ORIGINAL ARTICLE

RELATIONSHIP OF SLEEP QUALITY WITH MENTAL WELL-BEING AND ACADEMIC PRODUCTIVITY

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Background: Better sleep quality is associated with better mental health. This study aimed to link sleep quality of medical students with their psychiatric health and academic performance. **Methods:** Sleep quality of 104 medical students (52 each from 1st and 5th year of MBBS with equal gender distribution) was measured on Pittsburgh Sleep Quality Index (PSQI) while Hamilton Depression Rating Scale (HDRS) along with Hamilton Anxiety Rating Scale (HAM-A) was used to assess their psychiatric health, both of which were later correlated with their academic scores. **Results:** Sleep quality of 1st year medical students was significantly better as compared to their final year counterparts (p=0.001) and (p=0.000) respectively which affected indices of psychiatric health in such a way that 1st year medical students scored significantly lower on scales of depression as well as anxiety as compared to final year medical students (p=0.001), (p=0.000) and (p=0.001, p=0.000). Within 1st and final year (male and female) medical students, sleep quality had a strong positive correlation with scores of depression and anxiety (r=0.547, p=0.004), (r=0.587, p=0.002), (r=0.66, p=0.000) ,(r=0.490, p=0.011) and (r=0.518, p=0.007), (r=0.527, p=0.006), (r=0.541, p=0.004), (r=0.596, p=0.001) respectively, which in turn had a negative correlation with academic performance of theirs (r=-0.400, p=0.043), (r=-0.614, p=0.001) and (r=-0.550, p=0.004), (r=-0.573, p=0.002) respectively. **Conclusion:** Medical students with poor sleep quality, harbour higher degrees of depression and anxiety and perform poorly on academic front as compared to those with better sleep quality.

Keywords: Depression, Anxiety, Medical students, Sleep quality, Academic performance

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INTRODUCTION

Since better sleep quality has a specific neuro-protective role[1], its deterioration as an uptrend within a wide spectrum of society as well as medical fraternity under influence of a number of triggering factors such as long academic hours, hectic professional duties and heightened social expectations is being considered a matter of high concern as it can induce inflammatory as well as neuro-conductive anomalies reflecting in terms of inter-connected cognitive and psycho-psychiatric impairments.[2]

It is believed that psycho-psychiatric upheaval, which thrives within the boon of poor sleep quality, originates as a result of dysregulated bio-physiology of crucial neurological factors such as that of nuclear factor kappa-B which coupled with a continuous overstimulation of hypothalamo-pituitary axis (HPA) within a sleep deprived status leads to overexpression of a whole spectrum of Reactive Oxygen Species (ROS) such as IL-6 and TNF-α within neurological centers that primarily regulate mood and behaviour.[3] These dysregulations not only enhance presynaptic reuptake of monoamines and speed up their degradation but enhance glutamate associated excito-toxicity within circuits aligned with emotional control also[4] which then initiate a syndrome of emotional volatility that leads to evolution of depression (apsycho-psychiatric disorder highlighted by feelings of dejection, desolation, passivity and suicidal intentions)[5] and anxiety (psychosomatic condition marked by stressful notions that manifest themselves in form systemic upheavals).[6]

In addition to dysregulation of HPA, sleep deprivation also brews a chaos for neuro-biochemical levels of Vascular Endothelial Growth Factor (VEGF), Brain Derived Neurotropic Factor (BDNF) as well as cortisol that not only initiates a long term disruption of circadian rhythm where sleep deprivation and altered circadian biology keep potentiating each other in a complementary fashion but also enhances the probability of mood disorders presenting within the diaspora of depression.[7] Since sleep deprivation also leads to poor serotonin levels within various components of limbic cortex that gets linked with an altered neurophysiological status of cAMP associated 5HT-4 receptors within CA1 area of the hippocampus, an area primarily associated with retaining and learning capacities of the brain, hence sleep deprivation not only paves way for the establishment of depressive states but also for a consistent memory decline.[8]

An unchecked poor sleep leads to an enhanced cholinergic, glutaminergic as well as α-amino-3-hydroxy-5-methyl-4-isoxazolepropionic acid (AMPA) and N-methyl-D-aspartate (NMDA) receptor activity within the prefrontal cortex which is coupled with dysregulation of neuropeptide S (NPS) within central and lateral portions of amygdala, both of which in

unison strengthen the establishment of anxiety though an elevated neuronal activity within a myriad of limbic centres working in close association with hippocampal nuclei. This limbic overstimulation later initiates neuronal degeneration within hippocampal nuclei and this than depicts itself in terms of a long lasting decline of cognitive performance. Thus, sleep deprivation through above stated intricate pathways sets a fertile neuronal environment for evolution of depressive as well as anxiety disorders complimenting a consistent memory decline.[9]

Considering the importance of sleep quality for mental harmony of an individual, as has been stated in the above presented case, this study tried to extend a scientific proof regarding importance of proper sleep quality for mental wellbeing as well as academic productivity while working with a young population of the medical students of south Punjab who are considered to be the most brilliant lot of the country and are observed to experience a gradual decline of sleep quality as they ascend towards their graduation year.

METHODOLOGY

Sample size of 26 participants for each group of this cross-sectional, observational study was calculated with a power of 90% and an alpha level of 5% through utilization of mean differences of sleep quality between first and final year medical students.[10]

$$\frac{n= \sigma 2(Z1-\alpha/2+Z1-\beta)2}{(\mu 0-\mu 1)2}$$

The study was conducted after getting official approval from Institutional Review Board (IRB) of Nishtar Medical University, Multan. To ensure that obesity did not present itself as a confounder within psycho-psychiatric indices of our study, we only included non-obese subjects, declared so by the WHO 2000 and 2015 criteria (males with a BMI<24.9 and a WHR≤0.9 while females having a BMI<24.9 and a WHR≤0.8) respectively. Subjects considered obese, those with previous history of psycho-psychiatric and/or endo-metabolic ailment(s) and those with history of recreational drug use and/or family abuse were excluded from the paradigm of this study.

Consent in writing was obtained from medical students of 1st and 5th year of medicine. BMI and WHR were calculated to segregate a general pool of non-obese subjects, out of which 52 students from 1st year of medicine and 52 from 5th year of medicine were randomly selected through lottery ticket method (observing an equal gender representation). Group 1 and 2 thus consisted of 1st year males (1st YMs) and females (1st YFs), while Group 3 and 4 consisted of 5th year males (5th YMs) and females (5th YFs) respectively. The total population, hence consisted of 104 medical students with 26 subjects falling into each of the above mentioned four study groups.

Pittsburgh Sleep Quality Index (PSQI) scale with a Cronbach's alpha value of 0.83[11] was then administered to participants of all groups which, while running on a Likert scale, where a score higher than 5 represents a poorer shade of sleep quality while a score less than 5 depicts a better sleep quality, helped us deduce the sleep quality of the students from both 1st and 5th year of medicine. To assess degree of depression within medical students of each of the study groups, Hamilton Depression Rating Scale (HDRS), having a Cronbach's alpha of 0.86[12], was used. This tool runs on a Likert scale as well and here a score of 0–7 represents non-existence of depression, a score of 8–16 indicates presence of mild depression, a score of 17–23 implies existence of a moderate degree of depression while a score more than 24 indicated severe depression. To establish degree of anxiety of subjects, Hamilton Anxiety Rating Scale (HAM-A) with a Cronbach's alpha value of 0.87[13] was used. This too is a Likert scale associated tool where a score of <17 indicates non-existent to mild shade of anxiety, scores of 18–24 marks the presence of mild to moderate degree of anxiety while score of 25–30 represents moderate to severe form of anxiety. In addition to these scales, percentage of total score achieved by students of each of the four categories in the last professional examination was considered an index of academic performance.

Collected data was entered into SPSS-26 where it was analysed for normality distribution via Shapiro-Wilk's and Kolmogorov Smirnov's tests. Since most of study parameters were found to have a normal distribution, hence parametric inferential statistics was applied for data analysis. ANOVA, paired with Post-hoc Tukey's test was applied to draw a comparison of sleep quality, depression, anxiety and academic performance between study groups while Pearson's correlation was applied to determine correlation between various quantitative variables.

RESULTS

Since majority of our study parameters were normally distributed, hence our data has been represented as Mean±SD. It was noted that, 1st YM had an age of 19.538±0.760, weight of 60.069±5.903 Kg, squared height of 2.899±0.199 m^2, body mass index of 20.727±1.675 Kg/m^2, waist circumference of 76.788±5.665 Cm, hip circumference of 92.846±4.763 Cm and waist hip ratio of 0.826±0.030. 1st YF had an age of 18.807±0.693, weight of 52.926±5.677 Kg, squared height of 2.497±0.220 m^2, body mass index of 21.205±1.476 Kg/m^2, waist circumference of 72.038±4.268 Cm, hip circumference of 92.076±5.491 Cm and waist hip ratio of 0.779±0.024. 5th YM had an age of 22.884±0.816, weight of 65.042±7.931 Kg, squared height of 2.985±0.276 m^2, body mass index of 21.765±1.437 Kg/m^2, waist circumference of

75.384±9.073 Cm, hip circumference of 89.538±8.892 Cm and waist hip ratio of 0.840±0.028. The 5th YF had an age of 23.538±0.581, weight of 55.807±5.151 Kg, squared height of 2.645±0.183 m^2, body mass index of 21.121±1.610 Kg/m^2, waist circumference of 71.730±6.494 Cm, hip circumference of 93.038±7.372 Cm and waist hip ratio of 0.770±0.027.

After application of ANOVA to determine the existence of differences for PSQI, HDRS, HAM-A and AS (p=0.000, p=0.000, p=0.000 and p=0.000 respectively), we (through Post Hoc Tukey's Test) found that the sleep quality (deduced through PSQI) along with scores of depression (calculated on HDRS) and anxiety (estimated via HAM-A) within 1st YMs and 1st YFs were significantly lower than 5th YMs and 5th YFs and that 1st YM and 1st YF performed significantly better in their academia than 5th YMs and 5th YFs (Table–1).

It was also observed that sleep quality, both within 1st and 5th year male and female medical students, had a significant positive correlation with the degree of depression and anxiety while a negative one with academic aces. Moreover, the intensity of psycho-psychiatric instability that reflected itself in terms of the scores of depression and/or anxiety had an independent negative correlation with academic scores too. This data has been represented in Table-2 and 3 respectively.

The correlation of sleep quality and the indices of psycho-psychiatric and academic stability, for the whole of the study population combined together, has been represented in Figure-1.

Table-1: Comparison (Post Hoc Tukey's) of PSQI, HDRS, HAM and Academic Scores in study groups

Variable	Groups In Comparison (n=26)		p
PSQI Scores	1st YMs 3.320±2.035	1st YFs 4.840±2.211	0.641
	5th YMs 8.520±5.591	5th YFs 12.320±6.283	0.024
	1st YMs 3.320±2.035	5th YMs 8.520±5.591	0.001
	1st YFs 4.840±2.211	5th YFs 12.320±6.283	0.000
HRDS Scores	1st YMs 4.800±3.201	1st YFs 7.200±3.628	0.647
	5th YMs 12.240±8.733	5th YFs 14.680±8.591	0.607
	1st YMs 4.800±3.201	5th YMs 12.240±8.733	0.001
	1st YFs 7.200±3.628	5th YFs 14.680±8.591	0.001
HAMA Scores	1st YMs 12.800±7.388	1st YFs 16.680±9.910	0.549
	5th YMs 23.800±10.839	5th YFs 31.080±9.784	0.041
	1st YMs 12.800±7.388	5th YMs 23.800±10.839	0.000
	1st YFs 16.680±9.910	5th YFs 31.080±9.784	0.000
Academic Scores	1st YMs 85.840±5.171	1st YFs 83.820±5.798	0.667
	5th YMs 77.180±6.130	5th YFs 72.404±6.094	0.034
	1st YMs 85.840±5.171	5th YMs 77.180±6.130	0.000
	1st YFs 83.820±5.798	5th YFs 72.404±6.094	0.000

Table-2: Correlation of sleep quality with indices of depression, anxiety, and academia

	Sleep Quality							
	1st YMs		1st YFs		5th YMs		5th YFs	
Variable	***r***	***p***	***r***	***p***	***r***	***p***	***r***	***p***
HDRS	0.547	0.004	0.667	0.000	0.518	0.007	0.541	0.004
HAMA	0.587	0.002	0.490	0.011	0.527	0.006	0.596	0.001
AS	-0.400	0.043	-0.614	0.001	-0.550	0.004	-0.573	0.002

Table-3: Correlation of sleep quality with academic score for all the study groups

	Academic Score							
	1st YMs		1st YFs		5th YMs		5th YFs	
Variable	***r***	***p***	***r***	***r***	***r***	***p***	***r***	***p***
HDRS	-0.544	0.004	-0.393	0.047	-0.632	0.001	-0.660	0.000
HAMA	-0.631	0.001	-0.390	0.049	-0.570	0.003	-0.292	0.148

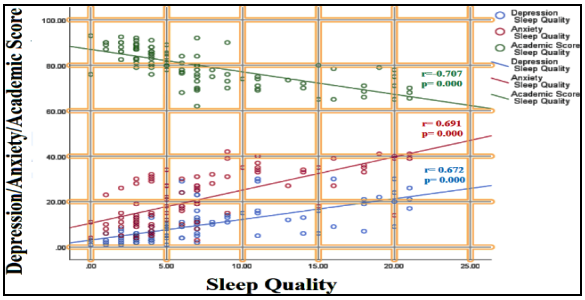

Figure-1: Correlation of sleep quality with indices of depression, anxiety and academia for whole of study population combined together

DISCUSSION

We observed that sleep quality of both male and female medical students attending their first year of medical school was significantly better than their final year counterparts, a fact which is supported by projections of earlier studies[14] and could be attributed to an ever more competency demanding academics and to non-availability of viable guidelines to tackle this pressure that ultimately leads to evolution of academic uncertainty within students of clinical years that affects their sleep quality by acting as a cutaneous stressor.[15]

Final year male and female medical students with poor sleep quality experienced a higher degree of depression than students in 1st year of medicine having better sleep quality. This finding is in accordance with those being reported by recent research papers[16] and could be justified on proposition that sleep deprivation leads to an increased degradation of tryptophan within kynurenine pathway which not only reduces serotonin levels in key mood controlling areas like hypothalamus and frontal cortex but also leads to their neurodegeneration due to accumulation of neurotoxic kynurenine metabolites which than becomes a prelude over which depression can thrive.[17]

Regardless of their gender final year medical students harboured a far more intense shade of anxiety than their first year counterparts which is a finding echoed within the projections of contemporary research papers[18] where it is suggested that sleep reduction not only increases the levels of inflammatory cytokines, i.e., IL-6, TNF-α, and IFN-γ, but also enhances the level of stress hormones like cortisol, both of which combined together lead to reduced production of neuro-calming chemicals like serotonin and melatonin as well as an increased accumulation of excitotoxins within basal ganglia and its associated cortical mood controlling areas and this provides an environment for stress disorders like anxiety to brew.[19]

Within students of final year of medicine, females did experience poor sleep quality and heightened anxiety even compared to their age and ethnicity matched male counterparts. This again is a finding that is inline with those which portray that an intense shade of anxiety syndrome expresses itself in females approaching postgraduate practical rung of life because they have to face higher degree of marital as well as domestic expectations[20] which when gets a unison with regularly fluctuating endo-menstrual status of theirs is able to alter expression of dopamine, serotonin, acetylcholine and GABA within cortico-hypothalamo-amygdaloid regions that disrupts harmony of HPA to create emotional volatility.[21]

Sleep deprivation, both within 1st and final year medical students regardless of gender, had a positive correlation with degree of depression as well as anxiety and a negative with academic performance, a finding that is supported by data projected by recently.[15] It is suggested that sleep deprivation leads to insensitivity of serotonin-1A receptors within the fronto-cortical circuitry associated with mood stability which than paves way for emergence of mood disturbances like depression and anxiety that disrupts intellectual focus and becomes the base of poor academia.[22]

Regardless of gender distribution, both within 1st and final year medical students, intensity of depression and anxiety that evolved over sleep deprived status showed an independent negative correlation with academic performance too. This stands in accord with projections of neuro-biochemical studies[23] which suggest that sleep deprivation, through glutathione-kynurenic acid imbalance, creates an environment of oxidative stress within hippocampus, basal amygdala as well as lateral prefrontal cortex that leads to their neuro-degeneration which consequently exacts a toll on the sleep deprived students' memory as well as on fact retrieval capacity and provides a prelude for poor academic focus and productivity.[24]

CONCLUSION

As the medical students move to their graduation year, their sleep quality declines while their degree of depression and anxiety plummets which leads to an academic deterioration. We advocate for better sleep quality, specifically for the students whose studies become ever more demanding towards the end of the degree courses, so that the most productive strata of the society which has to be the custodian of our nation's future could extend us its best instead of slipping into the clutches of psycho-psychiatric disorders. Future researchers who intend to further explore this domain of neurophysiology are recommended to carry out cohort studies which do observe a selected population over its entire period of graduation.

REFERENCES

1. Schneider L. Neurobiology and neuroprotective benefits of sleep. Continuum (Minneap Minn) 2020;26(4):848–70.
2. Vaseghi S, Arjmandi-Rad S, Eskandari M, Ebrahimnejad M, Kholghi G, Zarrindast MR. Modulating role of serotonergic signaling in sleep and memory. Pharmacol Rep 2022;74:1–26.
3. Agrawal S, Kumar V, Singh V, Singh C, Singh A. A review on pathophysiological aspects of sleep deprivation. CNS & Neurological Disorders-Drug Targets (Formerly Current Drug Targets-CNS & Neurological Disorders). 2023;22(8):1194–208.
4. Begdache L, Kianmehr H, Sabounchi N, Marszalek A, Dolma N. Principal component regression of academic performance, substance use and sleep quality in relation to risk of anxiety and depression in young adults. Trends Neurosci Educ 2019;15:29–37.
5. Benazzi F. Various forms of depression. Dialogues Clin Neurosci. 2006;8(2):151–61.
6. Daviu N, Bruchas MR, Moghaddam B, Sandi C, Beyeler A. Neurobiological links between stress and anxiety. Neurobiol Stress 2019;11:100191.
7. Vaseghi S, Mostafavijabbari A, Alizadeh MS, Ghaffarzadegan R, Kholghi G, Zarrindast MR. Intricate role of sleep deprivation in modulating depression: focusing on BDNF, VEGF, serotonin, cortisol, and TNF-α. Metab Brain Dis 2023;38(1):195–219.
8. Eydipour Z, Nasehi M, Vaseghi S, Jamaldini SH, Zarrindast MR. The role of 5-HT4 serotonin receptors in the CA1 hippocampal region on memory acquisition impairment induced by total (TSD) and REM sleep deprivation (RSD). Physiol Behav 2020;215:112788.
9. Xie JF, Shao YF, Wang HL, Wang C, Cui GF, Kong XP, *et al.* Neuropeptide S Counteracts Paradoxical Sleep Deprivation-Induced Anxiety-Like Behavior and Sleep Disturbances. Front Cell Neurosci 2018;12:64.
10. Choueiry N, Salamoun T, Jabbour H, El Osta N, Hajj A, Rabbaa Khabbaz L. Insomnia and Relationship with Anxiety in University Students: A Cross-Sectional Designed Study. PLoS One 2016;11(2):e0149643.

11. Morris JL, Rohay J, Chasens ER. Sex differences in the psychometric properties of the Pittsburgh sleep quality index. J Women's Health (Larchmt) 2018;27(3):278–82.
12. Obeid S, Abi Elias Hallit C, Haddad C, Hany Z, Hallit S. Validation of the Hamilton Depression Rating Scale (HDRS) and sociodemographic factors associated with Lebanese depressed patients. Encephale 2018;44(5):397–402.
13. Barbar S, Haddad C, Sacre H, Dagher D, Akel M, Kheir N, *et al.* Factors associated with problematic social media use among a sample of Lebanese adults: The mediating role of emotional intelligence. Perspect Psychiatr Care 2021;57(3):1313–22.
14. Bhatti AA, Khan UA, Khan HF. Sleep habits of first year and final year medical student. Rawal Med J 2012;37(2):148–51.
15. Shao R, He P, Ling B, Tan L, Xu L, Hou Y, *et al.* Prevalence of depression and anxiety and correlations between depression, anxiety, family functioning, social support and coping styles among Chinese medical students. BMC Psychol 2020;8(1):38.
16. Al-Khani AM, Sarhandi MI, Zaghloul MS, Ewid M, Saquib N. A cross-sectional survey on sleep quality, mental health, and academic performance among medical students in Saudi Arabia. BMC Res Notes 2019;12(1):665.
17. Bhat A, Pires AS, Tan V, Babu Chidambaram S, Guillemin GJ. Effects of Sleep Deprivation on the Tryptophan Metabolism. Int J Tryptophan Res 2020;13:1178646920970902.
18. Quek TT, Tam WW, Tran BX, Zhang M, Zhang Z, Ho CS, *et al.* The global prevalence of anxiety among medical students: A meta-analysis. Int J Environ Res Public Health 2019;16(15):2735.
19. Chanana P, Kumar A. Possible involvement of nitric oxide modulatory mechanisms in the neuroprotective effect of Centella Asiatica against sleep deprivation induced anxiety like behaviour, oxidative damage and neuro inflammation. Phytother Res 2016;30(4):671–80.
20. Pokhrel NB, Khadayat R, Tulachan P. Depression, anxiety, and burnout among medical students and residents of a medical school in Nepal: a cross-sectional study. BMC Psychiatry 2020;20(1):298.
21. Giannini A, Caretto M, Genazzani AR, Simoncini T. Neuroendocrine changes during menopausal transition. Endocrines 2021;2(4):405–16.
22. Frau R, Traccis F, Bortolato M. Neurobehavioural complications of sleep deprivation: Shedding light on the emerging role of neuroactive steroids. J Neuroendocrinol 2020;32(1):e12792.
23. Singh R, Suri JC, Sharma R, Suri T, Adhikari T. Sleep Pattern of Adolescents in a School in Delhi, India: Impact on their Mood and Academic Performance. Indian J Pediatr 2018;85(10):841–8.
24. Liaqat H, Parveen A, Kim SY. Neuroprotective Natural Products' Regulatory Effects on Depression via Gut-Brain Axis Targeting Tryptophan. Nutrients 2022;14(16):3270.

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HH: Conception, commencement, field work, statistical analysis, scripting and referencing
MM: Acquisition, analysis and representation of research data
MTM: Acquisition and analysis of research data
MAK: Analysis of research data and final drafting
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