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IMPACT OF SLEEP QUALITY AND DAYTIME SLEEPINESS ON WORKING MEMORY AND ACADEMIC STRESS OF COLLEGE STUDENTS

Psychology

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ABSTRACT

College students often experience sleep disturbances due to demanding schedules. This study investigates the relationship between sleep quality, daytime sleepiness, working memory, and academic stress in this population. A correlational design was employed, involving 225 students who completed self-report measures and a computer-based test. The self-report measures included Pittsburgh Scale Quality Index, Epworth Sleepiness Scale, and Academic Stress Scale, while the computerised test was Sequencing Test WOM-ASM. The participants consisted of 68% female and 32% male students. The findings of the study show a strong positive correlation between higher levels of academic stress, increased daytime sleepiness, and poor sleep quality. Working memory function and the quality of sleep, or daytime sleepiness, were not found to be directly correlated. Subsequent investigation showed that, in comparison to students who had good sleep quality, those who had poor sleep quality reported far greater levels of academic stress and daytime sleepiness. These findings emphasise the importance of addressing sleep quality and daytime sleepiness in university students to enhance their academic performance and overall well-being.

KEYWORDS

Sleep quality, daytime sleepiness, working memory, academic stress, college students

INTRODUCTION

Sleep is an inescapable biological downtime and has been characterized as "A dormant state of peripheral responsiveness" (Altevogt & Colten, 2006); it is one of the most universally essential parts of human physiology to restore functional capacity for both physical health and mental health overall quality of life. Previous research has shown that better sleep improves capacity and drives the collapse of working memory (Fenn et al., 2012). College students, however, often experience high daytime sleepiness, characterized by a strong desire to sleep during the day, even at inappropriate times. This is due to insufficient primary sleep (70%) and irregular bed schedules, with around 50 % of students reporting some level of daytime sleepiness. These factors have negative consequences on the academics, health, and safety of students (Hershner & Chervin 2014).

Daytime sleepiness and nighttime sleep appear to be closely and causally related. Excessive daytime sleepiness (EDS) is a prevalent issue among college students, with studies reporting rates of 32-72.4% (Premnath et al., 2022). It is a sign of inadequate sleep, whether due to sleep restriction/ deprivation or medical or psychiatric illness (Tsou & Chang, 2019). Premnath et al. (2022) found that a significant positive correlation exists between excessive daytime sleepiness, depression, and insomnia among college students. Working memory interfaces perception, long-term memory, and action (Pownall Graumann, 2016). It is assumed to be directed by the central executive, an attentional controller rather than a memory system (Baddeley, 2020). It is a type of memory that holds task-relevant information while the brain performs other mental tasks (Baddeley, 2012). Working memory capacity, which varies among individuals, is limited and strongly predicts cognitive abilities such as reasoning and mathematical skills (Lazar, 2017). Students with working memory defects are more prone to academic failure and stress (Roberts et al., 2011). Furthermore, working memory is vulnerable to sleep disruption (Peng et al., 2020).

Academic stress refers to the strain experienced by students, resulting in a state of distress that often manifests as various psychological and behavioral challenges (Khadka, 2024). Sources of stress include academic demands, financial pressures, and time management challenges (Sailo & Varghese, 2024). Academic stress is the transient experience of pressure, anxiety, or distress related to achieving academic goals (Pascoe et al., 2019). Students experience academic stress when concerned about their capacity to cope with academic challenges. Mental distress involves expected academic challenges or failure or even fear of the possibility of academic failure (Jagiello et al., 2024). Poor sleep quality is associated with increased daytime sleepiness (Conceição et al., 2013; Passos et al., 2013). Furthermore, students with poor sleep quality demonstrate worse executive function and working memory performance, as rated by informants (Parrilla et al., 2024).

Sleep, including working memory, is crucial in cognitive functions (Labad et al., 2020). Various research has been done on the impact of short-term sleep deprivation on cognitive variables (Lim & Dinges, 2010). Further, it has been shown that daytime sleepiness and poor sleep quality can significantly impair working memory in college students. It was found that increased sleep duration and improved sleep quality led to enhanced working memory and cognitive function among college athletes (Okano et al., 2019). A meta-analysis of seventy studies concluded that acute sleep deprivation harms most cognitive domains, such as simple attention, intricate attention, working memory, and short-term memory (Lim et al., 2010).

There is increasing concern about sleep health and the effects of sleep deprivation on the human body and cognition. There are many studies related to sleep and its impact on cognitive functions; poor quality sleep or daytime sleepiness negatively impacts learning, memory, and other cognitive performance (Hershner & Chervin, 2014). Academic activities, excessive use of social media, and psychological health issues like stress and anxiety are important causes of poor quality of sleep among students, leading to daytime sleepiness (Li et al., 2020; Xu, 2015). Excessive Daytime sleepiness (EDS) is associated with neurobehavioral (learning, attention/ hyperactivity, conduct) problems and poorer performance in processing speed and working memory (Calhoun et al., 2012). Some studies assessed the relationship between daytime sleepiness and working memory by stoop test among medical graduates (Khullar et al., 2021). However, the findings of this study were not conclusive.

Numerous research investigations have been conducted on medical students and healthcare staff to study the effects of sleep quality and daytime sleepiness on academic stress and working memory (Seoane et al., 2020). This may be attributable to the work demands of rigorous schedules, erratic shift schedules, and intensive workloads of medical school (Perotta et al., 2021). However, these findings lack generalizability to other populations or university students. Therefore, there is a compelling need to investigate the impact of sleep quality, daytime sleepiness, and academic stress on working memory among general college students. This study was planned to explore the relationship between sleep quality, daytime sleepiness, working memory, and academic stress in the general college population and is considering establishing generalizability, having broader relevance, and can be applied to similar populations or situations, contributing to a more comprehensive understanding of how sleep impacts working memory and academic stress across diverse educational fields.

Method

This study was planned and carried out with an observational design that measures the strength and direction of the relationship between two variables and examines whether they are positively or negatively correlated. However, the sampling was Google Forms based on individual invitations to participate to fill up the Google form with

participation on online test for a cognitive test for functional memory. The method used in this study was convenience sampling. This approach involved distributing a Google form to a readily accessible population of college students. Participants were invited to voluntarily complete the form, making it a self-selection process.

Participants

Participants were from various academic departments and different college campuses. The inclusion criteria were aged between 18 to 25 years of either gender, who consented to this study, and who were currently enrolled in a college/university. The exclusion criteria were either medical or nursing students and students who were doing part-time jobs and had a history of pre-existing psychiatric disorder, significant head injury, seizure disorder, addictive substance use disorders, or were on any medications for these illnesses.

Procedure

Snowball sampling was implemented by distributing a Google form to a readily accessible population of college students. The form was disseminated through various channels including social media platforms and classroom announcements. To ensure maximum reach, the form was shared with student organizations, departments, and faculty members, encouraging them to forward it to their networks. Participants were invited to voluntarily complete the form at their convenience. No incentives or restrictions were imposed, making it a purely self-selection process. This approach aimed to minimize the barriers to participation and allow individuals to decide whether or not to engage with the study based on their interests and availability.

The google form consisted of 6 sections. The first section contains the consent for participation, as well as a brief description of the purpose of the study. It is followed by socio-demographic details to obtain information regarding demographic status, medical history, education, and other variables. A soft copy of all three questionnaires- Pittsburgh Scale Quality Index, Epworth Sleepiness Scale, and Academic Stress Scale, and the link to the computerized test (Sequencing Test WOM-ASM) was provided.

The institution issued a research IRB number- CU: RCEC/00175/08/24

Tools Used

1. Socio-demographic data

The socio-demographic data would include age, gender, marital status, religion, community, education, and other clinical variables.

2. Informed Consent form

The informed consent form consists of all the information related to the research such as its purpose, risks, benefits, and withdrawal options. This protects their rights and maintains ethical research, ensuring participants voluntarily agree to research after understanding these aspects.

3. Academic stress scale

The Academic Stress Scale (ASS) is a self-report measure designed to assess the level of academic stress experienced by students. The ASS was developed by James P. Kohn and Gregory H. Frazer in 1986 and consists of 35 items that measure the perceived stressfulness of academic situations. Respondents rate each item on a 5-point Likert scale, ranging from 1 (not at all stressful) to 5 (extremely stressful). The ASS has been shown to have good test-retest reliability, with a correlation coefficient of 0.82. This means that there is a strong correlation between students' scores on the ASS when they take it twice, within a two-week period. It has been shown to have good validity, with a correlation coefficient of 0.73 with other measures of academic stress (Sharma & Gupta, 2018).

4. Pittsburgh Scale Quality Index

The Pittsburgh Sleep Quality Index (PSQI) is an effective instrument used to measure the quality and patterns of sleep in the older adult. It differentiates “poor” from “good” sleep by measuring seven domains: subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction over the last month. This has 19 items that evaluate subjective sleep quality. In this study we will use only the global score of PSQI (range 0 to 21). Values > 5 are considered poor quality of sleep, and higher scores will indicate worse sleep quality (Buysse et al., 1989). The PSQI demonstrates good internal consistency with a Cronbach's alpha of 0.83 for its seven components. This indicates that the items within the PSQI consistently measure the same construct. (Meo et al., 2021)

5. Epworth Sleepiness Scale

The Epworth Sleepiness Scale (ESS) is a short questionnaire to assess daytime sleepiness. This test assesses how likely a person falls asleep in eight different situations. The person has to rate on a scale of 0 to 3 how likely they are to fall asleep in different situations. A rating of 0 means they would never fall asleep, and a 3 reflects a high likelihood of dozing off. The test-retest reliability for ESS displayed good reliability (ICC2,1: 0.86), supported by the Bland-Altman graph and the scatterplot. Cronbach's alpha was reported as 0.86, and Pearson's coefficient was r: 0.62, p-value: 0.001 (Veqar et al., 2019).

6. Sequencing Test WOM-ASM

The WOM-ASM Sequencing Test is based on the WAIS-III classic direct and indirect digit test (Wechsler, 1997). Through this task, we can test the user's ability to retain the short-term phonological information presented visually. A series of balls with different numbers will appear on the screen. The user will have to memorize the series to repeat it later. The series will become longer and longer until the user makes a mistake. The user will be asked to repeat the series after each presentation. The time allowed is between approximately 30 seconds and 5 minutes.

RESULTS

After four months of data collection and data cleaning, we finally had a sample of 225 students fulfilling the inclusion and exclusion criteria with a mean age of 21.44± 02.08 years. Out of these, the majority (68%) were females and graduate students (62.7%). (Table:1)

Table 1: Socio-demographic Characteristics and Distribution of the Sample

	Variable	Total sample (n=225)
Mean age ± SD in years		21.44 ± 02.08
Gender	Male	72 (32%)
	Female	153 (68%)
Educational status	Graduation	141 (62.7%)
	Post Graduation	84 (37.3%)

The correlation analysis reveals significant relationships among the four variables. Notably, sleep quality is positively correlated with daytime sleepiness ($r = 0.307$, $p < .001$) and academic stress ($r = 0.364$, $p < .001$). These findings suggest that poorer sleep quality is associated with increased daytime sleepiness and higher levels of academic stress. However, the correlation between working memory and the other variables is weak and not statistically significant, indicating that sleep quality and daytime sleepiness do not have a meaningful linear association with working memory performance. (Table:3)

Table 2: Descriptives

	N	Mean	Median	SD	Shapiro-Wilk	
					W	p
Sleep Quality	225	5.60	5	2.95	0.944	< .001
Daytime Sleepiness	225	7.47	7	4.05	0.976	< .001
Academic Stress	225	63.94	63	30.92	0.986	0.029
Working Memory	225	62.71	60	19.60	0.964	< .001

Table 3: Pearson Correlation Chart Between the Four Variables

		Sleep Quality	Daytime Sleepiness	Academic Stress	Working memory
Sleep Quality	Pearson's r	-			
	p-value	-			
Daytime Sleepiness	Pearson's r	0.307	-		
	p-value	< .001	-		
Academic Stress	Pearson's r	0.364	0.321	-	
	p-value	< .001	< .001	-	
Working memory	Pearson's r	-0.048	0.057	-0.003	-
	p-value	0.477	0.396	0.964	-

We further categorised students as per their PSQI-based sleep quality scoring and found 123 (54.7%) as students with good sleep quality and remaining 102 (45.3 %) as students with bad sleep quality (Table:4).

Table 4: PSQI-based Categorization of Sleep Quality

Category	N	%
Good Sleep	123	54.7
Bad Sleep	102	45.3

On the basis of the good and bad sleep quality categorization, we compared daytime sleepiness, academic stress and working memory mean scores with an independent sample t-test. There was statistically significantly higher daytime sleepiness (t=-3.060, df=223, p=.002) and academic stress (t=-5.087, df= 223, p=.000) among students with bad sleep quality. However, there was no statistically significant difference in working memory (t=-.143, df=221, p=.886) (table: 5).

Table 5: Grouping Across Good and Bad Sleep Quality as per PSQI and Comparison of Daytime Sleepiness, Academic Stress and Working Memory Means with Independent t-test.

	Good (n=123)	Bad (n=102)	t-value	df	p-value
Daytime sleepiness (Mean ± SD)	6.73 ± 3.48	8.36 ± 4.50	-3.060	223	.002**
Academic stress (Mean ± SD)	54.88 ± 27.60	74.86 ± 31.30	-5.087	223	.000**
Working memory(Mean ± SD)	62.56 ± 20.39	62.94 ± 18.85	-.143	221	.886

*. Correlation is significant at the 0.05 level (2-tailed)
**. Correlation is significant at the 0.01 level (2-tailed)

DISCUSSION

In this cross-sectional observational study, we attempted to examine the relationship between sleep quality, daytime sleepiness, working memory, and academic stress. This study was specifically for university students of either gender, aged between 18-25 years.

Correlation between quality of sleep and academic stress:

We conducted a correlation analysis and observed that sleep quality is positively correlated with daytime sleepiness ($r = 0.307$, $p < .001$) and academic stress ($r = 0.364$, $p < .001$). Indicating that poorer sleep quality is associated with increased daytime sleepiness and higher levels of academic stress. This aligns with existing literature that indicates sleep disturbances can exacerbate stress levels, particularly in academic settings among medical students also (Abdulghani et al. 2012). Demirci et al. (2019) found a significant positive correlation between poor sleep quality and daytime sleepiness ($r = 0.332$, $p < 0.001$) among university students, closely matching your correlation coefficient. There is no reason to differentiate between academic stress between medical students and other non-medical university students. In accordance yet another study concludes that sleep duration and quality have direct and indirect effects via mood on college students' academic function (Wong et al. 2013). In concurrence, better quality, and greater sleep consistency are associated with lower academic stress (Okano et al. 2019).

However, we found a non-significant correlation between working memory and the other variables. This finding does not support the hypothesis that poor sleep quality and increased daytime sleepiness negatively impact working memory, suggesting that other factors may also play a more significant role in cognitive performance. This is in accordance with a recent study by Almarzouki et al. (2022) that concluded that students experiencing poor sleep suffered from poor mental health, but they maintained good results and working memory scores which may be due to high cognitive resilience.

Comparison of students grouped as students with Good and Bad sleep quality as per PSQI:

The independent samples t-test results in Table 5 further highlight the differences between participants with good and bad sleep quality. The significant differences in daytime sleepiness ($p = .002$) and academic stress ($p = .000$) reinforce the notion that individuals with poor sleep quality experience higher levels of daytime sleepiness and academic stress. These results are critical, as they highlight the potential impact of sleep quality on students' daily functioning and overall well-being. Seun-Fadipe & Mosaku (2017) reported significant differences in academic stress levels ($p = .001$) between good and poor sleepers, with poor sleepers experiencing higher levels of academic-related stress. In a similar study, it was found that effects of sleep quality were significant on visual working memory quantity, precision and offset indexes (Gong et al., 2024). In yet another study Gomes et al. (2019) studied arts and science undergraduates, reporting significant group differences in both daytime sleepiness ($p = .001$) and academic stress ($p < .001$) between students with good versus poor sleep quality. It was found that students with poor sleep quality consistently showed higher levels of both daytime sleepiness and academic stress. In a large-scale study of business students, Wong et al. (2013) found that students with poor sleep quality (PSQI > 5) showed significantly higher levels of daytime sleepiness ($p = .002$) and perceived academic stress ($p < .001$) compared to good sleepers.

However, the lack of significant difference in working memory performance ($p = .886$) between the two groups suggests that while sleep quality may influence subjective experiences of stress and alertness, it does not necessarily translate to measurable differences in cognitive performance as assessed in this study. Jiang, F et al. (2011) conducted an experimental study on a group of young adults who underwent a 2-week home-based sleep manipulation protocol. Subjective sleepiness was scored by the participant each morning, and working memory tests were administered. It was found that subjective sleepiness scores significantly increased after sleep restriction, but were not accompanied by significant changes in working memory. Nelabhotla & Shanmugam (2021) found sleep deprivation does affect working memory, but concluded that effects of sleep deprivation are not generalizable across individuals and that the impact of sleep deprivation is specific to each individual. There are even some evidence that the association between sleep disruptions poses risk of psychosis (Ouellet et al., 2024). These findings invite further investigation into the complexities of how sleep affects cognitive processes, as it may be that other variables, such as motivation or study habits, could mediate this relationship.

Limitations and Implications for Future Research

Although this study provides valuable information, it is important to look into the limitations of it as well. The study relied on self-report measures, which may be subject to biases. Methodologically we used an online survey snowball sampling which has many limitations, in comparison to face to face evaluation including no estimation of response rate. The weak relationship between working memory and the other variables suggests a need for further exploration into the factors that influence cognitive performance. Longitudinal studies could provide insights into how changes in sleep quality over time affect cognitive functioning.

CONCLUSION

In conclusion, this study found a significant positive relationship between poor sleep quality, increased daytime sleepiness, and higher levels of academic stress in college students, supporting existing literature that poor sleep contributes to stress especially in academic settings. However, the hypothesised negative relationship between sleep quality and daytime sleepiness with working memory performance was not supported, as no significant relationship was found. This non-significant finding suggests that there might be other factors that influence the relationship between sleep and working memory.

These findings highlight the importance of addressing sleep quality and daytime sleepiness in college students to improve their academic as well as overall well-being. Future research is needed to further explore the complex relationship between sleep, daytime sleepiness, working memory, and academic stress.

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