



Sleep Quality and Stress as Determinants of Headache in Adolescents Attending Senior High Schools in Ambon City

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Abstract

Background: Cephalgia is a condition where the sufferer will feel a sensation of pain in the head area which sometimes the sensation can spread to the face and neck. Factors that can trigger headaches are poor quality of sleep and stress.

Objective: This study was conducted with the aim of the influence of sleep quality and stress on the incidence of headaches in high school students in Ambon City.

Methods: This type of research is an analytical observational approach, cross-sectional design with a sample size of 367 and using accidental sampling techniques. The analysis used in this study is univariate and bivariate analysis using the chi-square test.

Results: The results of this study obtained the majority of respondents who experienced headaches had poor sleep quality 10.90% and the majority of respondents who experienced headaches had moderate stress levels 8.45%. Based on the results of bivariate analysis using the Chi-square test showed that there was a relationship between sleep quality and headaches, with a value of ($p = 0.014$) and the results of the Fisher test showed that there was a relationship between sleep quality and stress levels, with a value of ($p = 0.000$). Further analysis using multivariate tests showed that stress levels were the most influential variables on headaches with a value of ($p = 0.000$).

Conclusion: Thus, this study shows the importance of the role of parents and schools in terms of rest and sleep and problems being faced both at school and at home.

Keywords: Headache, Quality of sleep, Stress and Teenagers

Introduction

Headache remains a prevalent health complaint among adolescents. The prevalence of headache among school-aged adolescents continues to be substantial and constitutes a major contributor to school absenteeism. Moreover, the burden of headache often necessitates parental and family involvement in caregiving, which may adversely affect parental work productivity.¹

Adolescence is characterized by increasing autonomy and responsibility and represents one of the most critical developmental periods in an individual's life, marking the transitional phase from childhood to adulthood and influencing future maturity. Several factors have been reported to be associated with headache, including poor sleep quality and psychological stress. Both conditions are commonly experienced by adolescents and may negatively affect academic and non-academic productivity at school.² A study by Bierhals *et al.* in Brazil reported that among 1,916 adolescents aged 15 years, the prevalence of primary headache disorders was distributed as follows: migraine without aura (14,7%), migraine with aura (3,6%), and tension-type headache (31,8%).²

Sleep quality refers to an individual's subjective experience of sleep that results in feelings of refreshment and physical well-being upon awakening. Optimal sleep processes and conditions generally reflect a high level of sleep quality. In contrast, stress is a common physical and emotional response that occurs when individuals are exposed to environmental changes requiring physiological or psychological adaptation. Early detection and appropriate management of primary headache disorders in adolescents are essential to optimize health outcomes and overall quality of life.³⁻⁶ A small clinical study conducted by Khati *et al.* at the Neurology Clinic of The Ohio State University and Nationwide Children's Hospital in Columbus investigated risk factors associated with headache in adolescents. Among 29 adolescents included in the study, headache was found to be associated with stress (86%), sleep disturbances (41%), and back pain (35%).³

A preliminary study conducted by Machmud Amir and Adi Galih in 2023 among 48 second-grade senior high school students (santri) at Walisongo Islamic Boarding School, Sragen, examined the association between sleep quality, stress levels, and primary headache (migraine). The study demonstrated a significant relationship between sleep quality and stress levels with primary headache (migraine) among the students ($p = 0,010$).³ In 2022, the number of adolescents enrolled in senior high schools and equivalent institutions in Ambon City was recorded at 20,499 individuals, according to data from the Ambon City Department of Education.⁴ To date, no studies have been conducted among this adolescent population to examine the association between sleep quality, stress level, and headache occurrence. Therefore, this study was undertaken to address this research gap.

Headache, medically referred to as *cephalalgia*, is a condition characterized by pain localized in the head region, which may occasionally radiate to the face and neck. Adolescence represents a highly productive developmental stage marked by increased curiosity and activity, which may predispose individuals to inadequate sleep quality and elevated stress levels, which are commonly reported to be associated with headache occurrence. Based on these considerations, this study was conducted to examine the association between sleep quality, stress level, and headache occurrence among senior high school students in Ambon City.

Methods

This study employed an analytical cross-sectional design and was conducted among senior high school students in Ambon City, Indonesia, in August 2024. The study population consisted of adolescents aged 14–18 years who were actively enrolled in public and private senior high schools. Participants were recruited using accidental (convenience) sampling. Students who were present in selected classes during the scheduled data collection sessions and met the eligibility criteria were invited to participate. Data collection was conducted during school hours with permission from school authorities. The sampling procedure involved visiting selected schools and classes that agreed to participate and inviting all eligible students present at the time of data collection.

Students were included if they agreed to participate and provided informed consent (with parental consent where applicable). Students with diagnosed neurological or medical conditions that could cause secondary headache—such as brain tumors, epilepsy, history of significant head trauma, chronic sinusitis, hypertension, or regular use of medications affecting the nervous system—were excluded. Students were not excluded based on a general history of headache, since headache occurrence was the primary outcome variable. The minimum sample size was calculated using the formula for comparison of two categorical proportions, resulting in a minimum required sample of 330 participants.

The primary outcome was headache occurrence, defined operationally as at least one episode of headache during the last month before data collection. Headache status was assessed using a structured self-report question with dichotomous response options (yes/no). In addition, migraine screening was performed using the Migraine Screen Questionnaire (MS-Q). The study did not attempt to clinically distinguish primary and secondary headache types; therefore, headache assessment relied on self-reported symptoms and screening responses, which may be subject to recall bias.

Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI), a validated self-report instrument consisting of 19 items that generate a global score ranging from 0 to 21. A global PSQI score ≤ 5 was classified as good sleep quality, and a score > 5 as poor sleep quality, based on established cut-off values. Stress level was measured using the Perceived Stress Scale (PSS-10), a 10-item self-report questionnaire widely used to assess perceived stress. Total scores were initially categorized into four levels (no stress, mild, moderate, and severe) according to recommended cut-off points.

For inferential analysis, the stress variable was recategorized into two groups (mild vs. moderate) by collapsing adjacent categories (no+mild and moderate+severe). This recategorization was performed to ensure adequate cell counts in cross-tabulation analyses, reduce sparse-data bias, and improve the stability and interpretability of the logistic regression model. Such category collapsing is a recognized approach when some original categories contain small sample sizes.

All questionnaires were administered in the Indonesian language in a classroom setting under the researcher's supervision. Standardized instructions were provided, and students were allowed to ask clarification questions. Data were collected anonymously to ensure confidentiality.

Data were analyzed using SPSS software. Descriptive statistics were used to summarize participant characteristics and the distribution of sleep quality, stress level, and headache occurrence. Bivariate associations between sleep quality, stress level, and headache were tested using the chi-square test or Fisher's exact test when expected cell counts were small. Variables with p-values <0.25 in bivariate analysis, together with age and sex as potential confounders, were entered into a multivariate binary logistic regression model with headache status (yes/no) as the dependent variable. Results were reported as adjusted odds ratios (AORs) with 95% confidence intervals and p-values. Statistical significance was defined as $p < 0.05$.

This study received ethical approval from the Ethics Committee of the Faculty of Medicine, Pattimura University (Approval No. 179/FK-KOM.ETIK/VIII/2024).

Results

Table 1 shows that a total of 367 students participated in this study. Most respondents were aged 16 years (36,8%) and 17 years (32,4%), followed by 15 years (21,5%), 18 years (6,3%), and 14 years (3,0%). Female students slightly outnumbered males (53,4% vs 46,6%).

Based on the PSQI assessment, the majority of respondents had poor sleep quality (60,2%), while 39,8% had good sleep quality. Stress level, after category collapsing for analysis, showed that 56,7% of participants were classified in the moderate stress group and 43,3% in the mild stress group. Headache was reported by 14,4% of respondents, while 85,6% reported no headache in the defined recall period.

Table 1. Characteristics of Respondents Based on Age, Sex, Sleep Quality, Stress Level, and Headache Occurrence

	n	%
Age (Years)		
14	11	3
15	79	21,5
16	135	36,8
17	119	32,4
18	23	6,3
Total	367	100
Sex		
Male	171	46,6
Female	196	53,4
Total	367	100
Sleep Quality		
Good	146	39,8
Poor	221	60,2
Total	367	100
Stress Level		
Mild stress	159	43,3
Moderate stress	208	56,7
Total	367	100
Headache		
Yes	53	14,4
No	314	85,6
Total	367	100

Table 2 presents that when stratified by sex, poor sleep quality was more common than good sleep quality in both males and females. Among males, 28,07% had poor sleep quality, and among females, 32,15% fell into the poor sleep quality category.

For stress level (two-category classification), moderate stress was more frequent among female students (62,76%) compared with male students (49,71%). Conversely, the mild stress category was more common among males (50,29%) than females (37,24%). This indicates a higher proportion of female respondents with elevated stress levels.

Table 2 Distributions of Sleep Quality and Stress by Sex

Variables	Male		Female	
	n	%	n	%
Sleep Quality				
Good	68	18,53	78	21,25
Poor	103	28,07	118	32,15
Stress Level				
Mild Stress	86	50,29	73	37,24
Moderate Stress	85	49,71	123	62,76

Table 3 presents the association between sleep quality, stress level, and headache occurrence among high school students. Of the 146 students with good sleep quality, 13 (8.9%) experienced headaches, while 133 (91.1%) did not. In contrast, among the 221 students with poor sleep quality, 40 (18.1%) reported headaches and 181 (81.9%) did not. Bivariate analysis showed that poor sleep quality was associated with higher odds of headache compared to good sleep quality (crude OR = 2.26; 95% CI: 1.16–4.39; $p = 0.016$). However, after adjustment in the multivariate model, this association was attenuated and became marginally non-significant (adjusted OR = 1.96; 95% CI: 0.99–3.86; $p = 0.053$).

Regarding stress level, among 254 students with mild stress, 24 (9.4%) experienced headaches, whereas 230 (90.6%) did not. Among 113 students with moderate stress, 29 (25.7%) reported headaches and 84 (74.3%) did not. Both bivariate and multivariate analyses demonstrated a strong and statistically significant association between moderate stress and headache occurrence. Students with moderate stress had higher odds of experiencing headaches compared to those with mild stress (crude OR = 3.31; 95% CI: 1.82–6.00; $p < 0.001$), and this association remained significant after adjustment (adjusted OR = 3.05; 95% CI: 1.67–5.57; $p < 0.001$). Overall, these findings indicate that while poor sleep quality tends to increase the likelihood of headache occurrence, stress level—particularly moderate stress—emerges as the most robust determinant of headaches among high school students.

Table 3. Association of Sleep Quality and Stress Level with Headache Occurrence

Table 3: Association of Sleep Quality and Stress Level with Headache Occurrence									
Variable	Headache		No Headache		Total	Crude OR (95% CI)	p-value	Adjusted OR (95% CI)	p-value
	n	%	n	%					
Sleep Quality									
Good	13	8,9	133	91,1	146	1,00 (Ref)	-	1,00 (Ref)	-
Poor	40	18,1	181	81,9	221	2,26 (1,16-4,39)	0,016	1,96 (0,99-3,86)	0,053
Stress Level									
Mild Stress	24	9,4	230	90,6	254	1,00 (Ref)	-	1,00 (Ref)	-
Moderate Stress	29	25,7	84	74,3	113	3,31 (1,82-6,00)	<0,001	3,05 (1,67-5,57)	<0,001

Discussion

Characteristics of Respondents by Sex

This study examined the association between sleep quality and stress on the occurrence of headache among senior high school students in Ambon City. The study included a total sample of 367 students selected using an accidental sampling technique. Of the respondents, 196 were female, and 171 were male. Using a cross-sectional analytical approach, the findings showed that poor sleep quality and higher stress levels were common in this population; however, multivariate analysis demonstrated that stress levels had a stronger independent association with headache occurrence.

Characteristics of Respondents by Sleep Quality

In this study, sleep quality was classified into two categories: good and poor. The findings indicated that poor sleep quality was the most prevalent among the respondents. Senior high school students are undergoing late pubertal developmental changes that are associated with alterations in sleep patterns. Adolescents are often observed to go to bed late and wake up early due to academic demands. These findings are consistent with a study by Kesuma (2023), which reported that the majority of senior high school students experienced poor sleep quality, influenced by several factors, including age, sex, and stress level.⁸

Characteristics of Respondents by Stress Level

In academic settings, stress is one of the most commonly experienced psychological conditions among students at both secondary and tertiary levels of education. Stress in this study was initially measured using four standard categories (no stress, mild, moderate, and severe). However, for inferential analysis, these categories were collapsed into two groups (mild and moderate) to ensure adequate cell counts and improve statistical model stability. Based on this classification, more than half of the respondents were included in the moderate stress group, indicating that elevated stress levels were common in this student population. These findings are consistent with a previous study by Gusti RK, Saputera MD, and Chris A, which reported that 57,1% of students experienced stress. Academic stress among students is frequently attributed to performance pressure and academic demands.⁹

From a theoretical perspective, negative stress (distress) occurs when perceived demands exceed an individual's coping capacity. Distress has been associated with impaired daily functioning and reduced academic performance among students.¹

Characteristics of Sleep Quality by Age and Sex

The results of this study indicated that good sleep quality was most common among students aged 16 years, and poor sleep quality was also predominantly observed in this age group. Additionally, both good and poor sleep quality were more frequently reported among female students. These findings are consistent with a cross-sectional study conducted in China, which reported that the poorest sleep quality was most common among 16-year-old high school students (41,9%).¹¹ Similarly, during the COVID-19 pandemic, 94,7% of female adolescents experienced poor sleep quality compared to 71,2% of male adolescents.¹²

This finding aligns with theoretical perspectives indicating hormonal differences between males and females. In females, fluctuations in hormone levels during the menstrual cycle can

negatively affect sleep quality. Additionally, females are reported to have higher rates of mood-related sleep complaints in several studies, which can further adversely impact sleep quality.¹³

Sleep disturbance and stress are known to be closely interrelated. Elevated stress may contribute to difficulty initiating and maintaining sleep, while inadequate sleep may increase emotional reactivity and perceived stress. Shared physiological pathways involving autonomic activation and neuroendocrine responses may explain the overlap between stress, poor sleep quality, and headache vulnerability reported in previous studies.

Characteristics of Stress Level by Age and Sex

The distribution of stress levels by age showed that students aged 16 years contributed the largest proportion in both stress categories, which is consistent with the overall age distribution of the sample. After stress categories were collapsed into two groups for analysis, moderate stress was observed more frequently than mild stress across several age groups, indicating that elevated perceived stress is common during mid-adolescence.

By sex, moderate stress was more frequently observed among female students compared with male students. This pattern is consistent with previous studies reporting that female adolescents tend to report higher perceived stress levels than males, possibly due to differences in stress appraisal, coping style, and psychosocial responses to academic and social stressors.¹⁴ Rather than reflecting purely biological differences, current literature suggests that both psychosocial and behavioral factors contribute to higher reported stress levels among female students.

A biologically plausible explanation for the observed association between stress and headache involves both peripheral and central mechanisms. Stress activates neuroendocrine responses, including increased cortisol and catecholamine release, leading to heightened central nervous system arousal. Stress has also been linked to increased pericranial muscle tension and altered trigeminal nociceptive processing. These mechanisms may lower pain thresholds and facilitate headache episodes in susceptible individuals.

Characteristics of Headache by Age and Sex

Headache reports were most frequently observed in the 16-year age group, which also represents the largest proportion of the sample. Headache was more frequently reported among female students compared to male students. These findings are consistent with a study by Sari (2023), which reported that 65.6% of respondents at a senior high school in Palu experienced primary headache, all of whom were female.¹⁵

Theoretically, when a female enters puberty, hormonal changes occur that increase the frequency of headaches, which has been reported to be higher than in males after puberty. Another supporting theory is that females report higher pain sensitivity due to psychosocial factors, which may contribute to their increased perception of headache intensity.¹⁶ These findings are also consistent with the American Institute of Stress (2016), which reported that females are two to three times more susceptible to stress compared to males.¹⁷

Association Between Sleep Quality, Stress, and Headache

The results indicated differences in headache occurrence according to sleep quality and stress level, with a higher proportion of headaches observed among students reporting poorer sleep quality. Evidence from previous studies suggests that the association between stress level

and headache is not always consistent and may vary after adjustment for sleep-related and psychosocial factors.^{2,6} These findings are consistent with the present study, in which stress level demonstrated a stronger independent association with headache occurrence than sleep quality in the multivariate model, while sleep quality did not reach statistical significance after adjustment. Stress and sleep quality are closely interrelated through shared psychophysiological pathways, including neuroendocrine activation and cognitive arousal, which may contribute to heterogeneous findings across studies.¹⁰

Although bivariate analysis showed differences in the proportion of headache occurrence according to sleep quality, multivariate analysis indicated that sleep quality was not statistically significantly associated with headache occurrence after adjustment for other variables. An odds ratio close to two suggests a tendency toward an increased risk of headache among students with poor sleep quality; however, this association did not reach statistical significance ($p > 0.05$). Therefore, sleep quality cannot be considered an independent predictor of headache occurrence in this model.

In contrast, stress level showed a stronger association with headache occurrence. Students in the moderate stress group had approximately three times higher odds of experiencing headaches compared with those in the mild stress group. These findings suggest that perceived stress level may be a more dominant factor related to headache occurrence in this adolescent population than sleep quality when both variables are considered simultaneously.

Furthermore, stress level demonstrated the strongest independent association with headache occurrence, with a p-value of < 0.001 . Theoretically, the impact of stress on headache attacks may occur at both peripheral and central levels. At the peripheral level, stress can trigger perivascular inflammation and pericranial muscle tension. At the central level, stress may affect supraspinal neuronal control in the trigeminal caudalis nucleus, leading to increased excitability at the spinal/trigeminal level and reduced effectiveness of the endogenous antinociceptive system, thereby facilitating headache development in stressed individuals.

The bivariate analysis showed that both poor sleep quality and moderate stress were significantly associated with headache occurrence. However, after adjustment in the multivariate model, the association between sleep quality and headache became attenuated, indicating that the relationship may be influenced by other factors, particularly stress level. This finding suggests that stress may act as a confounding or mediating factor in the relationship between sleep quality and headache. In contrast, stress level remained a strong and independent determinant of headache occurrence, underscoring its central role in adolescent headache complaints.

Conclusion

This study found that poor sleep quality and higher stress levels were common among senior high school students. Headache was reported in a minority of respondents. Bivariate analysis showed that both sleep quality and stress level were associated with headache occurrence. However, after multivariate adjustment, only stress level remained significantly associated with headache, indicating a stronger independent relationship compared with sleep quality. These findings suggest that perceived stress may play a more prominent role in headache occurrence among adolescents in this population.

Stress level, particularly moderate stress, was identified as a significant determinant of headache occurrence, while poor sleep quality tended to increase the risk of headache but showed a weaker association after adjustment.

Because of the cross-sectional design, causal relationships cannot be established. Future longitudinal studies are recommended to further clarify temporal relationships between stress, sleep quality, and headache.

This study has several limitations. The cross-sectional design does not allow causal inference between sleep quality, stress, and headache. All variables were measured using self-report questionnaires, which may introduce recall and reporting bias. The use of convenience sampling may also limit generalizability beyond the study population. In addition, stress categories were collapsed for inferential analysis to ensure model stability, which may reduce category-level detail.

Conflict of Interest

The authors declare no conflicts of interest related to this study.

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