The Gut–Brain Axis in Action: A Cross-sectional Study on Probiotics and Mental Well-being of Medical Students

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ABSTRACT

Background:
The gut–brain axis is a bidirectional communication system linking gastrointestinal health with stress regulation, mood, and cognition. Medical students, who often experience high levels of stress, represent a vulnerable group in whom the impact of gut health on mental well-being is particularly relevant.

Objectives:
To examine the association between gut health and perceived stress, assess correlations with self-reported cognition, and explore the potential role of probiotics in supporting student well-being.

Methods:
A cross-sectional observational study was conducted among 144 undergraduate medical students (96 females, 48 males; aged 17–23 years). Participants completed the Gut Health Questionnaire (GHQ-15), Perceived Stress Scale (PSS-10), and Cognitive Self-Assessment Rating Scale (C-SARS-12). Data were analyzed using Spearman's correlation, with statistical significance set at $p < 0.05$.

Results:
Gut health scores demonstrated a moderate negative correlation with perceived stress, indicating that better dietary practices—particularly consumption of whole grains, nuts, and seeds—were associated with lower stress levels ($p < 0.05$). Poorer gut health correlated with cognitive difficulties such as impaired concentration and decision-making, while positive associations were observed between gut health and emotional resilience.

Conclusion:
This study highlights the significant role of gut health in stress regulation and cognitive well-being among medical students. Probiotics and probiotic-rich diets may represent accessible, non-pharmacological strategies to enhance resilience and academic performance. Further longitudinal

and interventional research is needed to establish causality and optimize probiotic use in educational settings.

Keywords: Gut–brain axis, probiotics, stress, cognition, medical students, microbiota.

Introduction

The concept of the gut as the "second brain" has gained traction in neuroscience and medical education. Microbial colonization begins at birth and continues to be shaped by diet, environment, and lifestyle factors. Medical students, often under significant cognitive and emotional stress, provide an important population in which to examine the influence of gut microbiota and probiotics.

Probiotics—live microorganisms that confer health benefits when administered in adequate amounts—have been shown to restore microbial balance, improve intestinal permeability, enhance production of neurochemicals such as serotonin, and reduce stress-related dysbiosis. Changes to microbiome taxonomic composition have the downstream effect of altering the translational profile of microbiome products as concluded by Karl etal [(1)]. Specific strains of *Lactobacillus* and *Bifidobacterium* have been shown to modulate stress responses by regulating cortisol secretion, enhancing neurotransmitter synthesis, and reducing systemic inflammation. Hayland etal [(2)] explained that when microbiome taxonomic changes occur, regulatory feedback from the gut lumen to the myenteric plexus is altered and ultimately projections to the central nervous system are up or downregulated.

The human gut microbiota has emerged as a critical regulator of physical and mental health, with growing evidence linking gut microbial balance to stress regulation, mood, and cognitive performance. Kelly etal [(3)] identified the significance of gut microbiome in the development of at least some psychiatric conditions such as anxiety, depression, schizophrenia and bipolar disorder. This bidirectional communication system, often termed the **gut–brain axis**, involves complex interactions between the gastrointestinal tract, the central nervous system, and the immune system. Noble etal [(4)] explained the impact of diet influencing the gut microbiome on cognitive function. Disruptions in gut microbial composition have been associated with increased stress, anxiety, depression, and impaired cognitive functions.

The profile of neuroactive substrates produced by the gut microbiome is becoming well characterized and includes serotonin, short chain fatty acids, GABA, dopamine and norepinephrine as stated by Mayer etal [(5)] . These effects may extend to improved attention, memory, and overall cognitive performance.

Medical students represent a unique and vulnerable population in this context. Intense academic demands, long study hours, irregular sleep patterns, and high psychological stress are common, all of which may negatively impact gut health and cognitive function. The interplay between stress, gut dysbiosis, and impaired mental performance may further compromise students' well-being and academic productivity. Incorporating probiotics into the lifestyle of medical students could represent a low-cost, non-pharmacological approach to improving stress resilience and enhancing cognitive performance.

Given the increasing prevalence of stress-related disorders in student populations and the need for strategies that promote academic and mental well-being, exploring the role of probiotics in supporting gut health and its downstream effects on stress regulation and cognition is both timely and relevant. This paper examines current evidence on the gut–brain axis, highlights the potential role of probiotics in modulating stress and cognitive function, and discusses their implications for medical students.

Objectives

1. To examine the association between gut health and perceived stress in medical students.
2. To assess correlations between gut health and self-reported cognition.
3. To discuss the potential role of probiotics in modulating the gut–brain axis for student well-being.

Methodology

- **Design:** Cross-sectional observational study
- **Participants:** 144 undergraduate medical students (96 females, 48 males), aged 17–23 years
- **Tools:**
    - Gut Health Questionnaire (GHQ-15)
    - Perceived Stress Scale (PSS-10)
    - Cognitive Self-Assessment Rating Scale (C-SARS-12)
- **Analysis:** Spearman's correlation; significance set at $p < 0.05$

Results

The following results were obtained from the study.

Table 1: Spearman Correlation & p value of Gut Health questionnaire and Perceived Stress Score

S No	GHQ	PSS	Spearman ρ	p-value
1.	How often do you include whole grains in your diet	How often have you felt nervous and stressed?	**-0.28**	**0.0052**
2.	Do you include nuts and seeds in your diet	How often have you felt unable to control the important things in your life	**-0.27**	**0.0025**
3.	How often do you consume fruits and vegetables	How often have you felt difficulties were piling up so high that you could not overcome them	-0.11	0.1750
4.	How often do you consume foods rich in prebiotics	How often have you found that you could not cope with all the things that you had to do	-0.10	0.3250
5.	How often do you consume whole grains	How often have you found that you could not cope with all the things that you had to do	**-0.27**	**0.0044**

Negative correlation ($\rho < 0$) means better diet is associated with less stress. Significant relationships ($p < 0.05$) are shown in bold. These are statistically meaningful. Whole grains and nuts/seeds show the strongest and most significant associations with reduced stress indicators.

Table 2 : Perceived Stress Score and Gut health Questoinnaire correlation

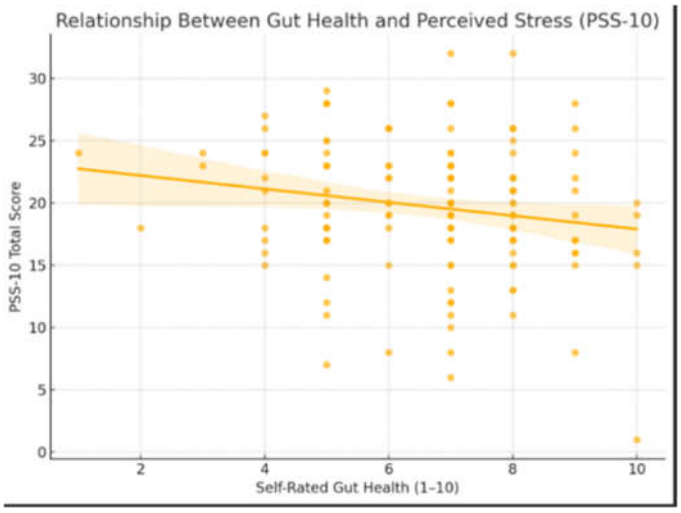
S No	PSS	Correlation with Gut health
1.	How often have you felt difficulties were piling up so high that you could not overcome them?	**-0.34**
2.	How often have you felt nervous and stressed?	**-0.33**
3.	How often have you been upset because of something that happened unexpectedly?	-0.19
4.	How often have you been angered because of things outside your control?	-0.15
5.	How often have you felt that you were unable to control important things in your life?	-0.15
6.	How often have you found that you could not cope with all the things that you had to do?	-0.11
7.	How often have you felt confident about handling personal problems?	+0.01
8.	How often have you felt that things were going your way?	**+0.19**
9.	How often have you felt on top of things?	**+0.21**

There is a moderate negative correlation between gut health and stress overload indicators as observed by the values of first and second row of the table in bold.

Conversely, gut health has a positive correlation as seen in the last two rows of the table in bold.

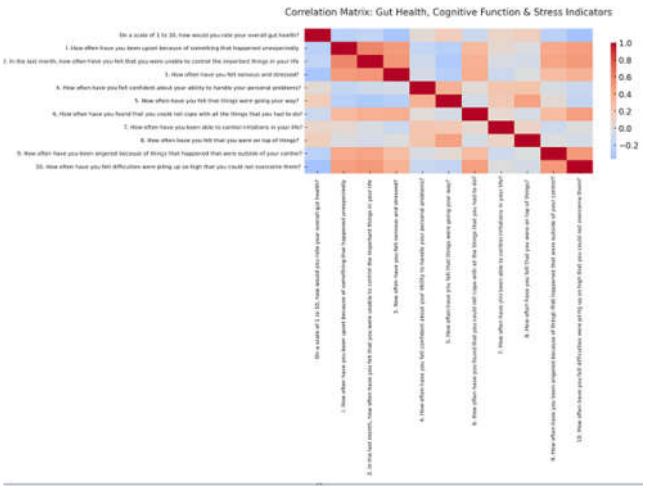
These correlations suggest a gut-brain link where better gut health is associated with lower stress and greater emotional resilience.

Graph 1: graphical representation of relationship between Gut health and Perceived Stress Score



Gut Health (x-axis): Self-rated on a scale from 1 to 10; PSS-10 Total Score (y-axis): Measures perceived stress, higher scores indicate more stress. The downward slope of the regression line suggests a negative correlation: As gut health ratings increase, perceived stress tends to decrease. This aligns with research on the gut-brain axis, where better gut health is often associated with lower levels of psychological stress.

Graph 2 : Correlation heatmap : Gut health, Cognitive function & Stress indicators



Red shades indicate negative correlations (e.g., higher stress linked with lower gut health). Blue shades indicate positive correlations (e.g., better emotional control linked with better gut health). The strongest negative associations are with: Feeling overwhelmed by difficulties & Feeling nervous/stressed.

Graph 3: Pie charts of the responses to the questions

62.5% students reported that they drink water moderately (4-7 glasses per day). Alarmingly 45.1%students replied that they rarely or never engage in a regular physical activity. The other reponses reveal 40.3% students rarely included whole grains in their diet (e.g., oats, brown rice, quinoa)., 81.3% students consumed daily foods rich in prebiotics (onion, garlic, legumes). 18.8% students reportedly announced that they donot consume nuts & seeds (almonds, chia seeds) in their diet at all. 36 students stated that they had difficulty in concentrating and 38 opined that they had difficulty planning ahead and making decisions. 35 students reported that they had difficulties in adjusting to changes. 29.2% students opined that they felt nervous and stressed very often. Only 6.3% students felt very often that they are on the top of things. 39.4% expressed that their difficulties were piling up so high that they could not overcome them.

Discussion

The findings support the hypothesis that gut health and stress are inversely related, aligning with existing research on the gut–brain axis. A randomized control study by Akkasheh etal [6] reported that the administration of a combination of *L acidophilus, L casei*, and *Bifidobacterium bifidum* for 8 weeks improved scores on the beck depression inventory. Probiotics, by enhancing microbial diversity and promoting production of short-chain fatty acids and serotonin, may offer an accessible intervention for stress reduction in medical students. According to Tooley's [7] narrative review, there may be a way to increase cognition through gut microbiota.

Integrating probiotic-rich foods (yogurt, kefir, fermented foods) or supplements into student diets could serve as a non-pharmacological strategy to improve resilience. Several studies have reported reduced levels of perceived stress, anxiety, and depressive symptoms following probiotic supplementation as stated by Wallace etal[8] and Sarkar etal [9]. Furthermore, dietary and lifestyle habits strongly influence microbiota diversity. Gender and marital status differences underscore the need to consider individual differences in gut-brain axis as concluded by Hameed etal [10]. This is particularly relevant for medical students, in whom optimal cognitive functioning

is crucial for academic performance and clinical decision-making. Fekete etal[11] thorough analysis emphasized the gut-brain axis's reciprocal connection and its function in preserving homeostasis. In the present study, a moderate negative correlation was found between gut health scores and stress indicators. Better dietary practices (including whole grains, nuts, and seeds) were associated with lower stress levels. Students reporting poorer gut health also showed higher perceived stress and cognitive difficulties, particularly feelings of being overwhelmed and nervous. Positive correlations emerged between gut health and self-perceived emotional control and resilience. Future research should focus on randomized controlled trials with standardized probiotic formulations and objective neurocognitive assessments to establish causality. Implications about the effect of Gut-brain axis through probiotics in medical education is the need of the hour. Curriculum should include awareness of gut–brain health. Promotion of dietary interventions (probiotics and synbiotics) alongside mindfulness and stress management strategies. Further longitudinal research is warranted to test the efficacy of probiotic supplementation in student populations.

Conclusion

This study highlights a significant link between gut health, stress, and cognitive self-assessment among medical students. Probiotics emerge as a promising adjunct in promoting resilience, reducing stress, and supporting academic performance. Nurturing microbial diversity may, in effect, nurture the minds of future physicians.

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