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ORIGINAL RESEARCH

Prevalence and Predictors of Poor Sleep Quality Among Adolescents in Central Sudan: The Role of Depression, Anxiety, and Gender

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Background: Sleep is crucial for adolescent health; however, there is a scarcity of data on adolescent sleep in Sudan, which has a major sociopolitical disruption. Thus, this study aimed to determine the prevalence of poor sleep quality and the factors associated with it among adolescents who returned after internal displacement in Central Sudan.

Methods: A multi-stage, stratified random sampling approach was used in a community-based, cross-sectional study conducted in East Gezira, Central Sudan. Data from 365 adolescents were collected on sociodemographic factors, body mass index (BMI), and mental health. The Pittsburgh Sleep Quality Index (PSQI) was used to assess sleep quality. The Patient Health Questionnaire (PHQ)-9 was used to measure symptoms of depression, and anxiety symptoms were measured using the Generalized Anxiety Disorder (GAD-7) questionnaire. Multivariate binary logistic regression was performed to identify factors associated with poor sleep quality, defined as a PSQI score > 5.

Results: A total of 365 adolescents were enrolled (52.1% were females; 47.9% were males). The median (interquartile range [IQR]) age and BMI were 14 (12–16) years and 16.2 (14.7–18.1) kg/m^2, respectively. The median (IQR) depression and anxiety scores were 2 (0–4) and 2 (1–5), respectively. Thirty-five (9.6%) of the 365 adolescents had poor sleep quality. A multivariate binary analysis showed that poor sleep quality was positively associated with depression scores (adjusted odds ratio [AOR] =1.20; 95% confidence interval [CI] = 1.04–1.37) and anxiety scores (AOR = 1.20; 95% CI = 1.05–1.38). Female adolescents were found to be at higher risk of poor sleep quality than males (AOR = 3.94; 95% CI = 1.18–13.07).

Conclusion: This study indicates that the prevalence of poor sleep quality (9.6%) among adolescents in Central Sudan is lower than reported in the existing literature. Poor sleep quality is significantly associated with mental health conditions, particularly depression and anxiety, as well as being female. These results highlight the need for mental health support to improve adolescent sleep health in the region.

Keywords: adolescents, mental health, depression, anxiety, Pittsburgh Sleep Quality Index, age, Sudan

Introduction

Sleep is a fundamental and often underestimated pillar of human health, especially during the formative years of adolescence.[1,2] According to the World Health Organization (WHO), adolescence is a period of life spanning from 10 to 19 years that is marked by significant physical, psychological, and social development.[3] During this critical phase, adequate, high-quality sleep is essential for cognitive function, emotional regulation, and overall well-being. Poor sleep quality can lead to a cascade of negative consequences, including impaired academic performance, an increased risk of accidents (cars, slips, and falls), and poor physical and mental health outcomes.[2,4–8] The modern world, with its proliferation of digital devices, academic pressures, and social media, presents numerous challenges to achieving optimal sleep, making the study of adolescent sleep patterns a matter of global public health importance.[5,6,9]

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The prevalence of poor sleep quality among adolescents has become a growing concern worldwide, including in Africa.[1,2,10–15] Various prevalence rates for poor sleep quality among adolescents have been reported in low- and middle-income countries (LMICs), such as in Nigeria, where it ranged from 15.0%[12] to 85.0%,[13] Ethiopia (38%),[14] and Brazil (28.2%).[15] The literature revealed several factors associated with poor sleep quality in adolescents, such as older age,[15] being female,[16,17] urban residence,[12] low socio-economic status,[18] tobacco use,[6,16] high body mass index (BMI),[15,19] the presence of diseases,[14,20] and addiction.[14,21] In addition to these factors, poor sleep quality was found to be associated with low hemoglobin,[22,23] high glycated hemoglobin (HbA1c),[24] depression,[13,15] and anxiety.[15] In addition, researchers have reported that poor sleep quality in adolescence increases the risk of type 2 diabetes mellitus in adulthood by influencing insulin sensitivity and leading to increased dietary intake, sedentary activity, and weight gain.[24,25]

Studies from high-income countries (HICs) consistently report that a significant portion of the adolescent population suffers from poor sleep quality, which is often linked to factors such as early school start times, a hyper-connected lifestyle, and the late-night use of electronic devices.[9,17,21] For example, the prevalence rates for poor sleep quality among adolescents in Turkey ranged from 50.4%[6] to 82.0%.[21] Another study that included 1717 European adolescents from Spain, Iceland, and Estonia aged 13 to 16 years and adopted the Pittsburgh Sleep Quality Index (PSQI) found poor sleep quality in 44% of boys and 53% of girls, with 68% and 69%, respectively, not obtaining the recommended hours of sleep (ie, 8–10 h).[17] These trends are not limited to the developed world. Acknowledging the global nature of this issue, the research community is increasingly focusing on the unique challenges faced by adolescents in LMICs, in which additional factors, such as socioeconomic instability and limited access to healthcare, may exacerbate the problem.

A key aspect of adolescent sleep health is its intricate and often bidirectional relationship with mental well-being.[4,23,26–28] Researchers have recommended screening patients with either mental health or sleep concerns for potential co-morbid conditions.[27] Poor sleep is not merely a symptom of mental health disorders. It is also a significant risk factor regarding their development.[5,29] Studies have shown that sleep disturbances can precede the onset of mental health conditions, such as depression and anxiety, suggesting that they may play a causal role in this regard.[5,29,30] For example, Goldstone et al reported that sleep disturbances predicted future mental health, particularly depression.[29] Furthermore, Scott et al, in their meta-analysis of randomized controlled trials, reported that improving sleep quality leads to better mental health.[30] Conversely, mental health disorders such as depression often lead to poor sleep quality among adolescents, which creates a vicious cycle.[28] Given the high co-morbidity between poor sleep quality and mental health issues, it is crucial to investigate this relationship, particularly in vulnerable populations.

Despite the growing global attention to adolescent sleep, there is a significant lack of research in many LMICs, including Sudan. The Sudanese context presents a unique set of challenges that may influence adolescent health and sleep patterns, especially during the ongoing war. Sudan has faced periods of political and economic instability, which can have profound effects on the daily lives of its citizens.[31,32] Factors such as food insecurity, limited educational opportunities, and a lack of mental health infrastructure may act as significant stressors, potentially contributing to poor sleep quality.[33] Moreover, cultural norms and social expectations within Sudanese communities, such as family structure and daily routines, may also play a role in shaping sleep habits. Without robust, context-specific data, public health professionals and policymakers in Sudan lack the necessary evidence to design effective interventions to address these issues. It is important to mention that the majority of available studies regarding sleep in Sudan have targeted medical students and medical professionals, rather than adolescents, and that the majority were conducted before the ongoing war began.[7,34–36]

Given the significant health implications of poor sleep and the scarcity of data in the region, this study aims to determine the prevalence of poor sleep quality and identify associated factors (specifically depression and anxiety scores) among adolescents who returned after internal displacement in Central Sudan.

Methods

Study Design and Setting

This community-based cross-sectional study was conducted from April to June 2025 among adolescents in Central Sudan. This study was conducted in Elrikieb, East Gezira, in Central Sudan. Gezira State is located in east-central Sudan, lying between the Blue and White Nile rivers. Elrikieb was chosen because it comprises four sub-villages, and its

inhabitants resemble those of the entire Gezira State. The inhabitants of Elrikieb were returned after internal displacement to eastern and northern Sudan due to the War. In this study, the authors strictly adhered to the Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines.[37]

Study Population and Sampling

For the present study, a total of 365 adolescents (aged 10 to 19 years) were recruited. These participants were recruited from the community using a systematic approach. A multi-stage stratified random sampling approach was employed to select the potential participants. Within each selected sub-village, households were randomly selected (lottery method), and their number was proportional to the sub-village's population. From each eligible household, one adolescent was randomly (lottery method) invited to participate. When there was no adolescent in the selected household, the next one was chosen as an alternative.

Inclusion and Exclusion Criteria

Before data collection, informed consent was obtained from the adolescents' parents and their guardians. The definition of an adolescent was that of the WHO.[38] Therefore, all adolescents aged 10 to 19 years were included in the present study, and those younger than 10 years or older than 19 years were excluded. Those who did not give their consent to participate in the study were excluded. All the recruited participants were apparently healthy, and those who were sick or known to have a mental health disorder, were pregnant, or were nursing were excluded.

Sample Size Calculation

The desired sample size was computed using the OpenEpi Menu software.[39] The authors assumed that 35.0% of the adolescents would have poor sleep quality. As there are no similar studies in Sudan, this assumption was based on a prior study that revealed that 30.7% of the adolescents had poor sleep quality.[16] Thus, a sample size of 365 adolescents was computed for this study. This sample size was calculated to detect a 5% difference at $\alpha = 0.05$, with 80% power. Moreover, the authors assumed that 10% of participants would not respond or would provide incomplete data.

Study Variables and Measures

The questionnaire was developed after a thorough review of the literature.[6,12–17,19–24] It was designed to collect sociodemographic data, including age in years, gender (male or female), parental educational levels (< secondary or ≥ secondary), mother's occupational status (housewife, or employed), father's occupational status (working or none), tobacco use (yes or no), and the presence of a family member who smokes (yes or no). Anthropometric measurements, such as weight and height, were collected and later expressed as BMI by dividing the weight in kg by the height in m squared.[40]

After the participants and their guardians agreed to participate and signed an informed consent form, the selected adolescents were approached by the trained research assistants. The adolescents were informed about the study objectives and provided with all the necessary information, such as the voluntary nature of their participation in the study; their right to withdraw from the study at any time without giving a reason; and the preventive measures taken to ensure the privacy, confidentiality, and safety of the participants, such as excluding personal identifiers during data collection. In this study, the primary outcome was sleep quality, and the secondary outcomes were the sociodemographic data, BMI, hemoglobin, HbA1c, depression, and anxiety.

The study's primary objective was to evaluate sleep quality among adolescents. Therefore, to achieve this, the authors employed the PSQI, a widely used instrument in various contexts, including Sudan.[7,34,35] The PSQI is a self-report questionnaire designed to assess sleep patterns and disturbances over the past month. The PSQI evaluates seven components of sleep health, including sleep duration, disturbances, and subjective quality, culminating in a single global score ranging from 0 to 21. A crucial aspect of this study's methodology was the use of a predefined cutoff score. Participants with a global PSQI score > 5 were classified as having poor sleep quality, while those scoring ≤ 5 were categorized as having good sleep quality. This methodological approach ensures that the findings are clinically relevant and comparable to those of other studies in the field. The study also included secondary outcomes such as mental health

(depression and anxiety) and metabolic markers. This study used the Arabic version of the "Patient Health Questionnaire (PHQ)-9 to measure symptoms of depression". PHQ-9 scores range from 0 to 27. As previously mentioned, adolescents with PHQ-9 scores of ≥ 8 were considered to have depression.[41] On the other hand, the Arabic version of the "Generalized Anxiety Disorder (GAD-7) questionnaire" was used to measure anxiety symptoms. GAD-7 scores range from 0 to 21. More details about these measures are available in the authors' prior work on Northern Sudan.[42] Adolescents with poor sleep or psychological distress were referred for care to the nearest health facility for further care.

Under aseptic conditions, 5 mls of blood was taken to measure hemoglobin and HbA1c. An automated hematology analyzer (Sysmex KX-21, Kobe, Japan) was used to measure hemoglobin levels, as described in the authors' prior work.[43] An Ichroma machine was used to measure HbA1c as per the manufacturer's instructions (Republic of Korea), as detailed in the authors' prior work.[44]

Statistical Analysis

The data were entered into SPSS for Windows (Version 22.0; SPSS Inc., New York, NY, USA) statistical software for analysis. The continuous data, including age, BMI, hemoglobin, HbA1c, depression scores, anxiety scores, and sleep scores, were tested for normality using the Kolmogorov–Smirnov test and were found to be nonnormally distributed. Consequently, they are expressed as medians (IQRs). Initially, a univariate binary analysis was performed on the PSQI scores, as the categorical dependent variable (poor sleep quality versus good sleep quality), and the sociodemographic data and metabolic markers, such as age and gender, hemoglobin, HbA1c, depression scores, anxiety scores, sleep scores, parents' education, parents' occupation, tobacco use, and the presence of a smoker in the family, as the independent variables. Multicollinearity was assessed (Inflation Variable Factors > 4.0) and was not present. All variables with p-values < 0.2 from the univariate binary analysis were included in a multivariate binary analysis to adjust for covariates. The adjusted odds ratios (AORs) and 95% CIs were computed. A two-sided p-value of < 0.05 was considered statistically significant. The model's goodness of fit was assessed using the Hosmer-Lemeshow test, which indicated a good fit ($P = 0.728$).

Results

General Characteristics

In this study, 365 adolescents were enrolled [190 (52.1%) were female, and 175 (47.9%) were male]. The median (IQR) age and BMI were 14 (12–16) years and 16.2 (14.7–18.1) kg/m,^{2} respectively. Fifty-five (15.1%) of the adolescents' mothers and 98 (26.8%) of the adolescents' fathers had education levels ≥ secondary. The majority of mothers were housewives (342, 93.7%), and 322 fathers (88.2%) were employed. Eleven (3.0%) were tobacco users. One hundred and eight adolescents (29.6%) reported the presence of smokers in their families. The median (IQR) hemoglobin and HbA1c were 12.6 (11.5–13.3) mg/l and 5.4 (5.1–5.5) %, respectively. The median (IQR) depression and anxiety scores were 2 (0–4) and 2 (1–5), respectively. Twenty-seven (7.4%) adolescents had depression (Table 1).

Sleep Quality and Its Components

The median (IQR) PSQI was 2 (1–3). One in ten 35 (9.6%) of the adolescents had poor sleep quality, and the remaining 330 (90.4%) had good sleep quality. Of the 365 adolescents, 310 (84.9%) reported sleeping >7 hours. The majority (99.5%) of the adolescents were not using sleep medications. Two hundred eight nine (79.2%) adolescents stated that their sleep quality was very good. Self-reports of daytime dysfunction were less frequent, with 3 students (0.8%) in the highest difficulty category. The details of sleep quality and its component scores among adolescents are shown in Table 2.

Factors Associated with Poor Sleep Quality

Higher median (IQR) depression scores [5(3–7) versus 1(0–3), p < 0.001] and anxiety scores [5(3–6) versus 2(0–4), p < 0.001] were observed among adolescents with poor sleep quality as compared to those with good sleep quality (Table 1). Compared with adolescents with good sleep quality, a significantly higher proportion of adolescents with poor sleep quality were female [24/35 (68.6%) vs. 151/330 (45.8%), P=0.003] and had depression (PHQ-9 scores of ≥ 8) [7/35 (20.0%) vs. 20/330 (6.1%), P=0.009].

Table 1 Sociodemographic and Clinical Characteristics of the Studied Adolescents in Central Sudan (n=365), 2025

Variable		Total (n = 365)	
		Median	**Interquartile range**
Age (years)		14	12–16
Body mass index (kg/m^2)		16.2	14.7–18.1
Hemoglobin mg/l		12.6	11.5–13.3
Glycated hemoglobin %		5.4	5.1–5.5
Patient Health Questionnaire (PHQ-9) scores		2	0–4
Generalized Anxiety Disorder (GAD-7) scores		2	1–5
		Frequency	**Percentage**
Sex	Male	190	52.1
	Female	175	47.9
Mother Education	≥ secondary	55	15.1
	<secondary	310	84.9
Father education	≥ secondary	98	26.8
	<secondary	267	73.2
Mother occupation	House wife	342	93.7
	Employed	23	6.3
Father occupation	Working	322	88.2
	Not working	43	11.8
Tobacco use	No	354	97.0
	Yes	11	3.0
Presence of a smoker in the family	No	257	70.4
	Yes	108	29.6
Pittsburgh Sleep Quality Index (PSQI) score	Good sleep quality (PSQI score ≤ 5)	330	90.4
	Poor sleep quality (PSQI scores > 5)	35	9.6

In the univariate binary analysis, among the investigated factors, age, gender, depression, anxiety, and the presence of a smoker in the family were found to be associated with poor sleep quality among adolescents. Other factors, such as BMI, hemoglobin, HbA1c, tobacco use, parental education, and parental occupation, were not associated with poor sleep quality among adolescents. The multivariate binary analysis showed that poor sleep quality among adolescents was positively associated with depression scores (AOR = 1.20, 95% CI 1.04–1.37) and anxiety scores (AOR = 1.20, 95% CI 1.05–1.38). In addition, female adolescents were at greater risk of poor sleep quality than their male counterparts (AOR = 3.94, 95% CI 1.18–13.07). Age was identified as a confounding factor (Table 3).

Discussion

This community-based cross-sectional study provides a critical first look at the prevalence of and factors associated with poor sleep quality among adolescents in a rural community in Central Sudan. The study's findings reveal a 9.6% prevalence for poor sleep quality, which is lower than many rates reported in both LMICs and HICs.[6,10,17] This low

Table 2 Sleep Quality and Its Components Score Among Adolescents in Central Sudan (n=365), 2025

Variables (Number =365)	Subgroups	Number	Percentage
Sleep duration	Greater than 7 hours	310	84.9
	6–7 hours	54	14.8
	5–hours	1	0.3
Sleep latency	Less than 5 hours	0	0
	0	237	64.9
	1	72	19.7
	2	47	12.9
	3	9	2.5
Daytime dysfunction	0	303	83.0
	1	45	12.3
	2	14	3.8
	3	3	0.8
Sleep efficacy	> 85.0%	310	84.9
	75.0– 84.0%	25	6.8
	65.0 – 74.0%	18	4.9
	<65.0%	12	3.3
Subjective sleep quality	Very Good	289	79.2
	Fairly good	65	17.8
	Fairly bad	1	0.3
	Very Bad	10	2.7
Sleep disturbance	0	69	18.9
	1	253	69.3
	2	40	11.0
	3	8	0.8
Use of sleep medication	Not during the last month	363	99.4
	Less than once a week	1	0.3
	Once or twice a week	1	0.3
	Three or more times a week	0	0

prevalence may reflect unique sociocultural and environmental characteristics of the rural community of Central Sudan. It is possible that adolescents in this setting face different daily routines and social pressures compared to their urban counterparts or those in a Western context, which may act as a buffer against some of the factors known to negatively affect sleep, such as late-night use of electronic devices or high-stress academic environments.[5,9,13] The alternative explanations include potential measurement bias, social desirability effects, or the impact of the exclusion criteria on case ascertainment. Despite this low prevalence, the identified risk factors deserve significant attention from public health

Table 3 Univariate and Multivariate Binary Analyses of the Factors Associated with Poor Sleep Quality Among Adolescents in Central Sudan (n=365), 2025

Variable		Adolescents with Poor Sleep Quality (n=35)	Adolescents with Good Sleep Quality (n=330)	Univariate Analysis		Multivariate Analysis	
		Median (Interquartile Range)		Odds Ratio (95% Confidence Interval, CI)	*p*	Adjusted Odds Ratio (95% CI)	*P*
Age (years)		15(13–17)	14(12–16)	1.16(1.01–1.34)	0.044	1.09 (0.89–1.35)	0.382
Body mass index (kg/m^2)		17.0(15.4–19.5)	16.2(14.6–18.1)	1.01(0.97–1.06)	0.421	–	–
Hemoglobin mg/l		13.2(11.7–13.5)	12.5(11.5–13.2)	1.24(0.92–1.66)	0.155	1.32(0.94–1.85)	0.097
Glycated hemoglobin %		5.4(5.4–5.6)	5.4(5.1–5.5)	1.42(0.84–2.40)	0.184	1.60(0.84–3.03)	0.149
Patient Health Questionnaire (PHQ-9) scores		5(3–7)	1(0–3)	1.24(1.13–1.36)	<0.001	1.20(1.04–1.37)	0.009
Generalized Anxiety Disorder (GAD-7) scores		5(3–6)	2(0–4)	1.18(1.08–1.28)	<0.001	1.20(1.05–1.38)	0.006
	Frequency (proportion)						
Sex	Male	11(31.4)	179(54.2)	Reference			
	Female	24(68.6)	151(45.8)	2.58(1.22–5.45)	0.013	3.94(1.18–13.07)	0.025
Mother's education level	≥ secondary level	6(17.1)	49(14.8)	Reference			
	< secondary level	29(82.9)	281(85.2)	0.84(0.33–2.13)	0.719	–	–
Mother's occupation status	Housewife	31(88.6)	311(94.2)	Reference			
	Employed	4(11.4)	19(5.8)	2.11(0.67–6.60)	0.199	3.0(0.68–13.27)	0.147
Father's education level	≥ secondary level	12(34.3)	86(26.1)	Reference			
	< secondary level	23(65.7)	244(73.9)	0.67(0.32–1.41)	0.266	–	–
Father's occupation status	Unemployed	30(85.7)	292(88.5)	Reference			
	Employed	5(14.3)	38(11.5)	1.28(0.46–3.50)	0.631	–	–
Adolescents' tobacco use	No	33(94.3)	321(97.3)	Reference			
	Yes	2(5.7)	9(2.7)	2.16(0.44–10.42)	0.337	–	–
Presence of a smoker in the family	No	16(45.7)	241(73.0)	Reference			
	Yes	19(54.3)	89(27.0)	3.21(1.58–6.52)	0.001	2.34(0.90–6.05)	0.079

authorities. Additionally, it is worth noting that during the ongoing war, the telecommunications infrastructure was severely damaged and internet functioning was impaired; therefore, the adolescents considered here may be less distracted by electronic devices and go to bed earlier than others.

A central finding of this study is the fact that there are strong associations between poor sleep quality and both depression and anxiety scores. The multivariate analysis showed that a one-unit increase in depression and anxiety scores was associated with a 20% increase in the odds of having poor sleep quality (AOR = 1.20 for both). This finding is consistent with a substantial body of international literature highlighting the intimate and often bidirectional relationship between sleep disturbances and mental health.[4,23,26–28] The findings support the notion of a vicious cycle in which psychological distress, a common experience in a population facing socioeconomic and environmental challenges, contributes to poor sleep, which, in turn, exacerbates symptoms of depression and anxiety.[29] The presence of these

associations in a Sudanese context, in which mental health is an understudied area, is particularly significant. It suggests that a comprehensive approach to adolescent health must integrate mental health support with sleep hygiene education.

The most striking finding of this study is the significant gender disparity regarding sleep quality. Female adolescents were found to be at a nearly fourfold increased risk of poor sleep quality as compared to their male counterparts (AOR = 3.94). This result is consistent with global research reporting a higher prevalence of sleep disturbances among female adolescents.[16,17] Several factors may contribute to this disparity. From a biological perspective, hormonal fluctuations during puberty in females may play a role.[45] Socially and psychologically, female adolescents may experience different types of stress, including higher rates of body image concerns, academic pressure, low physical activity, and social anxieties, all of which are known to influence sleep.[46–49] Moreover, the present data show that higher depression and anxiety scores are associated with poor sleep and that these mental health conditions are often reported more frequently among females; these findings reinforce the need for gender-sensitive mental health interventions. For example, the authors' prior research has reported that being female was associated with a five-fold increase in the risk of depressive symptoms among adolescents in Northern Sudan.[42]

In the current study, the association between poor sleep quality and the role of age as a confounding variable, and the disappearance of the family smoking association after adjustment, could be explained by a complex interplay among socioeconomic, behavioral, and psychological factors. Previous reports have shown that the initial association between certain environmental factors—such as family smoking or passive smoking—and poor sleep quality often weakens or disappears after adjusting for confounding variables, particularly age.[50]

Interestingly, several factors often associated with poor sleep quality in other studies, such as BMI, hemoglobin, HbA1c, and parental education or occupation, were not significant in this study. This may be due to the relatively homogenous socioeconomic status of the community in the studied area (Elrikieb), which could reduce the variability of these factors. The lack of association with BMI and HbA1c is particularly noteworthy, as poor sleep has been linked to an increased risk of type 2 diabetes mellitus and obesity in other populations.[24,25] The present finding aligns with the authors' prior work in Eastern Sudan, which revealed a high prevalence of prediabetes among adolescents, suggesting that the physiological factors influencing metabolic health may operate independently of, or be less influenced by, sleep quality in this population. In contrast to other studies, the presence of diseases[14,20] and internet addiction[14,21] was not found to be associated with sleep quality. This could be due to the study design, including the exclusion criteria, and the omission of internet usage from the questionnaire, as the internet network was not functioning well due to infrastructure damage sustained during the ongoing war.

Study Implications

The findings of this study have significant public health implications for Sudan. With poor sleep quality affecting nearly one in ten adolescents and being strongly associated with mental health symptoms, there is a need for integrated public health programs. Interventions should move beyond single-focus campaigns and aim to address both sleep and psychological well-being simultaneously. This could include developing school-based mental health literacy programs, providing access to basic counseling services, and promoting healthy sleep hygiene practices. Given the pronounced gender disparity regarding sleep quality, these programs should be tailored to meet the specific needs of female adolescents. The community-based nature of the current study suggests that such interventions should be delivered in a culturally sensitive, accessible manner for rural populations.

Study Strengths and Limitations

This study has several key strengths. Its community-based, cross-sectional design allows for the estimation of prevalence and the identification of associated factors in a population that has been largely overlooked in the literature. The use of a multi-stage, stratified random sampling approach enhances the representativeness of the sample, increasing the generalizability of the findings to similar rural settings in Central Sudan. Furthermore, the study's adherence to the STROBE guidelines ensures rigorous reporting and transparency. The use of validated and widely accepted instruments, such as the PSQI, PHQ-9, and GAD-7, further strengthens the reliability and comparability of the data.

Despite these strengths, the present study has several limitations that should be noted to inform future research. The cross-sectional design prevents the establishment of causality. While the findings show a strong association, it is impossible to determine whether poor sleep quality led to mental health issues or vice versa. Therefore, future longitudinal studies are needed to elucidate this bidirectional relationship. The reliance on self-report questionnaires for sleep quality, depression, and anxiety may have introduced recall and social desirability biases. The study's focus on a single community in Central Sudan (Elrikieb) provides valuable local data. However, it limits the generalizability of the findings to a broader national context, particularly urban areas or other regions of Sudan with different sociocultural dynamics. The wide confidence interval (1.18–13.07) for females and the association could reflect the study's small size and the reliability of the binary regression. This could be explained by the sample size calculation; we assumed a prevalence of 35%, whereas the observed prevalence was 9.6%. Finally, although many factors were investigated, other factors that may influence sleep hygiene and mental health status, such as physical activity, were not.[46,47]

Conclusion

This study indicates that the prevalence of poor sleep quality (9.6%) among adolescents in Central Sudan is lower than reported in the existing literature. Psychological factors (depression and anxiety) appear to have a stronger impact on sleep quality than physiological factors. A notable finding is the pronounced gender disparity, with female adolescents being at a substantially higher risk than males in this regard. These results underscore the need for a public health response that addresses both mental health and sleep health in an integrated manner, with a particular focus on supporting female adolescents. Future research should include longitudinal studies to establish causality and qualitative research to deepen understanding of the contextual factors that influence sleep and mental health among Sudanese adolescents.

Abbreviations

AOR, Adjusted odds ratio; CI, Confidence interval; PHQ-9, Patient Health Questionnaire; GAD-7, Generalized Anxiety Disorder; IQR, Interquartile range; HbA1c, Glycated hemoglobin; WHO, World Health Organization; PSQI, Pittsburgh Sleep Quality Index.

Data Sharing Statement

The datasets generated and/or analyzed during the current study are not publicly available, but are available from the corresponding author upon reasonable request.

Ethical Approval

Ethical approval for this study was obtained by the Institutional Review Board (IRB) of the Faculty of Medicine and Health Sciences at the University of Gadarif, in Gadarif, eastern Sudan (Ref. #2025, 04). Informed written consent was obtained from all participants and the participants' legal guardians before data collection. The study complies with the Declaration of Helsinki. The participants were assured of their confidentiality and anonymity. They were informed that participation was voluntary and that they had the right to withdraw at any time without penalty. Those adolescents with higher scores on the PSQI, PHQ, and GAD-7 were advised to seek further evaluation and management.

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Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

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Disclosure

The authors report no conflicts of interest in this work.

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