Original Article

Access this article online

Quick Response Code:

Website: www.jehp.net

DOI: 10.4103/jehp.jehp_1157_23

Balancing your mind and gut: Exploring the influence of sleep and gut health on emotional well-being

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Received: 02-08-2023
Accepted: 16-01-2024
Published: 28-10-2024

Abstract:

BACKGROUND: The relationship between the mind, gut, and sleep is not static and requires proper harmony for optimal emotional health. Recent evidence suggests that gut health is a key player in regulating mental and physical health via bidirectional communication between the brain and gut.

MATERIALS AND METHODS: A cross-sectional comparative study was undertaken on 200 participants aged 25-40 years old for two months at a tertiary care hospital. A community-based method was used to select the participants from in and around Pune. The survey was conducted online with the help of a self-designed well-structured detailed questionnaire that included a demographic profile, medical history, history of sleep pattern, gut health status, emotional well-being status about gut and sleep physiology, and lifestyle-related issues and problems was administered to all the study participants.

RESULTS: A statistically significant correlation was observed between the duration of sleep; and gastrointestinal (GI) symptoms including heartburn (P=0.03) constipation (*P*=0.03), bloating (*P*=0.04), and indigestion (*P*=0.051). Specific GI symptoms as mentioned above were found to affect the study participants' emotional well-being significantly. Regular physical exercise demonstrated a significant correlation with an increased duration of sleep (*P*=0.003). Consumption of tobacco, alcohol; smoking, and consumption of stimulants like tea, coffee, and coke showed a significant effect on both the duration and quality of sleep (*P*=0.004). Gut and sleep disturbances were more common in north Indian subjects as compared to south Indian subjects (*P*=0.003). The upper socioeconomic population had more GI; sleep and emotional disturbances as compared to the lower socioeconomic study subjects (*P*=0.002).

CONCLUSION: The relationship between sleep patterns, emotional well-being gut health is bidirectional. Prioritizing good sleep hygiene, managing stress through mindfulness or relaxation techniques, and maintaining a balanced diet that supports gut health are crucial steps in promoting overall well-being.

Keywords:

Axis, brain, gut, mental health, micro biome

Introduction

Humans are emotional creatures; the way we think, the way we speak, the way we act, all these are dependent on how we are feeling at that time.[1] Emotions act as a steering wheel of a car for us. We react according to it, which in turn affects our daily life. In 1947, the World Health Organization defined health as "a state of complete physical, mental and social well-being."[1] This statement clearly states the importance of synchronous functioning of the three pillars of health. Subjective well-being, perceived self-efficacy, autonomy, competence, generational dependency, and self-actualization of one's intellectual and emotional capacity, among other things, are all components of mental health.[2] Emotional well-being is

How to cite this article: Palve S, Singh S, Palve S, Lanka K. Balancing your mind and gut: Exploring the influence of sleep and gut health on emotional well-being. J Edu Health Promot 2024;13:390.

a salient part of holistic wellness, as it can impact our outlook on life, relationships, and health. Emotional well-being enables us to focus on the positive aspects of life while managing unpleasant emotions or sentiments we may experience in each setting.[3,4] Recent emerging testimonials reveal that the microbiome of our gastrointestinal (GI) system could be an important factor creating an impact on our emotional and behavioral health.[5,6] The enteric nervous system can activate the changes that may trigger big emotional shifts among patients suffering from various functional gut issues like dyspepsia, flatulence, diarrhea, constipation, and irritable bowel syndrome.[7] Recent research has shown an intricate link between the bidirectional gut–brain axis and emotional well-being.[8] The relationship between microbiota and Gut-brain Axis (GBA) seems to be bidirectional, with communication from gut microbiota to brain and brain to gut microbiota via neurological, endocrine, immunological, and humoral linkages.[9,10] Lack of sleep is having a negative impact on circadian and homeostatic mechanisms of the body along with cognitive functions.[11] Studies have also proven that sleep has a major influence on the microbiota of our gut as a decreased amount of sleep leads to the generation of less varied microbiota, which then interacts with our brain and influences its functioning.[11-13] Studies have also demonstrated an intimate relationship between sleep and emotion in a variety of ways, modulating the function of sleep on emotion and the modulating role of emotion in regulation of sleep is an interplay between emotional stress and sleep.[14] Although literature is available regarding how sleep affects gut health or how sleep affects emotional well-being.[12] Very minimal data are available regarding the interrelationship between sleep, gut health, and emotional well-being. Hence, the present study was conducted to assess the impact of sleep and gut health on emotional well-being among healthy, young volunteers. The objective of the current study is to examine the correlation between sleep patterns, gut, and bowel health, as well as how lifestyle choices impact an individual sleep pattern. Additionally, the study aims to evaluate the connection between gut disturbances and emotional well-being.

Material and Methods

Study design and setting

A cross-sectional comparative study was conducted at Symbiosis Medical College Hospital and Research Institute.

Study participants and sampling

200 participants between age group between 25-40 years were recruited for total duration of 2 months. Purposive sampling technique was adopted for patient recruitment.

Data collection tool and technique

A self-designed well-structured detailed questionnaire that included demographic profile, medical history, sleeping pattern history, and gut health status, emotional well-being status in relation to gut and sleep physiology, and lifestyle-related questions were administered to all the study participants. The following subsets of the questions were prepared

a) Demographic information-Name, Age, Gender, Occupation, community etc.
b) Medical history-Chronic illness history, medication history, etc.
c) Sleeping pattern analysis-Sleeping schedule and overall quality of sleep.
d) Gut health questions regarding sleep and gut and bowel disturbances.
e) Emotional health- Emotional well-being and the factors affecting it.
f) Lifestyle-related questions-Physical fitness, diet, water intake, etc.

For emotional well-being, the Warwick-Edinburgh Mental Well-Being Scale was used. Questions from Pittsburgh Sleep Quality Index were used to assess the sleep quality of the participants.

Validity and reliability of the research tool – To check the validity of the research tool/questionnaire, the initial version of the study questionnaire was presented to the guide based on constructive validation to analyze the particular cause and effect behaviors involved in the relationship between gut health and emotional well-being; Factor analysis was conducted utilizing principal component analysis (PCA) method. Items loaded above 0.40, with the minimum recommended value in research were considered for further analysis. Also, items cross loading above 0.40 were deleted. Factor analysis satisfied the criteria of construct validity including both the discriminant validity (loading of at least 0.40, no cross loading of items above 0.40) and convergent validity (eigen values of 1, loading of at least 0.40, items that load on posited constructs). To calculate the reliability of the research tool, the method of testing and retesting (Test - Retest) was adopted with a difference of a two-week time. The research tool was administered online to 20 individuals between the age group of 25-40 years upon which the reliability factor was calculated which was 0.87. Questionnaire was administered to all the study participants online via Google forms. The consent for participation was also obtained online.

Exclusion criteria

Individuals with self-identified with a history of gastrointestinal illness, severe liver diseases and subjects on prescribed medications for the same, Individuals suffering from diagnosed cases of sleeping and mental

disorders and subjects on prescribed medications for the same, And Individuals suffering from diagnosed cases of sleeping and mental disorders and subjects on prescribed medications for the same were excluded from the study.

Ethical consideration

This was a short-term studentship (STS) project funded by Indian Council of Medical Research (ICMR). Recruitment of the participants and study procedure was approved by the institutional research and ethics committee (SMCW/IRC/STS Res/6/2022). Prior informed consent was obtained from all the study participants.

Statistical analysis- Demographic analysis was performed using mean and standard deviation (SD). Emotional well-being scores were calculated based on the responses obtained from four-item scale score and by summing up the score for each of the 14 items. The scoring range for each item was between 1 and 5, and the total score was from 14 to 70. Mean and SD were calculated upon which the mental health status was assessed. Sleep quality was assessed by including questions from the Pittsburgh Sleep Quality Index.

All characteristics were summarized descriptively. For continuous variables, the summary statistics of mean ± SD was used. For categorical data, numbers and percentages were used from the data summaries. ANOVA analysis using the Posthoc Tukey test was used to analyze the association of duration of sleep with emotional well-being.

Results

The demographic analysis of the study participants showed that out of 200 study subjects 174 (87%) were males. The average age group of all the study participants was 41 years (39.12 ± 44.07), with an average BMI of 22.10 (19.77 ± 25.23). Most of the study participants were from the information and technology sector (IT) 125 (62.5%) and healthcare sector 75 (37.5%). Out of 200 participants, 146 (73%) were working in shift duties. [Table 1] The cultural variations in meal timings, meal practices and dietary habits can influence the gut microbiome as seen in the north Indian population of 120 (60%) individuals as compared with the 80 (40%) of the south Indian population whose diet are rich in fermented food products like idly and dosa and who have suffered with less gut disturbances as compared with the north Indian population ($P = 0.005$). Most of our study population belonging to the upper socioeconomic class working in the IT and healthcare sectors 124 (62%) showed more gut health problems and sleep disturbances in comparison with the76 (38%) of population working in again IT and healthcare sectors but at the lower positions like computer operators, nursing staff, etc., The gut problems and sleep disturbances were surprisingly more common in higher-income groups as compared with lower-income groups ($P = 0.003$).

The analysis encompassing both descriptive and inferential approaches, focused on the examination of sleep patterns and gastrointestinal tract (GIT) symptoms. Among the 88 participants who reported sleeping less than 7 hours (55%), the prevalence of specific GIT symptoms was as follows: loss of appetite in 28 participants (32%), constipation in 26 participants (30%), bloating in 115 participants (76.6%), abdominal cramps in 23 participants (26.1%), indigestion in 40 participants (26.6%), and belching in 12 participants (7.6%) statistically significant correlation was found between duration of sleep and symptoms like heartburn, constipation, bloating. and indigestion. [Table 2] When analyzed for GI symptoms and emotional well-being, it was found that symptoms like bloating, constipation, and belching significantly affect the emotional well-being of the study participants. [Table 3]

The comparison of emotional well-being scores of participants with different sleep patterns showed that the average emotional well-being score of participants who slept for <7 h is 3.16, 3.50 for participants who slept for 7–9 h, and 3.45 for those who slept for >9 h. We also found that the *F*-value was 5.677 and the *P* value was 0.004 (statistically significant). [Table 4] A significant relationship was found between less sleep, GI symptoms like heartburn, constipation (*P* value 0.03), bloating (*P* value 0.04), and indigestion (*P* value 0.051) on emotional well-being. [Table 5] Regular workout has shown a significant correlation with increased duration of sleep (*P* value 0.003). Out of the total study participants, 196 were consuming some or the other stimulant, and out of them, over 110 (56%) had <7 h of sleep duration.

Table 1: Demographic profile of study participants (*n*=200)

Characteristics	Participants (*n*=200)	*P*
Male (%)	174 (87%)	
Age (year)	41 (39.12±44.07)	
BMI (kg/m^2)	22.10 (19.77±25.23)	
Sector of work		
a. Information and technology sector (IT)	a. 125 (62.5%) b. 75 (37.5%)	
b. Healthcare sector		
Shift duty workers	146 (73%)	
Upper socioeconomic status	124 (62%)	0.003*
Lower socioeconomic status	76 (38%)	
North Indian subjects	120 (60%)	0.005*
South Indian subjects	80 (40%)	

This table summarizes the participants' demographics: 87% male, average age 41 years, 62.5% working in IT, and 73% on shift duties. Significant differences in gut and sleep disturbances were observed across socioeconomic groups (*P*=0.003*) and between North and South Indian participants, linked to dietary habits (*P*=0.005*)

Twenty-nine participants had addiction to tobacco consumption, out of whom 20 (69%) had <7 h of sleep duration. Similarly, for alcohol consumption (n = 128) 87 (68%) and for smoking (n = 79) 61 (77.2%) had <7 h of sleep duration (P value 0.004) [Table 6].

Table 2: Sleep pattern and GIT symptoms

GIT symptoms (n=200)		Sleep pattern			P
		<7 h	7–9 h	>9 h	
Abdominal cramp	Yes (10)	6	4	0	0.873
	No (190)	33	147	10	
Loss of appetite	Yes (83)	13	57	13	0.210
	No (117)	60	84	16	
Heart burn	Yes (138)	20	118	0	0.004
	No (62)	21	39	2	
Nausea	Yes (27)	16	11	0	0.684
	No (133)	72	58	2	
Constipation	Yes (125)	92	29	4	0.006
	No (75)	46	29	0	
Diarrhea	Yes (5)	3	2	0	0.936
	No (195)	38	137	25	
Bloating	Yes (129)	90	26	3	0.006
	No (71)	25	56	0	
Indigestion	Yes (140)	122	18	0	0.005
	No (60)	12	35	14	
Belching	Yes (12)	7	5	0	0.871
	No (188)	28	154	8	

P<0.05 is considered statistically significant

Table 3: GIT symptoms and emotional well-being

GIT symptoms		Mean	Standard deviation	P
Abdominal cramp	Yes	3.50	0.95	0.407
	No	3.30	0.64	
Loss of appetite	Yes	3.25	0.70	0.529
	No	3.33	0.64	
Heart burn	Yes	3.05	0.61	0.051
	No	3.35	0.66	
Nausea	Yes	3.23	0.66	0.520
	No	3.32	0.66	
Constipation	Yes	2.86	0.68	0.009
	No	3.00	0.65	
Diarrhea	Yes	3.55	1.10	0.397
	No	3.30	0.644	
Bloating	Yes	2.19	0.60	0.004
	No	3.35	0.67	
Indigestion	Yes	3.20	0.60	0.255
	No	3.34	0.67	
Belching	Yes	2.84	0.35	0.011
	No	3.34	0.66	

P<0.05 is considered statistically significant

Table 4: Sleep and emotional well-being

Sleep pattern	Emotional well-being		P
	Mean	Standard deviation	
<7 h (n=88)	3.16	0.58	0.004
7–9 h (n=69)	3.43	0.63	
>9 h (n=3)	3.56	0.78	

P<0.05 is considered statistically significant

Discussion

The current research highlights the impact of sleep on gut health and ultimately how gut health affects emotional well-being. Our study findings revealed that there is an association between poor sleep quality, altered gut health, and emotional well-being. Our results also showed a significant correlation between the quality of sleep and the consumption of various stimulant substances based on addiction. There are factors like bacterial health and bowel health that can affect the quality of sleep as well as the emotional well-being of an individual.[1,3,6] Evidence also suggests that the quality of sleep can be affected by the gut microbiome.[4] Poor quality and shorter duration of sleep both are associated with neurobehavioral abnormalities and cognitive impairment.[5,6,8] Although there is limited evidence regarding the gut microbiome and the brain interaction among humans, the theory is well supported based on the evidence generated from animal studies.[3] Kim *et al.*[15] in their study report done on healthy Korean women proved the hypothesis that any kind of reaction to emotional stimuli, in other words individual temperament, is associated with the composition of the gut microbiome. It is well-versed that sleep is a physiological process and has an impact on the immune system.[9,10] There are factors like bacterial health and bowel health that can affect the quality of sleep of an individual.[11] However, there is a paucity of information regarding this linkage in the context of the brain–gut microbiome axis.[2,3,12] Hormones that regulate the feeling of satiety and hunger are highly influenced by the quality of sleep.[7,8] It is well proven that quality and duration of sleep, individuals appetite, and obesity are interlinked with each other[7,12] Systemic review conducted by Wennyo Camilo *et al.* highlighted the impact of tobacco consumption on the quality of sleep among adults. There results showed that the quality of sleep is poor among the subjects who smoke tobacco as compared to the subjects who do not smoke tobacco.[13] The study conducted by Banks S *et al.*[8] on shift workers in 2016 showed that shift duties not only affect our sleep, as well as our biological rhythm, but also affect the rhythm of the gut microbiome. In our study findings, most of the study participants suffering from GI symptoms had having sleep duration for less than 7 h. According to our findings, GI symptoms like heartburn, constipation, and bloating have a significant impact on the emotional well-being of the participants which is in accordance with the study conducted by Daulatzai MA *et al.* and Ait-Belgnaoui A *et al.*[14,16] who highlighted the use of probiotics in modulating neuroprotective behavior by reducing the synaptopathies associated with stress. The use of probiotics can reduce the response of the HPA-axis by decreasing cortisol levels.[16] Various studies have also shown similar effects of the use of probiotics by reducing symptoms like anxiety and depression, thus

improving gut health.[17,18] Our findings are consistent with the findings of the study conducted by Kim *et al.* on 819 Korean high school students, where they showed that out of all psychological factors useful for the prediction of the abnormal bowel habits, when compared to anxiety, it was moderate to severe depression which acts as predictors for the occurrence of chronic diarrhea.[15] Findings from the study done by Michels and coauthors on 113 children analyzing the association between fecal microbial metabolites and perceived stress, emotional well-being, biological markers of stress, and gut inflammation found that there is an association between self-reported emotional problems and short-chain fatty acids.[12] Studies have also shown that via the sympathetic nervous system, chronic stress can affect the metabolites of the gut microbiome, which correlates and connects better with chronic stress.[19-22] Our study also showed the significant relationship of sleep disturbances with the use of stimulants and certain addictions and is consistent with the findings of the studies which highlighted a significant relationship between the poor quality of sleep and drug use or substance abuse. Alamir *et al*.[23] found a significant relationship between medicinal drugs like regular intake of painkillers and poor sleep quality among university students. Goodhines *et al*.[24] also reported a high prevalence of substance abuse among university students associated with poor sleep quality and insomnia. Researchers have also found a significant relationship between increased alcohol intake, sleep disturbances, and sleep quality among university students.[20,23-27] Quality of sleep was poor with increased intake of alcohol or with increased frequency of smoking, while the prevalence of sleep disturbances among smokers was high when compared with nonsmokers.[21,28] Tobacco contains nicotine which is responsible for the release of various neurotransmitters like dopamine, which is again responsible for the disturbances during sleep.[14] These findings are in accordance with our findings where we found a statistically significant correlation between sleep quality and tobacco consumption.

Table 5: Relationship between <7 h of sleep, gut symptoms, and emotional well-being

Sleep pattern <7 h	Gut symptoms		Emotional well-being		*F*	*P*
			Mean	SD		
	Abdominal Cramps	Yes	3.50	0.95	1.314	0.255
		No	3.30	0.64		
	Loss of appetite	Yes	3.25	0.70	0.236	0.628
		No	3.33	0.64		
	Heart burn	Yes	3.05	0.61	4.263	0.036
		No	3.35	0.66		
	Nausea	Yes	3.23	0.66	0.702	0.404
		No	3.32	0.66		
	Constipation	Yes	2.86	0.68	4.491	0.037
		No	3.00	0.65		
	Diarrhea	Yes	3.55	1.10	0.234	0.616
		No	3.30	0.644		
	Bloating	Yes	2.19	0.60	4.416	0.043
		No	3.35	0.67		
	Indigestion	Yes	3.20	0.60	3.356	0.051
		No	3.34	0.67		
	Belching	Yes	2.84	0.35	1.773	0.186
		No	3.34	0.66		

P<0.05 is considered statistically significant

Limitations and recommendation

The study cohort was variable in accordance with age, region, and socioeconomic status, as compared to previous studies which were performed on a single study subject group.

To gain a better understanding of the relationship between sleep, gut, and emotions, electrophysiological analysis in the form of a sleep study, in conjunction with hormonal assays, can be performed. Focused studies on the cross-cultural analysis of gut microbiome composition and emotional well-being to be planned to investigate how cultural variations in the diet and lifestyle impact the composition of the gut microbiome and its association with emotional well-being. A longitudinal study could provide insights into how changes in sleep architecture over the lifespan influence the gut–brain axis and mental health outcomes. Further studies are recommended in urban and rural population, to investigate how urban and rural living conditions influence sleep patterns and their subsequent effects on gut health and emotional well-being. We also propose a study on shift workers to investigate sleep patterns and mental health outcomes across different cultures and industries.

Conclusions

Our study showed that multiple factors affect sleep, which in turn adversely affects the gut health and emotional well-being of the subject, and these disturbances are bidirectional. Our study findings

Table 6: Relationship between sleep disturbances and addictions

Sleep duration	Workout (*n*=142)	Stimulants (*n*=196)	Tobacco (*n*=29)	Alcohol (*n*=128)	Smoking (*n*=79)
<7 h	22 (15.4%)	110 (56.1%)	20 (69%)	87 (68%)	61 (77.2%)
7–9 h	112 (80%)	70 (35.8%)	09 (31%)	33 (25.8%)	13 (16.4%)
>9 h	08 (5.7)	16 (8.1%)	00 (00%)	09 (7%)	05 (6.3%)
P	0.003	0.004	0.004	0.004	0.004

P<0.05 is considered statistically significant

highlight the interconnectedness of sleep duration, GI symptoms, and emotional well-being. Cultural variations, food preferences, and socioeconomic status have shown an impact on gut health, sleep disturbances, and emotional well-being. Additionally, consumption of substances such as tobacco, alcohol, and stimulants has been identified as factors significantly affecting both the duration and quality of sleep. Understanding these relationships is crucial for developing targeted interventions to improve overall health and well-being.

Acknowledgements

We acknowledge the ICMR for approving and funding this important topic as an STS) project. We also acknowledge our study participants for enthusiastically participating in this study.

Ethical approval and participation consent

Prior ethical clearance was obtained from the independent ethics committee of Symbiosis International University, where the study was conducted (ref no. SMCW/IRC/STS Res/6/2022). All methods were performed in accordance with the relevant guidelines and regulations. The methods in this study were performed following the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guidelines for reporting of observational studies, which includes a checklist for cross-sectional studies. All participants gave their informed consent for their feedback to be involved in this study.

Financial support and sponsorship

ICMR (Indian Council of Medical Research) Reference ID-2022-01326.

Conflicts of interest

There are no conflicts of interest.

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