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The relationship between sleep quality, stress, and academic performance among medical students

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Abstract:

BACKGROUND: Sleep is essential for the body, mind, memory, and learning. However, the relationship between sleep quality, stress, and academic performance has not been sufficiently addressed in the literature. The aim of this study was to assess the quality of sleep and psychological stress among medical students and investigate the relationship between sleep quality, stress, and academic performance.

MATERIALS AND METHODS: This cross-sectional study targeted all medical students in their preclinical years at a Saudi medical college in 2019. All students were asked to complete an electronic self-administered questionnaire comprising the Pittsburgh Sleep Quality Index (PSQI), the Kessler Psychological Distress Scale (K10), questions on the students' current overall grade point average, and other demographic and lifestyle factors. The associations between categorical variables were analyzed using Pearson's Chi-squared test at 0.05 significance level.

RESULTS: The mean PSQI score was 8.13 ± 3.46 ; 77% of the participants reported poor quality of sleep and 63.5% reported some level of psychological stress (mean K10 score: 23.72 ± 8.55). Poor quality of sleep was significantly associated with elevated mental stress levels ($P < 0.001$) and daytime naps ($P = 0.035$). Stepwise logistic regression model showed that stress and daytime nap were associated with poor sleep quality. Whereas, poor sleep or stress did not show any significant association with academic performance.

CONCLUSION: Poor sleep quality was significantly associated with elevated levels of stress. However, they did not show any statistically significant relationship with academic performance.

Keywords:

Academic performance, medical education, medical students, sleep, sleep quality, stress

Introduction

Sleep, an essential therapeutic part of human physiology, has been well established as critically important for functioning, mental health, and good quality of life.^[1] Sleep deprivation has a wide range of harmful effects on human biology and is associated with fatigue, daytime sleepiness, and reduced neurocognitive performance.^[2] Cognitive performance in students, including

concentration and estimated efforts to complete tasks, is negatively affected by sleep deprivation.^[3] The prevalence of poor sleep quality varies between countries. Using the Pittsburgh Sleep Quality Index (PSQI), it has been reported to be as low as 19% in a Chinese study and as high as 55.8% in a study in Ethiopia.^[4,5]

Sleep is vital for the enhancement of working memory capacity and memory consolidation.^[6] A meta-analysis of seventy studies concluded that acute sleep

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deprivation harms most cognitive domains, such as simple attention, intricate attention, working memory, and short-term memory.^[7] A prospective study from the 1990s identified prolonged psychological stress in college students who had reported symptoms of insomnia.^[8] A delayed circadian rhythm also leads to poor sleep quality, especially during examination periods, and both have been found to negatively affect academic performance.^[9,10] Stress, another factor prevalent among medical students, worsens the quality of sleep.^[11] Increased levels of stress have been found to be related to lower academic performance; however, appropriate coping strategies have been shown to help students deal with the negative impact of psychological distress.^[12-14]

Very few studies in Saudi Arabia have addressed the relationship between sleep quality, stress, and academic performance of medical students, and their findings on the impact of sleep on academic performance are variable,^[15-18] although poor sleep quality as high as 76% has been reported.^[18] Nevertheless, the majority of Saudi medical students think that the quality of their sleep is good.^[18,19] Multiple local data sources have also suggested high stress levels in medical students.^[18,20,21] The current study aims to assess sleep quality and psychological stress in medical students in their preclinical years and investigate the relationship between sleep quality, stress, and academic performance.

Materials and Methods

This observational, cross-sectional study was conducted at the College of Medicine at Imam Muhammad Ibn Saud Islamic University (IMSIU), Riyadh, Saudi Arabia, between February and June 2019. The study targeted all medical students in their preclinical phase (1st, 2nd, and 3rd years). In this phase, the college follows an outcome-based, community-oriented, integrated system in which students attend lectures and are engaged in problem-based learning (PBL) small group tutorials. Students are evaluated during and at the end of each body system block.

An electronic self-administered questionnaire was distributed by six well-trained data collectors, two for each academic year. To ensure adequate representation of the study population, the link was restricted to groups of invitees only. A total of 230 participants were required to obtain a 95% confidence level and a 5% margin of error. The link was open from April 7, 2019, to May 7, 2019, and reminders were sent every 3 days.

Ethical approval from the Institutional Review Board of IMSIU was obtained for the study. Participants were informed of the objectives of the study, and informed written consent was obtained from them. They were

free to withdraw from the study at any stage; their information was kept confidential and used for research purposes only.

The questionnaire had items on demographic and lifestyle characteristics (age, gender, marital status, work status, residency, academic level, and frequency of caffeine intake and daytime naps) and measures of sleep quality, psychological distress, and academic performance.

Sleep quality was assessed using the global score of the PSQI^[22] which starts with four questions on bedtime, sleep latency, wake-up time, and the total hours of actual sleep during the last month. Then, there were 14 questions in a scale form on several suggested factors that troubled sleep such as the utilization of sleep medications, daytime sleepiness, enthusiasm for productivity, and a concluding self-rating question of the overall quality of sleep in the past month. Finally, the global PSQI score was calculated using seven components formed from the content items. The PSQI is considered a cornerstone tool for the measurement of sleep quality.^[22,23]

The Kessler Psychological Distress Scale (K10) was used to investigate the prevalence and levels of stress in medical students. The K10 has ten questions that assessed anxiety and depressive symptoms during the previous month. Items on a 5-point scale had scores ranging from 10 to 50. Scores from 20 to 24 were considered mild distress, 25–29 were moderate, and 30 or higher were severe. The K10 is a popular global tool for assessing nonspecific psychological distress in population-based studies.^[24]

Academic performance was measured using the student's current overall grade point average (GPA). Self-reported overall GPA has been frequently used as a measurement of academic achievement in similar studies. Furthermore, high reliability and correlation with GPAs reported by the academic registry had been established.^[25,26] We classified GPA according to the grading system at IMSIU (out of 5.0, the grades 4.5–5.0 are excellent, 3.5–4.49 are very good, and <3.5 are good, pass, or fail).

Data were imported into Microsoft Excel 2016 and analyzed using the Statistical Package for the Social Sciences (SPSS), Version 25.0 (REL. 2017; IBM Corp., Armonk, NY., USA). Categorical variables were presented as frequencies and percentages and continuous variables as means and standard deviations. The associations between categorical variables were analyzed using Pearson's Chi-squared test ± continuity correction. To determine the predictors of poor sleep quality in medical students, a simple logistic

regression analysis was initially used to explore the data. Multivariable stepwise binary logistic regression analysis was then performed. The odds ratios (OR) and 95% confidence intervals (95% CI) were calculated, and the Hosmer–Lemeshow test was used to assess model goodness of fit. Statistical significance for all associations was considered to be at $P < 0.05$.

Results

The characteristics of the study participants are presented in Table 1. The total number of participants was 282; 64.5% were male, 61% were aged 21–24 years, and 36.5% were aged 18–21 years. The majority of students were single ($n = 276, 97.9\%$), did not have a job ($n = 223, 79.1\%$), and were living with their families ($n = 269, 95.4\%$). For the academic level, 39% of the respondents were in their 1st year, 25.9% in their 2nd year, and 35.1% in their 3rd year. Most students were rated very good (32.6%; GPA: 3.5–4.49) or excellent (33%; GPA: 4.5–5.0) in their academic performance; about one-third were good or below (34.4%; GPA: <3.5). Assessed dietary habits included frequency of caffeine consumption; 61.7% of the respondents consumed caffeine daily, 18.8% consumed it weekly (2–5 times per week), and 19.5% consumed every 2 weeks or less.

The prevalence of poor sleep quality of the participants was 77% ($n = 217$, mean PSQI score: 8.13 ± 3.46). The period from 00:00 to 1:59 was the most frequent for bedtime ($n = 145, 51.4\%$) followed by the period from 2:00 to 3:59 ($n = 73, 25.9\%$); only 19.1% had a usual bedtime before midnight. The average total hours of sleep were 5.87 ± 1.56 per night. However, >43% reported having a daytime nap. The overall total hours of actual sleep ranged from 2 to 12.

Distress was also prevalent: 63.5% of the students exhibited positive distress on the K10 ($n = 179$). More than 41% of the respondents had either a moderate or severe level of distress, and approximately one-fourth had a severe level of distress. Mild and moderate levels were 22% and 17.4%, respectively. The K10 scores covered the entire possible range, from 10 to 50, with a mean score of 23.72 ± 8.55 .

Table 2 presents the associations of poor sleep quality and stress with GPA, work status, and other variables in the study. A greater proportion of participants who had poor sleep quality reported distress compared to participants who did not have poor sleep quality (68.7% and 46.2%, respectively; $P = 0.002$). The prevalence of poor sleep quality also increased with each distress level: 67.7% for mild distress, 87.8% for moderate distress, and 94.1% for severe distress ($P < 0.001$). Taking a daytime nap showed a statistically significant association with poor sleep quality, with 81.9% of the participants who took daytime

Table 1: Characteristics of medical students in preclinical years ($n=282$)

Characteristics	N (%)
Gender	
Male	100 (64.5)
Female	182 (35.5)
Age (years)	
18-<21	103 (36.5)
21-<24	172 (61.0)
≥24	7 (2.5)
Marital status	
Single	276 (97.9)
Married	6 (2.1)
Residency	
With family	269 (95.4)
University/private	13 (4.6)
Academic level	
1 st year	110 (39.0)
2 nd year	73 (25.9)
3 rd year	99 (35.1)
Caffeine intake	
Daily	174 (61.7)
Weekly	53 (18.8)
<1/week	55 (19.5)
Work	
Yes	59 (20.9)
No	223 (79.1)
Daytime nap	
Yes	122 (43.3)
No	160 (56.7)
GPA	
4.5-5	93 (33.0)
3.5-4.49	92 (32.6)
<3.5	97 (34.4)
Poor sleep quality	
Yes	217 (77.0)
No	65 (23.0)
Bedtime	
Before 22:00	6 (2.1)
22:00-23:59	48 (17.0)
00:00-1:59	145 (51.4)
02:00-3:59	73 (25.9)
04:00 or later	10 (3.5)
Distress	
Well	103 (36.5)
Mild	62 (22.0)
Moderate	49 (17.4)
Severe	68 (24.1)

Work includes nonconstant, part-time, and full-time jobs. GPA=Grade point average

naps reporting poor sleep quality compared to only 70.5% of the participants who did not take naps ($P = 0.035$).

In contrast, poor sleep quality was nearly the same between the genders and academic levels. Similarly, there was no difference in the distress suffered by students who took daytime naps and those who did not or between

Table 2: Characteristics of the medical students in their preclinical years by sleep quality and stress (n=282)

Characteristics	Poor sleep quality		P-Value	Stress		P-Value
	YES N (%)	NO N (%)		YES N (%)	NO N (%)	
Gender						
Male	141 (77.5)	41 (22.5)	0.894	98 (53.8)	84 (46.2)	<0.001
Female	76 (76)	24 (24.0)		81 (81.0)	19 (19.0)	
Academic level						
1 st year	86 (78.2)	24 (21.8)	0.780	74 (67.3)	36 (32.7)	0.503
2 nd year	54 (74.0)	19 (26.0)		43 (58.9)	30 (41.1)	
3 rd year	77 (77.8)	22 (22.2)		62 (62.6)	37 (37.4)	
Caffeine intake						
Daily	140 (80.5)	34 (19.5)	0.206	110 (63.2)	64 (36.8)	0.753
Weekly	38 (71.7)	15 (28.3)		32 (60.4)	21 (39.6)	
<1/week	39 (70.9)	16 (29.1)		37 (67.3)	18 (32.7)	
Work						
Yes	51 (86.4)	8 (13.6)	0.076	39 (66.1)	20 (33.9)	0.750
No	166 (74.4)	57 (25.6)		140 (62.8)	83 (37.2)	
Daytime nap						
Yes	131 (81.9)	29 (18.1)	0.035	102 (63.7)	58 (36.3)	1.000
No	86 (70.5)	36 (29.5)		77 (63.1)	45 (36.9)	
GPA						
4.5-5	74 (79.6)	19 (20.4)	0.117	52 (55.9)	41 (44.1)	0.175
3.5-4.5	64 (69.6)	28 (30.4)		61 (66.3)	31 (33.7)	
3.49 ≥	79 (81.4)	18 (18.6)		66 (68.0)	31 (32.0)	
Sleep quality						
Poor				149 (68.7)	68 (31.3)	0.002
Not poor				30 (46.2)	35 (53.8)	
Distress						
Well	68 (66.0)	35 (34.0)	<0.001			
Mild	42 (67.7)	20 (32.3)				
Moderate	43 (87.8)	6 (12.2)				
Severe	64 (94.1)	4 (5.9)				

Work includes nonconstant, part-time, and full-time jobs. GPA=Grade point average

students who worked and those who did not. Students' current overall GPAs also did not show significant associations with poor sleep quality or distress level.

The multivariable stepwise binary logistic regression analysis to predict poor sleep quality in the participants is shown in Table 3. High levels of distress were highly associated with poor sleep quality. For instance, normal (OR = 0.108, 95% CI: 0.036–0.325) and mild (OR = 0.112, 95% CI: 0.035–0.358) distress showed significant negative associations with poor sleep, but there was no significant difference between the moderate distress level and the high distress level, which was used as a reference (OR = 0.383, 95% CI: 0.101–1.458, $P = 0.159$). Compared to students who took daytime naps, those who did not nap had only 0.453 times the odds of reporting poor sleep quality (95% CI: 0.250–0.821, $P = 0.009$).

Discussion

In the present study, 77% of the participants had a poor quality of sleep. This result is similar to other studies

in Saudi Arabia (76% and 74.2%).^[18,27] However, a study from the Southern region of Saudi Arabia had a different result (29.7%).^[28] Internationally, the quality of sleep of medical students has generally been found to be better: 50.9% in the United States,^[29] 55.8% in Ethiopia,^[5] 19% in China, and 40% in Lithuania.^[4] The prevalence of stress in participants in the current study was 63.5%, which is also higher than similar local and international studies. For instance, a prevalence of about 53% was found in two colleges in Riyadh^[18,20] and 41.9% in Malaysia.^[30]

Examination periods increase both stress and poor sleep quality of medical students.^[10,31] Ahrberg *et al.* found that the quality of sleep of students in the 5 weeks preceding examinations was significantly worse than in the semester or 4 weeks afterward.^[10] This could be an explanation for the high prevalence of poor sleep quality in the present study, since students were enrolled in a 3–6-week block systems in which they were assessed by weekly PBL sessions, mid-block and final examinations, and tutorial and seminar assessments.

Table 3: Correlates of poor sleep quality among the medical students in their preclinical years

Predictors	P-Value	OR	95% CI
Daytime nap			
No	0.009	0.453	0.250-0.821
Yes		-	
Distress			
Well	<0.001	0.108	0.036-0.325
Mild	<0.001	0.112	0.035-0.358
Moderate	0.159	0.383	0.101-1.458
Severe		-	

CI=Confidence interval, OR=Odds ratio

Poor sleep quality was significantly associated with the level of stress in medical students in this study ($P < 0.001$). This association has been widely reported.^[10,14,31] Morin *et al.* found that participants who had symptoms of insomnia were more stressed than noninsomniacs.^[14] They also concluded that there was either a direct or indirect relationship between insomnia and stress, nighttime arousal, and emotional responses to stress. Notably, stress was more prevalent in female students in this study ($P < 0.001$), but no significant association between gender and sleep quality was found.

In spite of the expected start of the first lecture of the day (8:00 am), the majority of students (80.8%) reported that they had gone to bed at midnight or later. Similarly delayed bedtime was found in other local universities (12:06 am \pm 1.58; 1:53 am \pm 3:51; and 77.2% at midnight or later).^[15,18,19] In a study from Thailand, 54% of the students reported a bedtime between 10.00 pm and 12.00 am, but during examination periods, 41% of the students would go to bed between 2:00 am and 4:00 am.^[32]

Taking a daytime nap not only increases afternoon alertness but also negatively affects sleep quality in young adults.^[33,34] However, in our study, daytime naps showed a significant association with, and were predictive of, poor sleep quality. This suggests that napping by participants in this study was more likely to be compensated for insufficient nighttime sleep than planned, and habitual compensatory daytime naps are frequently used to cope with altered circadian rhythms.^[9]

The negative impact of poor sleep quality and stress on academic performance has been well reported in the literature.^[9,10,12] However, surprisingly, in this study, academic performance showed no statistically significant association with sleep quality or stress levels. This result is similar to data reported by Alqarni *et al.*, Al-Zahrani *et al.*, and Abdulghani *et al.*^[16,17,21] Conversely, some local studies have concluded that sleep disorders negatively affect academic performance.^[15,35] This inconsistency in local studies may draw attention to the new trends

in sleep-wake habits and their relationship to the professional life of young adults in Saudi Arabia. This point, as well as the cultural aspects (sleep-wake patterns in hot countries), should be taken into consideration in future studies.

This study was based in a single institution, so the specific environment of that institution may have had an impact on the accuracy of the generalizability of the results. The cross-sectional design, which collected responses at a single point in time, could not provide a causal relationship between variables. Furthermore, since students were asked about their sleep quality and stress in the previous month, there could have been recall bias. We recommend that future studies continue to investigate different psychological and behavioral parameters of medical students and their impact on academic performance and assess the role of different medical pedagogies and ways of assessment in that relationship. In the meantime, sleep quality and levels of stress in medical students could be improved with campaigns on sleep education, counseling on time management, and plans for treatment.^[36-38]

Conclusion

This study showed that the quality of sleep in medical students in their preclinical years was poor and their stress levels elevated, with these two variables significantly associated. Furthermore, stress and daytime naps were significant predictors of poor sleep quality. Stress was more prevalent among females. Surprisingly, academic performance did not show any statistically significant association with sleep quality or stress levels. Researchers and medical educationists are encouraged to continue to assess students' well-being, methods of education, and factors that affect academic performance and in the meantime improve students' sleep quality through counseling and educational campaigns.

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Conflicts of interest

There are no conflicts of interest.

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