

ORIGINAL ARTICLE



Correlation of Breakfast Behaviour with Immune Status and Stress Levels Among Senior High School in Rural Areas of Indonesia

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ABSTRACT

Background: Breakfast plays a profoundly crucial role in the daily nutritional intake of adolescents, serving as the primary source of energy replenishment following overnight fasting. During this critical developmental phase, students require adequate energy and macro-micronutrients to support rigorous learning activities, optimal cognitive development, and stable mental health. Despite its established importance, the prevalence of routine breakfast consumption remains relatively low among high school students. Furthermore, based on a comprehensive literature review utilizing databases such as Google Scholar and PubMed, there is a distinct scarcity of national studies in Indonesia investigating the specific physiological and psychological impacts of breakfast behaviour on immune resistance and perceived stress.

Methods: This quantitative research utilized a cross-sectional study design. The study was conducted at Senior High Schools in rural areas, East Java, Indonesia. Data were gathered through a structured Google Form questionnaire encompassing four sections: demographics, the Breakfast Attitudes Questionnaire (BAQ), the Immune Status Questionnaire (ISQ), and the Perceived Stress Scale (PSS-10). Bivariate data analysis was performed using the Spearman's rho correlation test.

Results: The sample consisted of 64 students, predominantly female (71.9%) with a normal Body Mass Index (64.1%). An overwhelming majority (98.4%) suffered from severe sleep deprivation, 78.1% experienced moderate stress, and the cohort exhibited a very poor overall immune status. Students displayed a positive attitude toward breakfast (mean BAQ = 49.66). Statistical tests revealed no significant correlation between breakfast behaviour and immune status ($p = 0.085$) or stress levels ($p = 0.181$). However, a highly significant positive correlation existed between immune status and stress levels ($p = 0.016$).

Conclusion: A positive attitude toward breakfast is insufficient to independently enhance immune status or alleviate stress. Psychological stress, heavily exacerbated by chronic sleep deprivation, acts as the primary immunosuppressant in this demographic.

1 | Introduction

Adolescence is a critical transitional period characterized by rapid physical, cognitive, and psychosocial development, which ultimately determines numerous health behaviours and risks in adulthood. [1] According to data from the Indonesian Central Statistics Agency, the adolescent population in Indonesia reached 44.11 million in 2025. During this phase, individuals aged 10-19 years face immense physiological demands. Based on the 2019 Nutritional Adequacy Rate (AKG), the energy requirements for male adolescents aged 13-15 years are 2,400 kcal and 2,650 kcal for those aged 16-18 years, while female adolescents require 2,050 kcal and 2,100 kcal for the respective age groups. [2] Fulfilling these substantial metabolic demands is heavily reliant on structured dietary patterns, particularly the morning meal.

Breakfast is defined as the first meal consumed after a night of sleep, typically before 9:00 AM, and is universally regarded as the most important meal of the day. [3] Its primary physiological function is to replenish depleted glucose stores, restore energy levels, and enhance mental readiness for the day's activities. [4] Research by Shang et al. [5] demonstrated that breakfast accounts for approximately 25.9% of total daily energy intake. According to the UNICEF "AKSI BERGIZI" guidelines, an ideal adolescent breakfast should follow a balanced nutritional pattern, comprising 60-68% carbohydrates, 12-15% protein, and 15-25% fat. [2] Consuming such a meal neutralizes stomach acid, prevents hypoglycaemia, and increases bodily metabolism, which directly benefits cognitive, psychological, and emotional stability. [6] Conversely, skipping breakfast can lead to stunted physical growth, mental health disturbances, and difficulty concentrating during learning activities, which ultimately degrades the body's immune resistance and academic achievement. [7, 8]

Despite these clear benefits, the prevalence of consistent breakfast consumption remains alarmingly low among adolescents worldwide. A study by Sliwa et al. [9] analysing students in grades 9-12 across 50 US states and the District of Columbia revealed that only 27.4% of adolescents consumed breakfast daily, with more than half demonstrating inconsistent consumption patterns. Similarly, a local study in Jakarta by Sulianto and Charrisa [10] indicated that 41.1% of high school students habitually skipped breakfast. This behavioral deficit poses a significant threat to the psychoneuroimmunological stability of students. The immune system, comprising innate and adaptive components, requires a steady supply of immunonutrients to defend the body against pathogens. [11, 12] Concurrently, students are highly vulnerable to academic stress—a physical and emotional reaction to external pressures and environmental changes. [2] Symptoms of academic stress, as outlined by Hardjana [13], include physical manifestations like insomnia and fatigue, emotional volatility, cognitive impairments, and interpersonal conflicts.

Previous literature has explored isolated aspects of these variables. Muhibbah et al. [14] demonstrated that university students who routinely ate breakfast exhibited significantly better physical stamina and concentration compared to those who skipped it. Pengpid and Peltzer [15] found that skipping breakfast in a 28-country university cohort was strongly associated with poor mental health indicators, including increased stress and depression. Furthermore, Rizky [16] established that breakfast habits and academic stress simultaneously influence learning readiness, while Doloksaribu and Peranginangin [17] confirmed a significant relationship ($p = 0.003$) between breakfast and learning concentration. However, based on a rigorous literature review utilizing databases such as Google Scholar and PubMed, there is a distinct lack of research explicitly investigating the direct tripartite correlation between breakfast behaviour, the physiological parameter of immune status, and the psychological parameter of stress levels among high school students in Indonesia.

Therefore, this study aims to comprehensively ascertain and analyse the correlation of breakfast behaviour with immune status and stress levels among students at Senior High Schools in rural areas of Jember. By addressing this empirical gap, the findings are expected to enhance awareness regarding the multidimensional importance of breakfast, serving as an evidence-based foundation for schools to evaluate and improve the physical and psychological health status of their students.

2 | Methods

2.1 | Design

This research utilized a quantitative methodology with an observational cross-sectional study design. A cross-sectional approach involves collecting data from a population at a single, specific point in time. This specific design was highly

relevant and strategically selected because it allows for the efficient collection of data from a large number of subjects simultaneously to identify correlations among variables and capture the actual condition of the population. [18]

2.2 | Samples and Participants

The target population for this study encompassed the entire student body of Madrasah Aliyah Negeri (MAN) 1 Jember, located in Jember Regency, East Java Province, Indonesia. The sample consisted of 64 students from grades X, XI, and XII who were willing to participate and complete the questionnaire. The study employed a non-probability quota sampling technique, setting a strict quota of 30 students per grade cohort. This specific sampling technique was utilized to guarantee proportional representation across all academic levels within the school, providing time efficiency and logistical flexibility in the field without the need for an exhaustive sampling frame. [19]

2.3 | Instruments

Data collection was executed using a comprehensive, digitally formulated questionnaire constructed via Google Forms. The research instrument was systematically divided into four distinct sections:

- a. **Student Characteristics.** This section collected essential sociodemographic and anthropometric data, including gender, grade level, study program, age, body weight (kg), body height (cm), and total sleep duration. Body Mass Index (BMI) was calculated using the standard formula and categorized into Underweight (BMI < 18.5), Normal/Ideal (BMI 18.5 - 24.9), and Overweight (BMI ≥ 25). Sleep duration was strictly bifurcated into insufficient (< 7 hours) and normal (> 7 hours).
- b. **Breakfast Attitudes Questionnaire (BAQ).** This instrument measured the independent variable (breakfast behaviour). It consists of 13 specific items assessing positive and negative attitudes toward breakfast across three domains: feelings (affective), beliefs (cognitive regarding health, focus, and satiety), and actual habits (behavioural). Responses were recorded on a 5-point Likert scale ranging from "Strongly Disagree" (1) to "Strongly Agree" (5). Negative statements (items 6, 10, and 13) were subjected to reverse scoring prior to final tabulation.
- c. **Immune Status Questionnaire (ISQ).** This variable (Y1) measured the subjective perception of the respondents' immune resilience. The ISQ is a validated 7-item tool that asks respondents to rate the frequency of experiencing minor immune-related complaints (e.g., sudden high fever, diarrheal, headache, skin issues, muscle/joint pain, common cold, and cough) over the past 12 months. The 5-point Likert scale ranged from "Never" (0) to "Always" (4). Higher raw scores indicate a poorer immune status, with specific cut-offs utilized to categorize systemic immune fitness.
- d. **Perceived Stress Scale (PSS-10).** This instrument measured the second dependent variable (Y2), psychological stress. The 10-item scale evaluates the degree to which life situations over the past month were appraised as unpredictable, uncontrollable, and overwhelming. Responses utilized a 5-point Likert scale from "Never" (0) to "Very Often" (4). Four positive coping items (items 4, 5, 7, and 8) were reverse-scored. The total scores were categorized into low stress (0-13), moderate stress (14-26), and high stress (27-40). Prior to the main data collection, the translated Indonesian versions of the BAQ, ISQ, and PSS-10 were tested for validity and reliability on a separate pilot group of students. The Pearson correlation tests yielded r-values of previous studies for the items, which exceeded the critical r-value, thereby establishing strong construct validity. Furthermore, the internal consistency was confirmed with Cronbach's Alpha coefficients of previous studies for the ISQ, and previous studies for the PSS-10. These results demonstrate that the instruments accurately and consistently measured the intended variables within this specific demographic.

2.4 | Data Collection

The data collection procedure commenced with securing formal research authorization from the administration of Senior High School of Jember. Following approval, the Google Form link was systematically disseminated through official school communication channels, such as official class WhatsApp groups. The initial section of the digital form served as the informed consent protocol, detailing the study's scientific objectives, assuring absolute data confidentiality, and requiring a mandatory checklist agreement before respondents could proceed. Strict deadlines were established, and periodic follow-ups were conducted to ensure the targeted quota was met.

2.5 | Data Analysis

The raw data extracted from Google Forms were downloaded into spreadsheet software for initial cleaning and rigorous scoring. The tabulated data were subsequently imported into Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics were employed to calculate the mean, median, standard deviation, and frequency distributions to elucidate the general condition of the variables. For hypothesis testing, bivariate analysis was conducted using the Spearman's rho correlation test, as it is appropriate for non-normally distributed data or ordinal scales. The statistical significance threshold was firmly set at a p-value of < 0.05 .

While the primary analysis utilized Spearman's rho to establish foundational bivariate relationships, we recognize that sleep deprivation acted as a massive confounding variable. However, due to the extreme homogeneity of sleep deprivation within this specific sample (98.4%), we were statistically constrained from performing robust partial correlations or multivariate regression analyses to fully isolate the independent effect of breakfast behaviour while holding sleep and BMI constant. Consequently, the bivariate results reflect the unadjusted relationships between the variables.

3 | Results

The results section outlines the empirical findings derived from the 64 respondents. The data are structurally presented through descriptive participant characteristics, the distribution of scores across the three central variables, and the inferential correlation analysis mapping the relationships between these variables.

3.1 | General Formatting Principles and Participant Demographics

As demonstrated in Table 1, the demographic profile of the participants reveals distinct patterns in the student body. Out of the 64 respondents, the majority were female, comprising 46 individuals (71.9%), while males accounted for 18 individuals (28.1%). Academically, the largest proportion of participants were enrolled in grade X (40.6%), followed by grade XI (37.5%) and grade XII (21.9%). Regarding study programs, half of the respondents belonged to the Regular program (50%), with a significant portion in the Skills program (32.8%). The mean age of the cohort was 16.67 years, spanning a developmental range from 15 to 19 years. Anthropometric measurements indicated a mean height of 157.91 cm and a mean weight of 51.53 kg. Consequently, the average Body Mass Index (BMI) was calculated at 20.66, which comfortably falls within the ideal range. Specifically, 64.1% of students possessed a normal BMI, 23.4% were classified as underweight, and a minor 10.9% were overweight. Critically, the assessment of total sleep time unveiled a severe public health concern within this demographic: a staggering 63 students (98.4%) reported insufficient sleep (less than 7 hours per night). Concurrently, the psychological evaluation indicated that a vast majority, 50 students (78.1%), were experiencing moderate levels of stress.

3.2 | Distribution of Breakfast Behaviour, Immune Status, and Stress Scores

Table 2 provides the descriptive statistical distribution of the three primary instruments. For breakfast behaviour (measured via BAQ), the mean score was 49.66 with a median of 52 and a standard deviation (SD) of 9.64. This indicates that, on average, the students maintain a positive attitude towards breakfast, with moderate variance in their responses (Coefficient of Variation [CoV] = 19.41%). The immune status (measured via ISQ) yielded a highly concerning mean score of 15.11, with a median of 16 and a high standard deviation of 4.57. A total score of ≥ 15 strictly places the cohort in the category of possessing a "very poor" immune system. The large standard deviation (CoV = 30.24%) suggests substantial disparities in immune resilience among individual students. Lastly, the perceived stress level (measured via PSS) resulted in a mean and median score of exactly 22, accompanied by an SD of 5.78. This firmly positions the average student within the moderate stress category (range 14-26). The SD highlights a significant spread of data, meaning that while the average is moderate, many students deviate toward high or low extremes (CoV = 26.27%).

TABLE 1 | Respondent Characteristics

Variable	F	%	Mean
Gender			
Female	46	71.9	
Male	18	28.1	
Grade			
X	26	40.6	
XI	24	37.5	
XII	14	21.9	
Study Program			
Regular	32	50.0	
Skills	21	32.8	
BIC	7	10.9	
PK	4	6.3	
Age (years)			16.67
15	5	7.8	
16	23	35.9	
17	25	39.1	
18	10	15.6	
19	1	1.6	
Anthropometry			
Height (cm)			157.91
Weight (kg)			51.53
BMI			20.66
Underweight	15	23.4	
Normal (Ideal)	41	64.1	
Overweight	7	10.9	
Total Sleep Time			
Insufficient	63	98.4	
Normal	1	1.6	
Stress Level			
Low	3	4.7	
Moderate	50	78.1	
High	11	17.2	

Description: F = Frequency (Number of participants); % = Percentage; Mean = Average; BMI = Body Mass Index.

TABLE 2 | Distribution of Scores for Breakfast Behaviour, Immune Status, and Stress

Variable	Mean	Median	SD
Total BAQ Score	49.66	52	9.64
Total ISQ Score	15.11	16	4.57
Total PSS Score	22	22	5.78

Description: BAQ = Breakfast behaviour; ISQ = Immune status; PSS = Stress level; Mean = Average; Median = Middle value; SD = Standard deviation.

3.3 | Correlation Analysis

Table 3 presents the bivariate correlations calculated using Spearman's rho. The core findings negate the primary hypotheses: there is no statistically significant relationship between breakfast behaviour and immune status ($p = 0.085$), nor is there a significant relationship between breakfast behaviour and stress levels ($p = 0.181$). However, the statistical analysis discovered a highly significant positive correlation between immune status and stress levels ($p = 0.016$).

TABLE 3 | Spearman's Rho Correlation Matrix Between Key Variables

Variable	BMI	Sleep Time	Breakfast Behavior	Immune Status	Stress Level
BMI	1	0.864	0.660	0.918	0.972
Sleep Time	0.864	1	0.383	0.463	0.253
Breakfast Behavior	0.660	0.383	1	0.085	0.181
Immune Status	0.918	0.463	0.085	1	0.016*
Stress Level	0.972	0.253	0.181	0.016*	1

Description: BMI = Body Mass Index; * = significant ($p < 0.05$). The significance value (Sig.) was determined using the Spearman's rho statistical test.

4 | Discussion

The dominance of female participants (71.9%) reflects a common trend in secondary school research settings, where female adolescents generally exhibit higher compliance in filling out instruments compared to males. [2] Demographically, the cohort centralized around a mean age of 16.67 years. This period is recognized as a critical biological and psychosocial transition wherein adolescents gain autonomy over lifestyle choices, encompassing dietary patterns and sleep hygiene. [20]

Nutritionally, 64.1% of the students maintained an ideal Body Mass Index. This suggests that the baseline macroscopic nutritional status of the students at Senior High Schools in rural areas of Jember is proportional and sufficient to support linear somatic growth. [21] The most alarming demographic finding, however, pertains to sleep duration: 98.4% of the participants suffered from severe sleep deprivation. This massive sleep deficit is indicative of the overwhelming daily burdens placed upon students, spanning rigorous academic curriculums and demanding extracurricular activities. [22] Chronic sleep deprivation fundamentally disrupts circadian rhythms, leading to direct deteriorations in classroom cognitive functioning and severe fluctuations in stress hormones. [23]

The quantitative assessment utilizing the BAQ generated a mean score of 49.66, indicating that the students possess a commendably positive cognitive and affective predisposition toward the concept of breakfast. This positive attitude is an excellent foundational asset, as theoretical models suggest that belief in the benefits of a meal usually correlates positively with its consumption. [21] However, a positive attitude on a psychometric scale does not inherently guarantee the practical execution of a high-quality nutritional breakfast. Many adolescents, despite understanding its importance, frequently skip breakfast due to insurmountable practical barriers, such as extreme morning time constraints. [2]

The Immune Status Questionnaire (ISQ) data unveiled deeply concerning results, with a mean score of 15.11 categorizing the overarching cohort as possessing a "very poor" immune system. This extremely poor immune status cannot be viewed in isolation; it is deeply intertwined with the cohort's sleep profile. Immunological frameworks establish that chronic sleep deprivation severely suppresses the activity of Natural Killer (NK) cells and diminishes the production of crucial cytokines. [20] Sleep is the primary biological window for cellular repair; because 98.4% of the students lack adequate rest, their bodies are perpetually deprived of the opportunity to regenerate vital immune cells. [23]

Evaluating the psychological dimension through the PSS-10 yielded a mean score of 22, categorizing 78.1% of the students into a state of moderate stress. This indicates that psychological tension is a normative and chronic condition within the academic environment. The primary stressors activating this distress are inherently tied to the academic environment: mounting cognitive demands, intense peer competition, and unrelenting assignment deadlines (Adolfsson et al., 2018). This chronic exposure to stressors persistently activates the Hypothalamic-Pituitary-Adrenal (HPA) axis. [24]

Contrary to the initial hypothesis, the bivariate analysis unequivocally demonstrated no statistically significant correlation between breakfast behaviour and immune status ($p = 0.085$). The primary explanation for this lack of correlation lies in the nature of the measurement tool: the BAQ evaluates "positive attitudes," not the exact quantification of immunomodulatory nutrients consumed. [21] More critically, the potential immunological benefits of breakfast were entirely overshadowed by the destructive force of extreme sleep deprivation. According to host defence mechanism theories, sleep hygiene occupies a supreme position in the hierarchy of immune maintenance. [25]

Similarly, the statistical calculations firmly rejected the hypothesis linking breakfast behaviour to perceived stress levels ($p = 0.181$). While fasting-induced hypoglycaemia can trigger a transient fight-or-flight response, [2] this metabolic fluctuation is insufficient to manifest as profound psychological stress. [21] The root causes of distress are sociologically and academically driven. [22] Consequently, dietary interventions are fundamentally incapable of mitigating the core external pressures that generate this perceived stress. [25]

The most profound discovery of this research is the statistically significant positive correlation between the students' immune status and their stress levels ($p = 0.016$). This empirical finding robustly validates the complex paradigm of Psychoneuroimmunology, which dictates that the central nervous system and the immune system communicate through a bidirectional network. [24] When adolescents endure chronic academic stress, their adrenal glands continuously pump abnormal quantities of glucocorticoid hormones, which functionally inhibits the proliferation of lymphocytes. [20, 25] This creates a deadly triad—chronic sleep debt, elevated stress, and shattered immune defences—that operates entirely independently of the students' breakfast behaviours. [22, 23]

Contextualizing these findings within the current national health landscape is critical. As of the 2025/2026 academic year, the Indonesian government is actively implementing the Makan Bergizi Gratis (MBG) policy, which aims to provide free nutritious meals to school children and adolescents to eradicate malnutrition and boost academic focus. However, our findings strongly evaluate the potential efficacy of this intervention. The data implies that while the MBG program serves as a vital nutritional foundation, providing standardized, nutritious meals at school will not be sufficient in isolation to improve immune status and lower stress levels among high school students. The MBG program will only achieve its maximum public health efficacy if the government and educational institutions concurrently address the severe sleep deprivation and massive academic workload issues that act as the primary drivers of adolescent immunosuppression.

4.1 | Implication for Practice

The implications of these findings mandate a paradigm shift in how adolescent health is managed within educational institutions. Nursing and public health interventions must evolve to deploy comprehensive psychosocial strategies. Schools must urgently prioritize mental health support by integrating structured stress-management counselling and explicitly teaching time-management skills. Furthermore, to ensure the success of national nutritional interventions such as the MBG policy, policymakers and school administrators must synchronize dietary programs with strict regulations on academic workloads to guarantee students attain adequate sleep, thereby safeguarding their psychoneuroimmunological health.

4.2 | Limitations

This study acknowledges several methodological limitations. The evaluation of breakfast behaviour relied exclusively on an attitudinal questionnaire rather than a rigorous quantitative 24-hour dietary recall. Additionally, sleep deprivation emerged as a massive confounding variable but was measured merely by total hours reported. Third, the reliance on self-reported questionnaires distributed via Google Forms introduces inherent social desirability and recall biases, particularly regarding self-reported sleep times and dietary habits. Future longitudinal studies incorporating objective biometric tracking (e.g., actigraphy for sleep) and strict dietary logs are essential to establish definitive causality.

Fourth, the utilization of a non-probability quota sampling method yielded a relatively small sample size ($n=64$) from a single institution, limiting the statistical power of the findings. Furthermore, generalizing these results to the broader Indonesian adolescent population must be done with extreme caution; students in a Madrasah Aliyah (Islamic high school) possess unique daily routines, such as early morning prayers and specific religious boarding activities, which distinctly differentiate their sleep and breakfast patterns from students in standard public or urban schools. Finally, due to the overwhelmingly high prevalence of sleep deprivation in the sample, the study was statistically constrained from utilizing multivariate regression to completely isolate the independent effect of breakfast behaviour while holding sleep constant.

5 | Conclusion

This study investigated the students of Senior High Schools in rural areas of Jember, who presented a demographic profile characterized by normal BMI but catastrophic levels of sleep deprivation (98.4%), moderate perceived stress (78.1%),

and highly degraded immune systems. Despite possessing commendable attitudes toward breakfast consumption, this nutritional predisposition demonstrated no statistically significant correlation with improvements in either immune status ($p = 0.085$) or stress alleviation ($p = 0.181$). However, the study successfully established a highly significant correlation ($p = 0.016$) between elevated stress levels and deteriorating immune status. This fundamentally emphasizes that within high-pressure academic settings, psychological distress acts as the primary immunosuppressive agent, a condition catastrophically amplified by chronic sleep debt. Health interventions must transcend basic dietary advice and aggressively tackle the root causes of academic burnout.

Declaration of Interest

The authors affirm that there are no conflicting objectives.

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Data Availability

None

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