

Cross Sectional Study

A Cross-Sectional Analysis of Breakfast Frequency, Perceived Stress and Gastrointestinal Quality of Life among University Students Aged 20–30 Years in Pune

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ABSTRACT:

Introduction: Regular breakfast consumption has been associated with improved nutritional status and overall health; however, its relationship with perceived stress and digestive quality of life among university students remains insufficiently understood, particularly in the Indian context. **Objective:** To examine the association between breakfast frequency and perceived stress among university students and to evaluate its relationship with digestive quality of life and body mass index (BMI). **Methods:** This cross-sectional study included 103 undergraduate and postgraduate students recruited by convenience sampling. Data on breakfast frequency, the Perceived Stress Scale (PSS-10), the Digestive Quality of Life Questionnaire (DQLQ) and BMI were collected using a structured online questionnaire. Spearman's correlation and multivariable linear regression were performed. **Results:** Breakfast frequency was not significantly associated with perceived stress, digestive quality of life, or BMI after adjustment for covariates. Perceived stress was also not significantly predicted by the multivariable model ($F(5,97) = 1.297, p = 0.272, \text{adjusted } R^2 = 0.014$). **Conclusion:** Breakfast frequency was not independently associated with perceived stress, digestive quality of life, or BMI in this sample. Longitudinal studies with larger, multi-center samples are warranted.

KEYWORDS: Breakfast frequency, DQLQ, Gastrointestinal quality of life, Perceived stress, PSS-10, University students.

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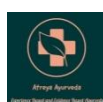
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1. INTRODUCTION

Breakfast contributes to daily nutrient intake, cognitive function, metabolic regulation and overall health. [1-3] However, breakfast skipping is common among university students due to academic demands, irregular sleep, commuting, financial constraints and changing eating behaviors during the transition to adulthood. [1, 4-8] The relationship between psychological stress and gastrointestinal health is increasingly recognized through the bidirectional gut-brain axis. Stress may influence gastrointestinal motility, permeability, secretions and microbial composition, contributing to symptoms such as bloating, abdominal discomfort and altered bowel habits. [9-12] Dietary practices, including meal regularity and overall diet quality, may further influence gastrointestinal well-being. Thus, breakfast behavior may have potential implications for both psychological and digestive health. [13-14]

Although international evidence on breakfast consumption, stress and gastrointestinal outcomes remains inconsistent, evidence among Indian university students is limited. [15-17] Existing Indian studies have largely focused on nutritional status, obesity, academic performance, or mental well-being, with less attention to gastrointestinal quality of life. [18,19] Moreover, the combined association of breakfast frequency with perceived stress and digestion-associated quality of life using validated instruments such as the PSS-10 and DQLQ remains insufficiently studied. [20,21] Therefore, this study examined the relationship between breakfast consumption frequency, perceived stress and digestion-associated quality of life among university students in Pune, India.

Pune represents an important setting for such investigation because it is recognized as a major educational hub with a large and diverse student population. Students residing in Pune often experience demanding academic environments, long travel durations, hostel living, financial adjustments and changes in food accessibility. These conditions may influence meal patterns, stress levels and digestive health

behaviors differently compared to students from smaller cities or non-urban regions. The multicultural student population in Pune also reflects varying dietary practices and lifestyle habits, making it a suitable population for studying behavioral and health-related associations among young adults.

Study Hypotheses

Null Hypothesis (H₀): There is no statistically significant association between breakfast frequency, perceived stress and gastrointestinal quality of life among university students aged 20- 30 years in Pune.

Alternative Hypothesis (H₁): There is a statistically significant association between breakfast frequency, perceived stress and gastrointestinal quality of life among university students aged 20- 30 years in Pune.

2. MATERIALS AND METHODS

Study Design and Reporting: This cross-sectional observational study was conducted between February and March 2026 among university students enrolled at Symbiosis Skills and Professional University (SSPU) and Brihan Maharashtra College of Commerce (BMCC), Pune, Maharashtra, India. The study was reported in accordance with the STROBE guidelines for cross-sectional studies. The institutions were selected based on accessibility and feasibility, which may limit the generalizability of findings.

Study Population: Eligible participants were apparently healthy male and female university students aged 20–30 years who were enrolled as full-time students during the study period. Participants were excluded if they were pregnant or lactating, reported physician-diagnosed chronic medical conditions, had food allergies or food intolerances, were following therapeutic diets, or were taking medications known to influence gastrointestinal function, appetite, or psychological stress.

Outcomes: The primary outcome of the study was the association between breakfast consumption frequency and perceived stress, measured using the Perceived Stress Scale (PSS-10). The secondary outcome was the association between breakfast consumption frequency and

gastrointestinal quality of life, assessed using the Digestion-associated Quality of Life Questionnaire (DQLQ). Additional exploratory analyses examined the relationship of physical activity, sleep duration, caffeine intake, BMI and selected socio-demographic characteristics with perceived stress and gastrointestinal quality of life.

Sample Size Calculation: The required sample size was estimated using Fisher's Z transformation for correlation analysis, assuming a moderate anticipated correlation coefficient ($r = 0.30$). The anticipated correlation was selected based on previously published observational studies reporting moderate associations between dietary behaviors and psychological health outcomes among young adults.

The calculation assumed:

- 95% confidence level ($Z\alpha = 1.96$)
- 80% statistical power ($Z\beta = 0.84$)
- anticipated correlation coefficient ($r = 0.30$)

The required sample size was calculated using

$$n = \left(\frac{Z_{\alpha} + Z_{\beta}}{C} \right)^2 + 3$$

$$C = \frac{1}{2} \ln \left(\frac{1+r}{1-r} \right)$$

This yielded a minimum sample size of 85 participants. To compensate for potential non-response and incomplete questionnaires, the sample size was increased by approximately 20%, resulting in a final target sample of 103 students.

Sampling Technique: A stratified non-probability convenience sampling approach was employed. The total sample was proportionally allocated between SSPU and BMCC according to the estimated student population of each institution, resulting in target recruitment of 54 students from SSPU and 49 students from BMCC.

Convenience sampling was selected because it enabled practical recruitment within the available study period and institutional resources. Although this approach improved feasibility, it may have introduced selection bias because

participation depended on voluntary response rather than random selection. Consequently, the study sample may not fully represent the broader university student population.

Participant Recruitment and Flow: Students meeting the eligibility criteria were invited to participate through institutional communication channels and student networks. A total of 145 students were invited, 103 responded, 43 questionnaires were excluded because of duplicate submissions or failure to meet eligibility criteria and 103 participants were included in the final analysis. A detailed participant flow diagram has been prepared according to the STROBE recommendations.

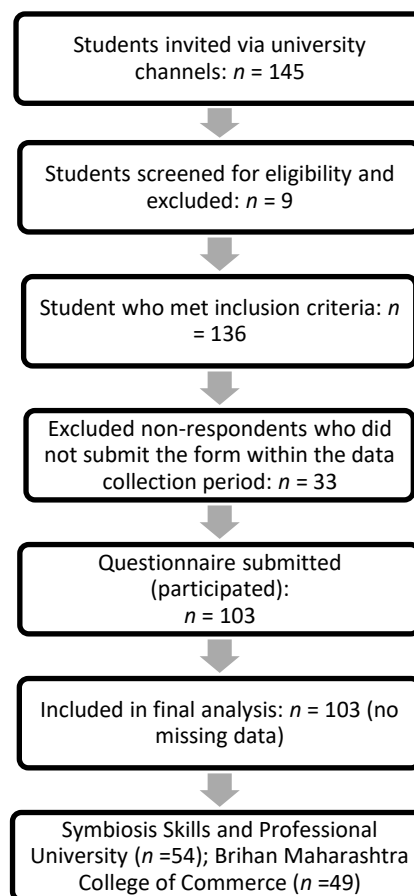


Figure 1. Participant Flow Diagram for Sample Selection

Data Collection: Data were collected using a structured questionnaire administered via Google Forms and paper format, adapted from validated studies.[20, 22, 23] It assessed socio-demographic characteristics, breakfast frequency and choices, perceived stress (PSS-10) and digestive quality of life (DQLQ). Participation was voluntary

and anonymous. Duplicate and ineligible responses were excluded and the final dataset contained no missing data.

Study Instruments and Reliability: Perceived stress was assessed using the validated 10-item Perceived Stress Scale (PSS-10), scored from 0–40, with higher scores indicating greater perceived stress. Digestion-associated quality of life was assessed using the validated DQLQ, with higher scores indicating poorer gastrointestinal quality of life and greater symptom burden. Both instruments demonstrated good internal consistency in previous validation studies, with Cronbach's α of 0.81 for PSS-10 and 0.84 for DQLQ, respectively. [20-21]

Ethical Considerations: Ethical approval was obtained from the Institutional Ethics Committee of Symbiosis Skills and Professional University (Reference No. IEC/SND-M/2025-26/013). Electronic informed consent was obtained from all participants before completion of the questionnaire. Participation was voluntary; Participants could withdraw at any stage without consequence; No financial incentives were provided and all collected information was anonymized and used exclusively for research purposes.

Potential Sources of Bias: Potential biases included selection and volunteer bias due to convenience sampling and self-selection. Recall and reporting bias may have occurred because breakfast intake, anthropometric measures, lifestyle behaviors and stress were self-reported. Online data collection may also have introduced digital access bias. These risks were minimized through validated instruments, anonymous participation, mandatory responses and duplicate-response screening.

Statistical Analysis: Statistical Analyses were performed using RStudio. Data distribution was assessed using the Shapiro–Wilk test and graphical methods. Spearman's correlation, chi-square test, Welch's *t*-test and multivariable linear regression were applied as appropriate. Regression assumptions were assessed and results are reported as β coefficients, 95% CIs, adjusted R^2 and *p*-values. All tests

were two-sided, with $p < 0.05$ considered significant. No adjustment for multiple comparisons was performed.

Predictor Selection: Physical activity, sleep duration, caffeine intake, and breakfast frequency were included as explanatory variables based on previous evidence. BMI was assessed descriptively but excluded from regression models due to potential collinearity with lifestyle variables. Gender was not included as a covariate because the study was exploratory and not powered for sex-stratified analyses; the female predominance is acknowledged as a limitation.

3. RESULTS

Participant Characteristics: A total of 103 university students were included in the final analysis, with no missing data. Most participants were aged 20–25 years (95.1%) and female (59.2%). Normal BMI was observed in 44.7% of participants, while the remainder were classified as underweight, overweight, or obese. Nearly two-thirds were undergraduate and most were full-time students. The majority reported 5–7 hours of sleep per night and low caffeine intake. Moderate physical activity was more common among BMCC students, whereas sedentary behavior was more frequently reported among SSPU students ([Table 1](#); [Figure 1](#)).

Breakfast Consumption Patterns: Breakfast patterns are presented in [Table 2](#). Overall, 46.6% of participants consumed breakfast daily, while 8.7% reported never consuming breakfast. Daily breakfast consumption was reported by 40.7% of SSPU and 53.0% of BMCC students. Breakfast was predominantly consumed at home, usually between 8:00 and 10:00 AM. Non-vegetarian diets were most common, followed by vegetarian diets. Cereals, pulses, dairy products, fruits and nuts were consumed more frequently than eggs, meat and seafood. Although most participants recognized the health benefits of breakfast, this awareness did not consistently translate into regular consumption.

Table 1: Socio-Demographic Profile of University Students

VARIABLE	SSPU FREQUENCY	SSPU (%)	BMCC FREQUENCY	BMCC (%)
AGE				
20-25	50	92.6	48	97.9
26-30	4	7.4	1	2.0
GENDER				
MALE	19	35.1	23	46.9
FEMALE	35	64.8	26	53.0
BMI				
UNDERWEIGHT	8	14.8	7	14.2
NORMAL	23	42.5	23	46.9
OVERWEIGHT	9	16.6	4	8.1
OBESITY	6	11.1	9	18.3
SEVERE OBESITY	8	14.8	6	12.2
EDUCATIONAL LEVEL				
UNDERGRADUATE	34	62.9	30	61.2
POSTGRADUATE	20	37.0	19	38.7
OCCUPATION				
FULL TIME STUDENT	46	85.1	42	85.7
FULL TIME STUDENT AND PART TIME WORKING PROFESSIONAL	8	14.8	7	14.2
RESIDENCE				
WITH FAMILY	23	42.5	26	53.0
HOSTEL	14	25.9	11	22.4
RENTED FLAT	14	25.9	9	18.3
PAYING GUEST	3	5.5	3	6.1
MONTHLY POCKET MONEY				
< ₹5000/-	26	48.1	20	40.8
₹5,000–₹10,000/-	9	16.6	15	30.6
₹10,001–₹15,000/-	13	24.0	10	20.4
> ₹15,000/-	6	11.1	4	8.1
AVERAGE SLEEP DURATION PER NIGHT				
< 5 HOURS	6	11.1	3	6.1
5-6 HOURS	20	37.0	10	20.4
6-7 HOURS	18	33.3	23	46.9
7-8 HOURS	9	16.6	9	18.3
> 8 HOURS	1	1.8	4	8.1
PHYSICAL ACTIVITY LEVEL				
SEDENTARY	31	57.4	16	32.6
MODERATE	19	35.1	31	63.2
HIGHLY ACTIVE	4	7.4	2	4.0
DAILY CAFFEINE CONSUMPTION				
NONE	17	31.4	16	32.6

1 CUP	27	50.0	16	32.6
2-3 CUPS	9	16.6	15	30.6
4-5 CUPS	1	1.8	1	2.0
> 5 CUPS	0	0.0	1	2.0

Table 2. Breakfast Consumption pattern among University Students

Variable	SSPU Frequency	SSPU (%)	BMCC Frequency	BMCC (%)
Food preference				
Vegetarian	23	42.5	20	40.8
Non Vegetarian	28	51.8	24	48.9
Eggetarian	3	5.5	3	6.1
Jain	0	0.0	2	4.0
How often do you consume breakfast in a week?				
All 7 days	22	40.7	26	53.0
5-6 days a week	4	7.4	6	12.2
3-4 days a week	13	24.0	6	12.2
1-2 days a week	10	18.5	7	14.2
Never	5	9.2	4	8.1
Timing				
6-7 am	2	3.7	1	2.0
7-8 am	10	18.5	9	18.3
8-9 am	24	44.4	14	28.5
9-10 am	11	20.3	16	32.6
10-11 am	2	3.7	5	10.2
Never	5	9.2	4	8.1
Location				
Home	31	57.4	30	61.2
Hostel Mess	14	25.9	8	16.3
College Canteen	3	5.5	4	8.1
Cafe/ Street Food	1	1.8	3	6.1
Skips Breakfast	5	9.2	4	8.1
Weekly cereals & millets consumption				
Daily	10	18.5	16	32.6
5-6 times	5	9.2	3	6.1
3-4 times	11	20.3	10	20.4
1-2 times	22	40.7	12	24.4
Never	6	11.1	8	16.3
Weekly pulses & legumes consumption				
Daily	7	12.9	11	22.4
5-6 times	3	5.5	3	6.1
3-4 times	10	18.5	5	10.2
1-2 times	27	50.0	17	34.6

Never	7	12.9	13	26.5
Weekly milk & milk products consumption				
Daily	13	24.0	15	30.6
5-6 times	5	9.2	4	8.1
3-4 times	12	22.2	5	10.2
1-2 times	15	27.7	16	32.6
Never	9	16.6	9	18.3
Weekly egg/ meat/ seafood consumption				
Daily	5	9.2	4	8.1
5-6 times	1	1.8	4	8.1
3-4 times	11	20.3	4	8.1
1-2 times	16	29.6	15	30.6
Never	21	38.8	22	44.8
Weekly fruits consumption				
Daily	10	18.5	12	24.4
5-6 times	17	31.4	2	4.0
3-4 times	13	24.0	6	12.2
1-2 times	1	1.8	20	40.8
Never	13	24.0	9	18.3
Weekly nuts and seeds consumption				
Daily	11	20.3	12	24.4
5-6 times	1	1.8	4	8.1
3-4 times	12	22.2	7	14.2
1-2 times	23	42.5	13	26.5
Never	7	12.9	13	26.5
Weekly fats and oil consumption				
Daily	16	29.6	16	32.6
5-6 times	5	9.2	2	4.0
3-4 times	9	16.6	7	14.2
1-2 times	19	35.1	13	26.5
Never	5	9.2	11	22.4
Weekly sugar and sweets consumption				
Daily	8	14.8	9	18.3
5-6 times	4	7.4	2	4.0
3-4 times	14	25.9	7	14.2
1-2 times	18	33.3	17	34.6
Never	10	18.5	14	28.5
Eating breakfast will help you to: improve grades and academic performance				
Strongly Disagree	6	11.1	1	2.0
Disagree	3	5.5	1	2.0
Neutral	16	29.6	18	36.7
Agree	17	31.4	17	34.6

Strongly Agree	12	22.2	12	24.4
Eating breakfast will help you to: reduce absenteeism / tardiness				
Strongly Disagree	1	1.8	0.0	0.0
Disagree	5	9.2	2	4.0
Neutral	16	29.6	13	26.5
Agree	20	37.0	22	44.8
Strongly Agree	12	22.2	12	24.4
Eating breakfast will help you to: increase your memory, attention span and problem solving skills				
Strongly Disagree	2	3.7	0.0	0.0
Disagree	5	9.2	1	2.0
Neutral	14	25.9	18	36.7
Agree	20	37.0	20	40.8
Strongly Agree	13	24.0	10	20.4
Eating breakfast will help you to: get nutrients, vitamins, minerals				
Strongly Disagree	1	1.8	0.0	0.0
Disagree	1	1.8	0.0	0.0
Neutral	10	18.5	4	8.1
Agree	23	42.5	23	46.9
Strongly Agree	19	35.1	22	44.8

Digestion-associated Quality of Life: Responses to the nine-item Digestion-associated Quality of Life Questionnaire (DQLQ) are presented in [Table 3](#). Digestive symptoms varied across participants, with appetite changes, food avoidance, physical discomfort and interference with daily activities commonly reported. Overall, poor digestion-associated quality of life was observed in 51.8% of SSPU students and

40.8% of BMCC students, while good quality of life was reported by approximately one-fifth of participants at both institutions ([Table 4](#)). These findings suggest that gastrointestinal symptoms may have affected dietary choices, physical activity, social interactions and daily functioning among a proportion of students.

Table 3. Physical activities, digestive health and quality of life among university students

PARAMETER	SSPU FREQUENCY	SSPU (%)	BMCC FREQUENCY	BMCC (%)
PHYSICAL ACTIVITIES (RUNNING, WALKING, GARDENING ETC.) WERE UNPLEASANT OR AVOIDED				
NEVER	8	14.8	8	16.3
RARELY	8	14.8	14	28.5
OCCASIONALLY	13	24.0	12	24.4
SOMETIMES	7	12.9	8	16.3
FREQUENTLY	8	14.8	4	8.1
USUALLY	5	9.2	2	4.0
ALWAYS	5	9.2	1	2.0
MY USUAL APPETITE CHANGED				
NEVER	4	7.4	3	6.1
RARELY	7	12.9	12	24.4
OCCASIONALLY	11	20.3	13	26.5

SOMETIMES	23	42.5	11	22.4
FREQUENTLY	5	9.2	6	12.2
USUALLY	0	0.0	4	8.1
ALWAYS	4	7.4	1	2.0
I WAS INCONVENIENCED OR PHYSICALLY UNCOMFORTABLE				
NEVER	9	16.6	11	22.4
RARELY	17	31.4	16	32.6
OCCASIONALLY	11	20.3	8	16.3
SOMETIMES	11	20.3	8	16.3
FREQUENTLY	2	3.7	4	8.1
USUALLY	2	3.7	1	2.0
ALWAYS	2	3.7	1	2.0
I AVOIDED CERTAIN FOODS				
NEVER	5	9.2	7	14.2
RARELY	12	22.2	7	14.2
OCCASIONALLY	10	18.5	8	16.3
SOMETIMES	12	22.2	15	30.6
FREQUENTLY	6	11.1	7	14.2
USUALLY	5	9.2	2	4.0
ALWAYS	4	7.4	3	6.1
SOCIAL ACTIVITIES (LIKE SPENDING TIME WITH FRIENDS OR FAMILY, GOING OUT TO EAT, ETC.) WERE UNPLEASANT OR AVOIDED				
NEVER	14	25.9	19	38.7
RARELY	8	14.8	5	10.2
OCCASIONALLY	11	20.3	8	16.3
SOMETIMES	12	22.2	10	20.4
FREQUENTLY	4	7.4	4	8.1
USUALLY	1	1.8	2	4.0
ALWAYS	4	7.4	1	2.0

Students of SSPU face a higher burden of digestive issues which affects their quality of life compared to BMCC students. The overall trend shows that gut associated symptoms are more frequent and severe in SSPU student group ([Table 4](#)). More than half of the SSPU participants (51.8%) were classified under poor digestion-related quality of life, whereas 40.8% of BMCC students also fell within the poor QOL category, indicating that gastrointestinal concerns were relatively common among students from both institutions. [20]

Moderate QOL scores were observed among 29.6% of SSPU and 38.7% of BMCC participants, while only a smaller

proportion of students demonstrated good digestion-associated quality of life. These findings suggest that digestive health issues may have a substantial influence on the day-to-day wellbeing of university students.

Table 4 Digestion Associated Quality of Life Score

Digestion Associated Quality of Life Score	SSPU Frequency	SSPU (%)	BMCC Frequency	BMCC (%)
Good QOL= 0 to 1.5	10	18.5	10	20.4
Moderate QOL= 1.6 to 3	16	29.6	19	38.7
Poor QOL= >3	28	51.8	20	40.8

The association between breakfast frequency and perceived stress score was assessed using Spearman correlation analysis. The results showed a very weak positive correlation between breakfast frequency and perceived stress score ($\rho = 0.03$), which was statistically non-significant ($p = 0.760$) (Table 5). This indicates that breakfast consumption frequency was not significantly associated with perceived stress levels among the study participants. Consequently, the findings fail to support a meaningful relationship between regular breakfast intake and stress perception within this study population.

Table 5: Correlation with variable pairs (Breakfast, Stress, Digestive Health, Physical Activity and Caffeine consumption)

VARIABLE PAIR	SPEARMAN'S P	P-VALUE	INTERPRETATION
BREAKFAST VS. STRESS	0.03	0.760	Not significant
BREAKFAST VS. DIGESTIVE HEALTH	-0.116	0.243	Not significant
STRESS VS. DIGESTIVE HEALTH	0.167	0.091	Not significant (trend only)
PHYSICAL ACTIVITY VS. DIGESTIVE HEALTH	-0.235	0.017	Significant
CAFFEINE VS. DIGESTIVE HEALTH	0.152	0.125	Not significant

Multivariable Linear Regression for Perceived Stress:

Multivariable linear regression model evaluating predictors of perceived stress (Table 7). The overall model was not statistically significant ($F(5,97) = 1.297$, $p = 0.271$), explaining only a small proportion of the variance in perceived stress (Adjusted $R^2 = 0.014$). Breakfast frequency remained independently non-significant after adjustment for sleep duration, physical activity, caffeine intake, and institution ($\beta = -0.078$, $SE = 0.414$, $95\% p = 0.852$). Sleep duration ($\beta = -1.011$, $p = 0.100$) and physical activity ($\beta = -1.717$, $p = 0.085$) demonstrated inverse trends but did not achieve statistical significance.

Table 6: Association between perceived stress and digestive health score

Test	Variable_1	Variable_2	Rho	P
Spearman correlation	PSS score	Digestive health score	0.167	0.091

Regression diagnostics indicated acceptable model assumptions. Variance Inflation Factor (VIF) values were below 2.0 for all predictors, residual plots demonstrated

Correlation Analysis: Normality assessment using the Shapiro–Wilk test indicated that several continuous variables were not normally distributed; therefore, Spearman's rank correlation coefficient was used for bivariate analyses. Correlation coefficients are summarized in Table 5. Breakfast frequency was not significantly correlated with perceived stress ($p = 0.030$, $p = 0.760$) or digestive health ($p = -0.116$, $p = 0.243$). Physical activity showed the only significant association with digestive health ($p = -0.235$, $p = 0.017$). Other correlations were non-significant (Table 5; Figures 2–5).

approximate normality and homoscedasticity and no influential observations were identified.

Multivariable Linear Regression for Digestion-associated

Quality of Life: The multivariable regression model was statistically significant ($F(5,97) = 2.794$, $p = 0.021$) and explained 12.6% of the variance in DQLQ scores (adjusted $R^2 = 0.081$) (Table 8). Higher physical activity was independently associated with better digestion-associated quality of life ($\beta = -0.879$, $p = 0.005$), whereas greater caffeine intake was associated with poorer quality of life ($\beta = 0.470$, $p = 0.032$). Breakfast frequency, sleep duration and institution were not significant predictors. Model diagnostics indicated acceptable fit, with minimal multicollinearity ($VIF < 2.0$) and no influential observations.

Table 7: Exploratory multivariable linear regression model predicting perceived stress score

Predictor	Estimate	Std. Error	t value	p-value
(Intercept)	33.758	3.121	10.816	0.000
Breakfast frequency	-0.078	0.414	-0.187	0.852
Sleep	-1.011	0.609	-1.660	0.100
Physical Activity	-1.717	0.987	-1.740	0.085

Caffeine	-0.532	0.704	-0.756	0.452
University SSPU	-0.893	1.211	-0.737	0.463

Table 8: Exploratory multivariable linear regression model predicting digestive health score

Predictor	Estimate	Std. Error	t value	Pr (> t)
(Intercept)	3.078	0.958	3.212	0.002
Break-fast frequency	-0.179	0.127	-1.406	0.163
Sleep	0.264	0.187	1.411	0.162
Physical Activity	-0.879	0.303	-2.900	0.005
Caffeine	0.470	0.216	2.177	0.032
University SSPU	0.423	0.372	1.138	0.258

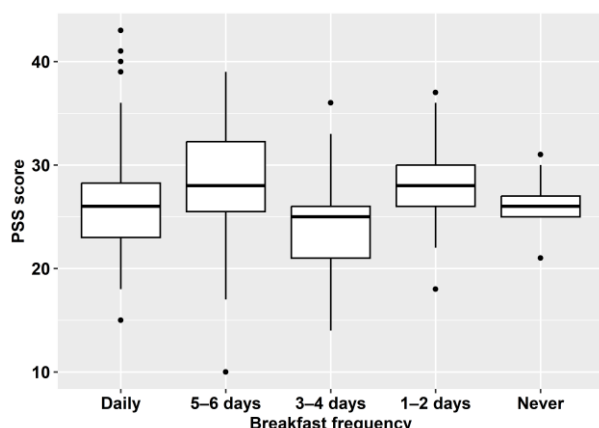


Figure 2. Perceived Stress Scores by Breakfast Frequency.

Note: Boxplots show PSS-10 score distributions across breakfast-frequency groups. No significant association was observed ($p = 0.03$, $p = 0.760$).

Breakfast frequency vs. Digestive health score: Breakfast frequency showed a weak, negative and non-significant association with digestive health scores (Spearman's $\rho = -0.116$, $p = 0.243$) (Table 5). Although more frequent breakfast consumption showed a slight favorable trend, the association was insufficient to indicate an independent relationship. Other lifestyle, dietary and psychosocial factors may contribute more substantially to digestion-associated quality of life.

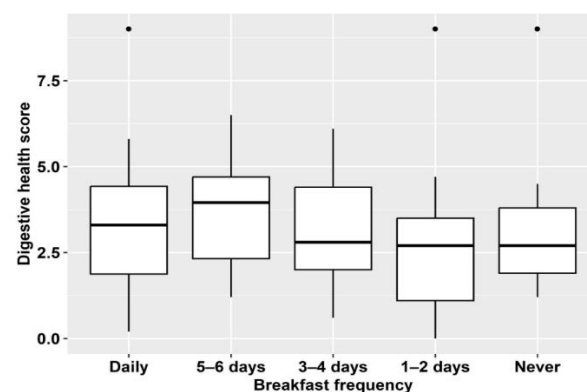


Figure 3. Digestive Health Scores by Breakfast Frequency.

Note: Boxplots show DQLQ score distributions across breakfast-frequency groups. No significant association was observed ($\rho = -0.116$, $p = 0.243$). Higher scores indicate poorer gastrointestinal quality of life.

PSS score vs. Digestive health score: Perceived stress showed a weak positive correlation with digestive health scores (Spearman's $\rho = 0.167$, $p = 0.091$) (Table 6). Although higher stress tended to be associated with poorer digestion-associated quality of life, the relationship was not statistically significant. Thus, the finding represents a weak trend rather than a confirmed association in this sample.

Physical activity vs. Digestive health score: Physical activity was weakly but significantly associated with digestive health scores (Spearman's $\rho = -0.235$, $p = 0.017$) (Table 5). Higher physical activity was associated with lower scores, indicating better digestion-associated quality of life. Consistent patterns were observed in the boxplot and jitter plot (Figure 4), making this the strongest association identified in the analysis.

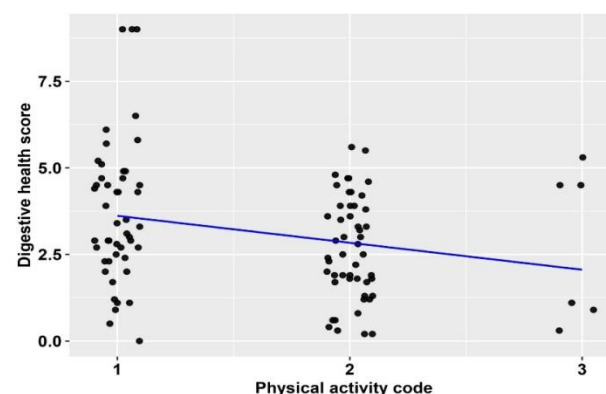


Figure 4. Association Between Physical Activity and Digestive Health Score.

Note: Higher physical activity was significantly associated with lower (better) DQLQ scores ($p = -0.235$, $p = 0.017$; $n = 103$). DQLQ - Digestion-associated Quality of Life Questionnaire.

Caffeine intake vs. Digestive health score: Caffeine intake showed a weak positive correlation with digestive health scores (Spearman's $\rho = 0.152$, $p = 0.125$) (Table 5). Although higher caffeine intake showed a slight trend toward poorer digestion-associated quality of life, the association was not statistically significant. Thus, caffeine intake alone was not a significant determinant of digestive health in this study.

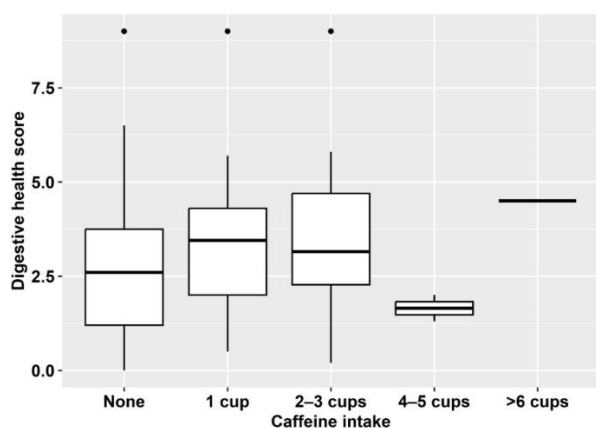


Figure 5. Digestive Health Scores by Caffeine Intake.

Note: Boxplots show DQLQ score distributions across caffeine-intake groups. Differences were not statistically significant. Higher DQLQ scores indicate poorer gastrointestinal quality of life.

The multivariable regression model predicting perceived stress was not significant ($F(5,97) = 1.297$, $p = 0.272$, $R^2 = 0.063$, adjusted $R^2 = 0.014$). None of the predictors were significantly associated with PSS-10 scores. Sleep ($\beta = -1.011$, $p = 0.100$) and physical activity ($\beta = -1.717$, $p = 0.085$) showed non-significant negative trends, while breakfast frequency was not associated with stress ($\beta = -0.078$, $p = 0.852$). VIFs < 2 indicated no substantial multicollinearity.

4. DISCUSSION

This cross-sectional study examined breakfast frequency, perceived stress, and gastrointestinal quality of life among university students in Pune. Breakfast frequency was not

significantly associated with either outcome after adjustment for selected lifestyle factors. In contrast, physical activity was associated with better digestive health, whereas higher caffeine intake was associated with poorer gastrointestinal quality of life. These findings suggest that student health may be influenced by multiple behavioral and environmental factors rather than breakfast frequency alone.

Breakfast Frequency and Perceived Stress: Contrary to the initial hypothesis, breakfast frequency was not significantly associated with perceived stress. This finding differs from some international studies linking breakfast skipping with psychological distress, anxiety and depressive symptoms, [24, 17] but is consistent with evidence from Asian populations suggesting that academic demands and broader lifestyle factors may have greater influence than meal timing alone. [25, 18] Differences across studies may reflect variations in dietary practices, study populations, assessment methods and confounding factors.

Participants generally reported moderate perceived stress, which may reflect common university-related pressures such as academic workload, examinations, financial concerns and career uncertainty. These factors may have outweighed any potential influence of breakfast frequency. Furthermore, breakfast quality, composition, timing and overall dietary regularity may be more relevant to psychological well-being than breakfast frequency alone.

Breakfast frequency and digestion associated quality of life: Breakfast frequency was not significantly associated with digestion-associated quality of life, suggesting that meal timing alone may not explain gastrointestinal well-being. In contrast, physical activity and caffeine intake showed stronger associations with DQLQ scores, highlighting the importance of broader lifestyle behaviors. This finding is consistent with Indian evidence showing inconsistent health effects of breakfast omission among university students. [18]

The observed associations may partly reflect unmeasured dietary factors, including fiber intake, ultra-processed food

consumption, hydration, dietary diversity and overall meal regularity. [13,14] Student-specific barriers such as time constraints, irregular schedules, and academic demands may also influence breakfast habits and broader lifestyle patterns. Furthermore, the PSS-10 does not distinguish specific stressors, which may have obscured relationships between different types of stress and gastrointestinal symptoms. [9,17] Future studies should incorporate comprehensive dietary assessment and examine potential mediating pathways involving physical activity and stress. Differences from international findings may reflect cultural, socioeconomic, and methodological variations. [23,26]

Influence of physical activity and other lifestyle factors:

Among the lifestyle variables examined, physical activity demonstrated the strongest association with gastrointestinal quality of life. Students reporting higher physical activity levels tended to report better digestive health. Previous studies have similarly shown that regular physical activity is associated with improved gastrointestinal motility, enhanced gut microbiota diversity, reduced systemic inflammation and improved psychological resilience. [19]

Higher caffeine intake was independently associated with poorer digestive health. Caffeine has been reported to increase gastric acid secretion and gastrointestinal motility in susceptible individuals, although individual tolerance varies considerably. These findings suggest that lifestyle behaviors beyond breakfast consumption may play a more important role in gastrointestinal well-being among university students.

Residual confounding and interpretation of findings:

Although multivariable regression analyses adjusted for several lifestyle characteristics, the possibility of residual confounding cannot be excluded. Overall dietary quality, dietary diversity, fiber intake, meal composition and consumption of ultra-processed foods were not comprehensively assessed and may have influenced both stress and gastrointestinal outcomes. Similarly, sleep quality, smoking, alcohol consumption, socioeconomic

status, mental health conditions and academic workload were not included in the regression models but have been consistently associated with both psychological stress and gastrointestinal symptoms in previous research. Consequently, the observed associations should be interpreted cautiously, as unmeasured lifestyle and environmental factors may partially explain the findings.

Categorization of breakfast frequency: Breakfast frequency was analyzed as an ordinal categorical variable (daily, 5–6, 3–4, 1–2 days/week and never) to facilitate clinical interpretation and comparison with previous studies. Continuous or non-linear modelling was not used because of the modest sample size and sparse observations in some categories. Larger studies could explore dose–response relationships using continuous or spline-based approaches. The findings are consistent with evidence suggesting that breakfast frequency alone may not independently predict psychological or gastrointestinal outcomes after accounting for lifestyle factors. Conversely, some studies have reported benefits of regular breakfast consumption for mental health and cardiometabolic outcomes. Differences may reflect variation in study populations, breakfast quality, methodology, confounding factors and cultural dietary practices. Causal interpretation remains limited by the observational design.

5. LIMITATIONS

This study has several limitations. The cross-sectional design limits causal inference, while self-reported dietary, lifestyle, stress and anthropometric data may be subject to recall and reporting bias. Convenience sampling and recruitment from two urban universities may limit generalizability and the female predominance may have affected representativeness. Residual confounding from unmeasured dietary, socioeconomic and lifestyle factors cannot be excluded. Furthermore, no adjustment for multiple comparisons was performed. Future multi-center prospective studies using larger, representative samples and objective measurements are warranted.

Future Recommendations: Future research can shed more light on how breakfast, stress and digestive health are interconnected by adopting longitudinal studies and targeted interventions. Future studies should employ larger, more diverse samples and mixed-methods designs to explore the psychosocial and contextual determinants of breakfast-skipping behavior among Indian university students. Additionally, mapping out the physiological processes through thorough nutrient analysis and microbiome testing will be crucial. Recognizing adjustable factors such as sleep quality, academic stress and mental health support within the rich tapestry of Indian cultural contexts will play a vital role in improving student wellbeing.

6. CONCLUSION

In this cross-sectional study of university students in Pune, breakfast frequency was not significantly associated with perceived stress or digestion-associated quality of life. In contrast, higher physical activity was associated with better digestive health, whereas greater caffeine intake was associated with poorer gastrointestinal quality of life. Overall, these findings suggest that breakfast frequency alone may not explain variation in psychological or digestive health, which is likely influenced by multiple lifestyle factors. University health programs should therefore promote an integrated approach addressing diet, physical activity, sleep and stress management. Longitudinal and multi-center studies are warranted to clarify these relationships.

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