13 to 18 years, and regularly sleeping less than this amount has been linked to problems with attention, behavior, learning, and emotional regulation.[2]

Sleep quality is a multidimensional construct that encompasses sleep latency, duration, efficiency, disturbances, and the consequences of sleep on daytime functioning. Daytime dysfunction, which includes difficulty staying awake during daily activities and reduced enthusiasm to complete tasks, is a direct expression of inadequate sleep and may compromise cognitive performance and psychological well-being.[1,3] Evening behaviors, including late-night studying and screen exposure, can delay sleep onset and shorten the opportunity for sleep when wake times are fixed by school schedules.[4,5]

Sleep has also been examined in relation to the nutritional status. Short or poor-quality sleep may promote weight gain through altered appetite regulation, reduced physical activity, and metabolic changes, whereas excess adiposity may impair sleep through discomfort and sleep-disordered breathing.[6–9] However, the evidence linking sleep quality specifically with weight status in adolescents remains inconsistent.[7]

In Indonesia, the Indonesian version of the Pittsburgh Sleep Quality Index (PSQI) has been validated in adolescents,[10] but population-based data on sleep quality, daytime dysfunction, and late-night academic activity among senior high school students remain scarce, particularly outside large metropolitan areas. Sorowako, located in East Luwu Regency, South Sulawesi, is a nickel mining town with a distinct socioeconomic and

community setting. Senior high school students in this setting face academic pressure related to national assessments and university admission; however, no local data are available to guide school health programs. Such data are needed to identify at-risk groups and design context-appropriate interventions.

Therefore, this study aimed to determine the prevalence of poor sleep quality and daytime dysfunction among senior high school students in Sorowako and examine their associations with sex, nutritional status, and late-night academic activity.

2. METHODS

Study design and setting

This cross-sectional analytical study was conducted among senior high school students in Sorowako, Nuha District, East Luwu Regency, South Sulawesi Province, Indonesia. Data were collected from January to March 2025 across three senior high schools. The study was reported in accordance with the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.

Participants and sampling

The target population comprised all students enrolled in senior high schools in Sorowako during the 2024/2025 academic year. A total sampling technique was employed, whereby all students who met the eligibility criteria during the study period were invited to participate in the study. The inclusion criteria were (1) enrollment as a senior high school student in Sorowako during the study period and (2) willingness to participate, with consent obtained as described below. Students who did not complete the PSQI questionnaire were excluded.

Of the 650 eligible students, 650 were invited, 20 declined to participate, and 12 were excluded because of incomplete questionnaire data, leaving 618 students for analysis. Body mass index (BMI) data were unavailable for 35 participants (5.7%) because of absence on the day of anthropometric measurement; these participants were retained in all analyses that did not involve nutritional status. The final sample of 618 exceeded the minimum of 385 participants required to estimate a prevalence of 50% with an absolute precision of 5% at a 95% confidence level.

Ethical considerations

The study protocol was approved by the Faculty of Medicine, Kurnia Jaya Persada University, Palopo, South Sulawesi, Indonesia. Permission was obtained from the participating schools. Written informed consent was obtained from the parents or guardians of participants younger than 18 years, together with the students' assent; participants aged 18 years or older provided their own written consent. Participation was voluntary, and all data were anonymized before analysis.

Assessment of sleep quality

Sleep quality was assessed using the Indonesian version of the PSQI, a self-administered questionnaire that evaluates sleep over the preceding month.[11] Its 19 items generate seven component scores (subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleeping medication, and daytime dysfunction), each ranging from 0 to 3. The component scores are summed to produce a global score of 0 to 21, with higher scores indicating poorer sleep quality. The Indonesian version has demonstrated adequate internal consistency, construct validity, and known-group validity among Indonesian adolescents.[10] In the present study, the internal consistency

of the questionnaire was evaluated using Cronbach's alpha, yielding a coefficient of 0.82, indicating good internal consistency. Consistent with the original instrument and to facilitate international comparisons, a global PSQI score greater than 5 was used to define poor sleep quality, whereas a score of 5 or lower indicated good sleep quality. Sleep latency and sleep duration were also reported descriptively using the corresponding PSQI items.[11] Sleep latency and sleep duration were also reported descriptively using the corresponding PSQI items.

Assessment of daytime dysfunction

Daytime dysfunction was derived from PSQI component 7, which combines the frequency of trouble staying awake while driving, eating, or engaging in social activity with the degree of difficulty in maintaining enthusiasm to get things done.[11] The component score was categorized as no problem (0), mild (1), moderate (2), or severe (3). For bivariate analysis, daytime dysfunction was dichotomized as absent (score 0) or present (score 1–3).

Assessment of late-night academic activity

Late-night academic activity was assessed with a single additional questionnaire item: "What time do you usually finish completing your school assignments on school nights?" The response options were as follows: (1) before 8:00 PM, (2) between 8:00 PM and 9:00 PM, (3) between 9:00 PM and 10:00 PM, and (4) after 10:00 PM. Students who usually completed their school assignments after 9:00 PM (21:00) on school nights (response options 3 and 4) were classified as engaging in late-night academic activity, whereas those who usually finished at or before 9:00 PM (response options 1 and 2) were classified as not engaging in late-night academic activity. This cut-off was defined a priori because, with classes starting at approximately 07:00, completing assignments after 9:00 PM leaves limited opportunity to achieve the recommended 8–10 hours of sleep.[2]

Anthropometric measurements and nutritional status

Body weight was measured to the nearest 0.1 kg using a digital weighing scale (Omron HN-289, Omron Healthcare, Japan), and height was measured to the nearest 0.1 cm using a portable stadiometer (SECA 213, SECA GmbH & Co. KG, Germany). Measurements were performed by trained research assistants, with the participants wearing light clothing and no shoes. Both measurements were obtained twice, and the mean of the two measurements was used for the analysis. The weighing scale was calibrated using a standard reference weight before each measurement session, and the stadiometer was checked against a fixed reference length to ensure measurement accuracy.

BMI was calculated as weight in kilograms divided by height in meters squared. Because the participants were younger than 20 years, nutritional status was classified using sex-specific BMI-for-age percentiles from the 2000 Centers for Disease Control and Prevention (CDC) growth charts[12]: underweight (<5th percentile), healthy weight (5th to <85th percentile), overweight (85th to <95th percentile), and obesity (≥95th percentile).

Data collection procedures

Data were collected at the participating schools during school hours. After the study objectives and procedures were explained, participants completed the questionnaires independently under the supervision of the researchers or trained assistants, who were available to clarify items without influencing responses. Anthropometric measurements were performed in a separate room to ensure privacy.

Statistical analysis

Data were analyzed using IBM SPSS Statistics version 30.0 (IBM Corp., Armonk, NY, USA). Continuous variables are presented as mean ± standard deviation (SD) or median (range), and categorical variables as frequencies and percentages. Associations between categorical variables were examined using Pearson's chi-square test or Fisher's exact test when more than 20% of cells had an expected count below 5. Crude odds ratios (ORs) with 95% confidence intervals (CIs) were calculated for binary comparisons.

Multivariable binary logistic regression was performed to identify factors independently associated with poor sleep quality. Age, sex, nutritional status (reference: healthy weight), and late-night academic activity were entered simultaneously, and results are expressed as adjusted ORs (AORs) with 95% CIs. Model fit was assessed using the Hosmer–Lemeshow test, and multicollinearity was checked using variance inflation factors. Sleep duration was not entered into the model because it is a component of the PSQI global score; its inclusion would introduce circularity between the exposure and outcome. Analyses involving nutritional status were restricted to participants with complete BMI data (n = 583). Exact p-values are reported to three decimal places, with values below 0.001 reported as $p < 0.001$. All tests were two-sided, and $p < 0.05$ was considered statistically significant.

3. RESULTS

Participant characteristics

A total of 618 students were included in this analysis. The mean age was 16.17 ± 0.86 years (median, 16 years; range, 15–19 years), and 345 participants (55.8%) were women. Among the 583 students with BMI data, 435 (74.6%) had a healthy weight, 59 (10.1%) were underweight, 54 (9.3%) were overweight, and 35 (6.0%) were obese. Overall, 248 students (40.1%) reported that they usually completed school assignments after 9:00 PM (Table 1).

Table 1. Characteristics of the study participants

Characteristic	Value
Age, years, mean ± SD	16.17 ± 0.86
Age, years, median (range)	16 (15–19)
Sex, n (%)	
Male	273 (44.2)
Female	345 (55.8)
Nutritional status, n (%)[a]	
Underweight	59 (10.1)
Healthy weight	435 (74.6)
Overweight	54 (9.3)
Obesity	35 (6.0)
Missing BMI data[b]	35 (5.7)
Late-night academic activity, n (%)	
No (finished at or before 9:00 PM)	370 (59.9)
Yes (finished after 9:00 PM)	248 (40.1)

Note: SD, standard deviation; BMI, body mass index. [a]Percentages were calculated among participants with BMI data (n = 583); classification based on CDC BMI-for-age percentiles. [b]Percentage of the total sample (N = 618).

Sleep quality and sleep characteristics

Poor sleep quality (PSQI global score >5) was identified in 280 students (45.3%). Most students (91.3%) reported a sleep latency of 30 minutes or less. The most common sleep duration was 6–7 hours per night (47.2%), and only 29.1% of students slept more than 7 h, whereas 23.6% slept 6 hours or less (Table 2).

Table 2. Sleep quality and sleep characteristics

Variable	n (%)
Sleep quality (PSQI global score)	
Good (≤5)	338 (54.7)
Poor (>5)	280 (45.3)
Sleep latency	
≤30 minutes	564 (91.3)
>30 minutes	54 (8.7)
Sleep duration per night	
>7 hours	180 (29.1)
6–7 hours	292 (47.2)
5–6 hours	107 (17.3)
<5 hours	39 (6.3)

Note: PSQI: Pittsburgh Sleep Quality Index.

Daytime dysfunction

Overall, 460 (74.4 %) students reported some degree of daytime dysfunction. Mild dysfunction was the most common category (45.1%), followed by moderate (24.3%) and severe (5.0%) dysfunction, whereas 158 students (25.6%) reported no daytime dysfunction (Table 3).

Table 3. Daytime dysfunction (PSQI component 7)

Daytime dysfunction	n (%)
No problem (score 0)	158 (25.6)
Mild (score 1)	279 (45.1)
Moderate (score 2)	150 (24.3)
Severe (score 3)	31 (5.0)
Any dysfunction (score 1–3)	460 (74.4)

Note: PSQI: Pittsburgh Sleep Quality Index.

Factors associated with sleep quality

Poor sleep quality was more common among female students than male students (50.4% vs. 38.8%; OR 1.60, 95% CI 1.16–2.21; $p = 0.004$). Students who completed assignments after 9:00 PM also had a higher prevalence of poor sleep quality than those who finished earlier (54.4% vs. 39.2%; OR 1.85, 95% CI 1.34–2.57; $p < 0.001$). Although poor sleep quality was most frequent among students with obesity (60.0%), nutritional status was not significantly associated with sleep quality ($p = 0.335$), and the crude OR for obesity compared with healthy weight was not significant (OR 1.90, 95% CI 0.94–3.83). As expected, students who slept for 7 hours or less had a higher prevalence of poor sleep quality than those who slept

for more than 7 h (54.1% vs. 23.9%; p < 0.001); because sleep duration is a component of the PSQI global score, this comparison is presented for descriptive purposes only (Table 4).

Table 4. Bivariate analysis of factors associated with poor sleep quality

Variable	Good sleep quality, n (%)	Poor sleep quality, n (%)	Crude OR (95% CI)	p-value
Sex (n = 618)				0.004
Male	167 (61.2)	106 (38.8)	1.00 (reference)	
Female	171 (49.6)	174 (50.4)	1.60 (1.16–2.21)	
Late-night academic activity (n = 618)				<0.001
No (≤9:00 PM)	225 (60.8)	145 (39.2)	1.00 (reference)	
Yes (>9:00 PM)	113 (45.6)	135 (54.4)	1.85 (1.34–2.57)	
Nutritional status (n = 583)				0.335
Underweight	31 (52.5)	28 (47.5)	1.14 (0.66–1.97)	
Healthy weight	243 (55.9)	192 (44.1)	1.00 (reference)	
Overweight	29 (53.7)	25 (46.3)	1.09 (0.62–1.92)	
Obesity	14 (40.0)	21 (60.0)	1.90 (0.94–3.83)	
Sleep duration[a] (n = 618)				<0.001
>7 hours	137 (76.1)	43 (23.9)	—	
≤7 hours	201 (45.9)	237 (54.1)	—	

Note: Percentages are the row percentages. p-values from Pearson's chi-square test. OR, odds ratio; CI, confidence interval. [a]Sleep duration is a component of the PSQI global score and is shown for descriptive purposes only; it was not included in the multivariable model.

Late-night academic activity and daytime dysfunction

Late-night academic activities were significantly associated with daytime dysfunction (p = 0.001). Specifically, 81.5% of students who completed their school assignments after 9:00 PM reported daytime dysfunction, compared with 69.7% of those who finished at or before 9:00 PM. Students engaging in late-night academic activities had approximately 1.91 times higher odds of daytime dysfunction than those who completed their assignments earlier (OR 1.91, 95% CI 1.29–2.81) (Table 5). Nutritional status was not significantly associated with daytime dysfunction (p = 0.197; data not shown).

Table 5. Association between late-night academic activity and daytime dysfunction

Late-night academic activity	Daytime dysfunction present, n (%)	No daytime dysfunction, n (%)	Crude OR (95% CI)	p-value
No (≤9:00 PM)	258 (69.7)	112 (30.3)	1.00 (reference)	0.001
Yes (>9:00 PM)	202 (81.5)	46 (18.5)	1.91 (1.29–2.81)	

Note: Percentages are the row percentages. p-value from Pearson's chi-square test. Daytime dysfunction = PSQI component 7 score of 1–3. OR, odds ratio; CI, confidence interval.

Multivariable analysis

In the multivariable logistic regression analysis, female sex and late-night academic activity remained independently associated with poor sleep quality after adjusting for age and

nutritional status. Female students had 1.55 times higher odds of poor sleep quality than male students (AOR 1.55, 95% CI 1.09–2.20; p = 0.015). Similarly, students who completed their assignments after 9:00 PM had higher odds of poor sleep quality than those who finished earlier (AOR 1.78, 95% CI 1.23–2.57; p = 0.002). Age and nutritional status were not significantly associated with poor sleep quality in the adjusted model. The Hosmer–Lemeshow goodness-of-fit test indicated no evidence of poor model fit ($\chi^2 = 6.21$; p = 0.623), while the Nagelkerke R^2 was 0.061 (Table 6).

Table 6. Multivariable logistic regression of factors associated with poor sleep quality

Variable	AOR	95% CI	p-value
Age (per year)	1.04	0.82–1.31	0.750
Female sex (vs. male)	1.55	1.09–2.20	0.015
Underweight	1.12	0.62–2.04	0.710
Overweight	1.06	0.55–2.05	0.860
Obesity	1.79	0.79–4.07	0.160
Late-night academic activity	1.78	1.23–2.57	0.002

Note: Reference category for nutritional status: healthy weight. Reference category for sex: male. Reference category for academic activity: no late-night academic activity. AOR, adjusted odds ratio; CI, confidence interval. All variables were entered simultaneously. Hosmer–Lemeshow test: $\chi^2 = 6.21$, p = 0.623; Nagelkerke $R^2 = 0.061$.

4. DISCUSSIONS

This study identified three principal findings among senior high school students in Sorowako. First, poor sleep quality was common, affecting 45.3% of students, and three in four students reported some degree of daytime dysfunction. Second, female students had higher odds of poor sleep quality than male students. Third, completing school assignments after 9:00 PM was associated with both daytime dysfunction and poor sleep quality. In contrast, nutritional status was not associated with either outcome.

The prevalence of poor sleep quality in this study is comparable to that reported among adolescents in other Asian settings using the same PSQI cut-off; for example, 52.5% of adolescents in Mumbai, India, had a global PSQI score >5.5 Notably, most students in our sample fell asleep within 30 minutes, suggesting that difficulty initiating sleep was not the main driver of poor sleep quality. Instead, insufficient sleep appears to be more relevant: only 29.1% of students slept more than 7 hours per night, meaning that most did not meet the recommended 8 to 10 hours for their age.2 This pattern is consistent with the “perfect storm” model of adolescent sleep, in which a maturational delay in circadian timing combines with early school start times and academic and social demands to restrict sleep opportunity.1 Because the later sleep cycles, which contain a greater proportion of rapid eye movement sleep, are preferentially lost when sleep is curtailed, chronic sleep restriction may affect processes relevant to learning and emotional regulation.1,3

The higher prevalence of poor sleep quality among female students (50.4% vs. 38.8%) is consistent with previous reports that adolescent girls report poorer sleep quality and more sleep complaints than boys.13 Proposed explanations include earlier pubertal maturation and hormonal changes in girls, a higher prevalence of insomnia symptoms and emotional distress, and sex differences in evening behaviors, such as social media use.13,14 Sex differences in how adolescents perceive and report their sleep may also contribute because the PSQI is a self-reported measure. These findings suggest that sleep health promotion in schools should give specific attention to female students.

The association between late-night academic activity and daytime dysfunction is potentially important because homework timing is a modifiable behavior that schools and families can address. When wake time is fixed by the school schedule, finishing academic work late in the evening is likely to delay bedtime and shorten total sleep; in addition, cognitively demanding activity and screen use close to bedtime may increase pre-sleep arousal.4,5 The parallel association with poor sleep quality supports this interpretation. However, the direction of these associations could not be determined because of the cross-sectional design. Students with an evening chronotype or with pre-existing daytime fatigue may work more slowly and therefore finish assignments later, and the association may also be influenced by unmeasured factors such as academic workload, screen time, and psychological stress.3,14

Nutritional status was not associated with sleep quality or daytime dysfunction. Although the proportion of poor sleep quality was highest among students with obesity (60.0%), the confidence interval for the corresponding OR was wide and included 1.0, most likely reflecting the small number of students with obesity (n = 35) and limited statistical power. Previous studies have reported a bidirectional relationship between sleep and adiposity,6,8,9,15,16 but systematic reviews indicate that associations are more consistent for sleep timing and duration than for subjective sleep quality.7,14 Our findings therefore do not exclude an association, and they should be confirmed in larger samples that include more adolescents with overweight or obesity and that account for diet, physical activity, and screen time.17–20

These findings have several practical implications. School health programs in Sorowako should incorporate sleep health education that emphasizes regular sleep schedules, adequate sleep duration, and limiting academic work and screen use late in the evening. Coordinating homework assignments across subjects may help reduce the need for students to work late hours. Parents and school health services can support these efforts by monitoring students' evening routines and identifying those with persistent daytime dysfunction.

This study has several limitations. First, its cross-sectional design precludes causal inference. Second, sleep quality and daytime dysfunction were self-reported and may be subject to recall and reporting bias; furthermore, daytime dysfunction is itself a component of the PSQI, so the two outcomes are not independent. Third, late-night academic activity was measured using a single, non-validated item that did not capture the type or duration of evening activity. Fourth, we used the conventional PSQI cut-off of >5, whereas the Indonesian adolescent validation study suggested a higher optimal cut-off of 6.510; the prevalence of poor sleep quality may therefore be somewhat overestimated compared with that obtained using the population-specific threshold. Fifth, BMI data were missing for 5.7% of participants, which may have introduced selection bias in the nutritional status analyses. Sixth, potentially important confounders, including screen time, psychological stress, socioeconomic status, physical activity, chronotype, and caffeine intake, were not measured. Finally, the study was conducted in a single town, which may limit generalizability to other Indonesian settings. Strengths of the study include its relatively large sample, the use of a validated instrument, and the direct measurement of anthropometric variables.

5. CONCLUSION

Poor sleep quality affected 45.3% of senior high school students in Sorowako, and 74.4% reported some degree of daytime dysfunction. Sex was associated with poor sleep quality, and completing school assignments after 9:00 PM was associated with daytime dysfunction and poor sleep quality. Nutritional status was not associated with either outcome. Because of the cross-sectional design, these associations should not be interpreted as causal. Nevertheless, the findings support school-based sleep health education and closer attention to evening academic workload, particularly for female students. Longitudinal studies that include objective sleep measures and a broader range of behavioral factors are needed.

CONFLICT OF INTEREST

The authors declare no conflicts of interest.

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This research did not receive any external funding.

DATA AVAILABILITY

The data supporting the findings of this study are available from the corresponding author upon reasonable requests.

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Conflict of Interest Statement:

The author declares that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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