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The association between sleep quality and anemia incidence among Junior high school students: A cross-sectional study

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Abstract (10 pt)

Background: Anemia is a common health issue among adolescents, particularly due to iron deficiency. Poor sleep quality is believed to contribute to the prevalence of anemia; however, the relationship between the two remains a topic of debate.

Objective: This study aims to determine the relationship between sleep patterns and the incidence of anemia in adolescents at a Junior high school.

Method: This research employed a quantitative method with a cross-sectional approach. The study population consisted of 161 students, from whom a sample of 115 respondents was selected using a purposive sampling technique. Data collection involved administering the Pittsburgh Sleep Quality Index (PSQI) questionnaire to assess sleep quality and measuring hemoglobin (Hb) levels using the Easy Touch GCHB tool. Data analysis was performed using the Chi-Square statistical test.

Results: The findings revealed that the majority of respondents (55.7%) experienced poor sleep quality, and 44.3% were found to have moderate anemia. The results of the bivariate analysis using the Chi-Square test indicated no significant relationship between sleep patterns and the incidence of anemia among junior high school students, with a p-value of 0.217 (>0.05).

Conclusion: Sleep quality does not significantly affect the incidence of anemia in junior high school students. Other factors, such as diet, iron intake, and physical activity, may have a greater impact on hemoglobin levels. Therefore, it is essential to enhance health education related to nutrition and establish good sleep patterns to help prevent anemia in adolescents.

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1. Introduction

Adolescence, which spans the ages of 10 to 19, is a crucial developmental stage marked by significant physical growth, hormonal changes, and rapid cognitive development (WHO, 2023). During this period, proper nutrition and adequate sleep are crucial for meeting increased metabolic demands (Sears et al., 2021). Neglecting these biological needs can lead to

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widespread public health issues, such as anemia and poor sleep quality (Pibriyanti et al., 2025; Manish, 2025). It is essential to comprehend the individual and combined effects of these factors in order to develop effective health promotion initiatives, particularly in resource-constrained settings.

Anemia is a condition characterized by a deficiency of red blood cells or low hemoglobin levels, which reduces the blood's ability to carry oxygen (Wirth & Melse-Boonstra, 2021). According to the World Health Organization (WHO), over 1.6 billion people are affected by anemia, with adolescents, particularly girls, being at a higher risk. This increased susceptibility is often due to factors such as insufficient dietary intake and blood loss during menstruation (Stoltzfus, 2022). Iron deficiency anemia (IDA) is the most common type found in this age group, impacting 25% to 61% of adolescents globally, especially in low- and middle-income countries (Fitariani et al., 2025; Manish, 2025). In addition to physical fatigue, anemia can negatively affect cognitive functions, leading to issues such as decreased attention, memory difficulties, and lower academic performance (Smith et al., 2020). It can also impair intelligence, mental health, and overall development, significantly impacting school achievement and concentration (Suprayogi et al., 2023; Chauhan et al., 2016). Moreover, anemia compromises the immune system, increasing the risk of infections (Ministry of Health Indonesia, 2021). The high rates of anemia among school-aged adolescents in Indonesia highlight the urgent need for local studies to identify key modifiable risk factors for this public health issue.

In addition to nutrition, adequate patterns of sleep and rest, considering duration, efficiency, timing, and personal sleep quality, are essential for maintaining physiological balance and supporting neurological growth (Walker, 2017). Adolescence often leads to changes in circadian rhythms, resulting in delayed sleep onset and insufficient sleep duration, a phenomenon known as social jetlag (Carskadon, 2020). The Pittsburgh Sleep Quality Index (PSQI) is a widely recognized tool used globally to assess sleep disturbances. From a physiological perspective, chronic sleep deprivation and poor sleep quality serve as significant stressors, triggering a low-grade systemic inflammatory response (Irwin, 2015). This ongoing inflammatory response is believed to be a key mechanism linking poor sleep with various health issues, including potential disorders in iron metabolism.

Despite this strong biological rationale, epidemiological research confirming a direct and substantial link between subjective sleep quality and the occurrence of anemia in adolescents remains inconclusive. Numerous extensive population-based studies have found a significant inverse relationship, supporting the idea that improved sleep hygiene may act as a protective factor against anemia (Chang et al., 2018). Conversely, several similarly comprehensive studies conducted in various global contexts reported no significant correlation, suggesting that primary nutritional deficiencies in iron and other micronutrients may have a far greater impact on hemoglobin status, overshadowing the minor effects of sleep-related inflammation (Lee & Wong, 2019). The variations in these research findings underscore the need for localized studies to account for distinct regional factors, such as dietary practices, rates

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of parasitic infections, and specific socioeconomic influences, which may alter this relationship.

This research focused on a group of adolescent junior high school students in Dompu Regency, West Nusa Tenggara, Indonesia. Initial data indicated that a significant percentage of these students were experiencing poor sleep quality (55.7%) and a considerable prevalence of moderate anemia (44.3%) (Central Bureau of Statistics, 2022). This simultaneous occurrence emphasizes the need to explore the potential connection between these two issues in this at-risk population. Furthermore, the objective of this study was to investigate the relationship between sleep patterns and the prevalence of anemia among junior high school students.

2. Methods

2.1 Research design

This study utilized a quantitative, cross-sectional research design featuring a descriptive-correlational approach. This design was chosen to explore the connection between sleep quality patterns and the prevalence of anemia among adolescents at a specific time point, while controlling for other variables (Polit & Beck, 2020).

2.2 Setting and samples

The research was conducted at SMP Negeri 3 Woja, located in Dompu Regency, in November 2024. The target demographic consisted of 161 female students from the school. To ensure a representative sample, the sample size was determined using Slovin's formula, which included a 5% margin of error, resulting in a minimum requirement of 115 participants.

Participants were chosen using a purposive sampling method based on specific inclusion and exclusion criteria. The inclusion criteria were: (1) female students aged between 10 and 19 years, (2) students enrolled at SMP Negeri 3 Woja, and (3) willingness to take part in the study. The exclusion criteria included students who were absent during the data collection period.

2.3 Measurement and data collection;

Data gathering involved two main tools: a demographic and sleep quality questionnaire, and a digital hemoglobinometer.

Sleep Quality: Sleep patterns were evaluated using the Pittsburgh Sleep Quality Index (PSQI). This standardized tool comprises 19 self-reported questions categorized into seven component scores: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction. Each component is rated on a scale from 0 to 3. The overall PSQI score varies from 0 to 21, with scores greater than 5 indicating poor sleep quality and scores of 5 or lower indicating good sleep quality (Buysse et al., 1989).

Hemoglobin Levels: The status of anemia was assessed by measuring capillary blood hemoglobin levels with the Easy Touch GCHB digital monitoring system. Anemia severity was categorized based on hemoglobin (Hb) levels: Normal (≥12 g/dL), Mild Anemia (11.0–11.9 g/dL), Moderate Anemia (8.0–10.9 g/dL), and Severe Anemia (<8.0 g/dL).

2.4 Data analysis;

The data were analyzed using statistical software. Univariate analysis was performed to illustrate the characteristics of the respondents, including age, sleep quality scores, and hemoglobin levels, presented as frequencies and percentages. Bivariate analysis utilized the

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Chi-square test to investigate the relationship between sleep quality (independent variable) and the prevalence of anemia (dependent variable). The threshold for statistical significance was set at $p < .05$.

2.5 Ethical considerations.

Prior to data collection, written informed consent was obtained from all participants. The study upheld the principles of beneficence, non-maleficence, and justice. Participation was voluntary, with respondents assured of their right to withdraw at any moment. Anonymity and confidentiality were strictly maintained by using coding systems (initials) instead of names during data processing and analysis.

3. Results

3.1 Univariate analysis

The demographic and clinical characteristics of the respondents are presented in Tables 1 and 2. The majority of the participants were female (n =73, 63.5 %) and fell within the early adolescent age range of 11–14 years (n =94, 81.7 %).

Regarding hematological status (table 2), the prevalence of anemia was notably high. Only 26.1% of students had normal hemoglobin (Hb) levels. The largest proportion of students suffered from moderate anemia (44.3 %), followed by mild (17.4 %) and severe anemia (12.2 %). Regarding sleep hygiene, the study revealed that more than half of the respondents (55.7 %) experienced poor sleep quality.

Table 1. Demographic characteristics od respondents (n=115)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	42	36,5
	Female	73	63,5
Age	10 – 14 years old	94	81,7
	15 – 19 years old	21	18,3

Table. 2 Hemoglobin levels and sleep quality (n=115)

Variable	Category	Frequency (n)	Percentage (%)
Hemoglobin level	Normal	30	26,1
	Mild Anemia	20	17,4
	Moderate Anemia	52	44,3
	Severa Anemia	14	12,2
Sleep quality	Good	51	44,4
	Poor	64	55,7

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3.2 Bivaraiate analysis

Bivariate Analysis aims to determine the relationship between sleep patterns and the incidence of anemia; a Chi-Square test was performed. The cross-tabulation (Table 3) indicates that among those with poor sleep quality (n=64), the highest proportion suffered from moderate anemia (27.8 %). However, statistical analysis yielded a p-value of 0.217 ($p > 0.05$). Consequently, the alternative hypothesis (Ha) is rejected, indicating no statistically significant relationship between sleep quality and the incidence of anemia among adolescents at SMP Negeri 3 Woja.

Table 3. Relationship between sleep quality and anemia incidence (chi-square test)

Hb Status	Good Sleep Quality		Poor Sleep Quality		Total		p-value
	n	%	n	%	n	%	
Normal	18	15,7	12	10,4	30	26,1	
Mild Anemia	9	7,8	11	9,6	20	17,4	0,217
Moderat Anemia	19	16,5	43	27,8	51	44,3	
Severe Anemia	5	4,3	9	7,8	14	12,2	
Total	51	44,3	64	55,7	115	100	

4. Discussion

This study aimed to investigate the potential relationship between sleep quality and anemia in adolescents in a developing region. The key finding reveals an unexpected outcome: while both anemia (73.9%) and poor sleep quality (55.7%) are notably prevalent, no statistically significant link exists between these two factors ($p = 0.217$). This outcome contrasts with earlier research, such as that by Handini et al. (2023), which suggested a strong connection ($p = 0.003$). However, this finding is consistent with the results of Sahashika and Setiyaningrum (2024) and Oktorina and Ramadhan (2025), who also reported no direct association. The absence of a significant relationship in this context necessitates a thorough analysis of physiological, nutritional, and methodological factors.

The lack of correlation suggests that, in this particular demographic, the causes of anemia are primarily driven by nutritional deficiencies rather than the secondary physiological consequences of sleep deprivation. The survey participants are predominantly female (63.5%) and in early adolescence (81.7%). During this developmental stage, the need for iron increases due to rapid growth and the onset of menstruation. Research indicates that adolescents in Indonesia often consume diets low in heme iron (found in meat) and high in inhibitors (such as tannins and phytates) (Aulya et al., 2022; Widhawati et al., 2024). It is reasonable to propose that the extent of nutritional iron deficiency in Dompu is the primary cause of anemia, overshadowing any minor biological effects that sleep disturbances may have on erythropoiesis. When the primary resource (iron) is lacking, the regulatory elements (such as sleep and circadian rhythm) become less relevant to the outcome.

In theory, a lack of sleep disrupts the circadian rhythm, leading to systemic inflammation and reduced erythropoietin levels, which could worsen anemia (Neumann et al., 2021). However, the finding of "no relationship" suggests that the observed poor sleep in this population may

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stem from environmental or behavioral factors, such as screen time and academic pressures, rather than from chronic pathological insomnia that significantly disrupts metabolic homeostasis (Ayuningdyah et al., 2024). If the sleep disturbances are temporary or occasional, the body's compensatory mechanisms might sustain hematopoiesis, preventing a direct decline in hemoglobin levels. Furthermore, recent research indicates that the connection between sleep and anemia is complex and bidirectional; anemia can lead to fatigue, which is often misidentified as "sleepiness" but does not necessarily correspond to "poor sleep quality" as assessed by subjective surveys (Susanto et al., 2024).

5. Implication and limitations

The findings have important implications for health initiatives targeting adolescents. Since sleep quality was not found to contribute to anemia, programs aimed at reducing anemia rates at SMP Negeri 3 Woja should prioritize nutritional education and supplementation. The existing government initiative for iron supplementation (Tablet Tambah Darah) requires more rigorous monitoring and verification of compliance (Kas et al., 2022).

Although there is no statistical connection, the significant prevalence of poor sleep (55.7%) is a serious health issue in its own right. School nurses and health officials should recognize sleep hygiene as a separate area for intervention, as it is essential for mental well-being and cognitive functioning, even if it does not directly address anemia. Given that females represent the majority of those affected, educational initiatives should focus on menstrual hygiene and promote iron-rich diets specifically designed for young women to mitigate the physiological blood loss that worsens anemia (Sukmanawati et al., 2023).

Several limitations should be considered when interpreting these findings. First, the cross-sectional design of the study prevents the establishment of causal relationships. Second, the reliance on self-reported questionnaires to evaluate sleep quality introduces subjective bias, as adolescents may struggle to recall their sleep onset and duration accurately. Third, the study did not account for significant confounding variables, such as dietary iron intake, parasitic infections (including hookworm), or menstrual blood loss, all of which are important factors influencing hemoglobin levels. Lastly, any calibration errors or the sensitivity of the Point-of-Care Testing (POCT) instruments used for hemoglobin assessment may have affected data accuracy, potentially contributing to the statistically non-significant outcome.

6. Conclusion

This research indicates that anemia and inadequate sleep quality are both common issues among adolescents at SMP Negeri 3 Woja. However, these two health concerns are unrelated to each other. The absence of a significant connection suggests that anemia in this population is likely influenced by factors other than sleep hygiene, primarily nutritional deficiencies and the physiological changes associated with puberty and menstruation. Therefore, health programs should address these issues simultaneously but through distinct strategies: implementing nutritional interventions to combat anemia and developing educational initiatives aimed at improving sleep hygiene to enhance overall health and academic success.

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Author contribution

WL: led the data collection at SMP Negeri 3 Woja and prepared the original manuscript draft. SKD: supervised the research process, refined the methodology, and managed project administration. FA: performed the formal statistical analysis and validated the interpretation of the data. Both SKD and FA made significant contributions to the critical revision and editing of the final manuscript. All authors approved the final version for submission.

Conflict of interest

The authors declare there is a conflict of interest in this study.

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