Jurnal Gizi dan Dietetik Indonesia
(Indonesian Journal of Nutrition and Dietetics)
Vol 14, Issue 3, 2026: 231-242

Available online at: https://ejournal.almaata.ac.id/index.php/IJND
p-ISSN 2303-3045 e-ISSN 2503-183X
DOI: https://dx.doi.org/10.21927/ijnd.2026.14(3).231-242

The relationship between breakfast habits with cognitive performance and academic achievement in adolescents in Bogor District

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ABSTRAK

Latar Belakang: *Pemenuhan gizi sangat krusial pada masa remaja. Meski sarapan berkontribusi 15–30% terhadap kebutuhan energi harian, 26,1% remaja Indonesia masih melewatkannya. Padahal, sarapan berpengaruh positif terhadap fungsi kognitif dan prestasi akademik remaja.*
Tujuan: *Menganalisis hubungan antara kebiasaan sarapan dengan performa kognitif dan prestasi akademik pada remaja di Kabupaten Bogor.*
Metode: *Penelitian cross-sectional ini melibatkan 55 remaja dari Sekolah Menengah Pertama (SMP) Negeri 1 Cibungbulang dengan purposive sampling. Data kebiasaan sarapan (kuesioner), asupan (food recall 2x24 jam), performa kognitif menggunakan Letter Cancellation Test untuk atensi dan Digit Letter Substitution Test untuk kecepatan pemrosesan, prestasi akademik diperoleh dari nilai Ujian Tengah Semester. Analisis data bivariat menggunakan uji Spearman, Pearson, dan Independet T-test.*
Hasil: *Mayoritas subjek (60%) memiliki kebiasaan sarapan yang baik dengan rata-rata skor atensi (33,0±16,4), kecepatan pemrosesan (42,9±22,0), dan nilai ujian (56,2±29,8) yang lebih tinggi dibanding kelompok tidak sarapan (40%). Namun, tidak terdapat perbedaan yang signifikan antara subjek yang terbiasa sarapan dan tidak terbiasa sarapan pada aspek atensi ($p = 0.297$), kecepatan pemrosesan ($p = 0.887$), dan prestasi akademik ($p = 0.898$). Tidak terdapat hubungan frekuensi sarapan maupun kontribusi energi dengan atensi, kecepatan pemrosesan, dan prestasi akademik ($p = 0.220$, $p = 0.937$, dan $p = 0.913$); ($p = 0.522$, $p = 0.897$, dan $p = 0.726$).*
Kesimpulan: *Tidak terdapat hubungan kebiasaan sarapan dengan performa kognitif dan prestasi akademik pada remaja di Kabupaten Bogor. Edukasi gizi mengenai manfaat sarapan terhadap performa kognitif dan prestasi akademik serta jenis sarapan perlu disampaikan untuk meningkatkan kuantitas dan kualitas sarapan pada remaja.*

KATA KUNCI: *kebiasaan sarapan; performa kognitif; prestasi akademik; remaja*

ABSTRACT

Background: *Nutritional fulfillment was crucial during adolescence. Although breakfast contributed 15–30% of daily energy needs, 26.1% of Indonesian adolescents still skipped it, despite evidence that breakfast had a positive impact on cognitive function and academic achievement.*

Objectives*: To analyze the relationship between breakfast habits and cognitive performance and academic achievement among adolescents in Bogor Regency.*

Methods: *This cross-sectional study involved 55 adolescents from State Junior High School 1 Cibungbulang selected using purposive sampling. Data were collected on breakfast habits (questionnaire), dietary intake (2×24-hour food recall), cognitive performance using the Letter Cancellation Test (attention) and Digit Letter Substitution Test (processing speed), and academic achievement based on midterm exam scores. Bivariate analysis was conducted using Spearman's test, Pearson's test, and independent t-test.*

Results: *The majority of subjects (60%) had good breakfast habits, with average scores on attention (33.0±16.4), processing speed (42.9±22.0), and exam scores (56.2±29.8) higher than those of the non-breakfast group (40%). However, no significant differences were found between habitual breakfast and non-breakfast groups in attention (p=0.297), processing speed (p=0.887), or academic achievement (p=0.898). There was no relationship between breakfast frequency and energy contribution with attention, processing speed, and academic achievement (p = 0.220, p = 0.937, and p = 0.913, respectively); (p = 0.522, p = 0.897, and p = 0.726, respectively).*

Conclusions: *Breakfast habits were not relationship with cognitive performance or academic achievement among adolescents in Bogor Regency. Nutrition education on the benefits and quality of breakfast remains necessary to improve adolescents' dietary practices.*

KEYWORDS*: academic achievement, adolescents, breakfast habits, cognitive performance*

Article info: Received October 21, 2024; 1st revision January 23, 2025; 2nd revision February 12, 2025; 3th revision February 12, 2025; 4th revision July 12, 2025; 5th revision August 26, 2025; 6th revision September 22, 2025; accepted October 28, 2025; available online May 29, 2026; published May 29, 2026.

INTRODUCTION

Adolescence was defined as someone who is in the age range of 10 to 19 years (1). Adolescence is a crucial period because there are many changes due to biological growth as well as emotional and cognitive development, and other changes in habits caused by changes in the social environment (2). Nutritional fulfillment in adolescents is essential to consider, as it affects cognitive, motor, and emotional abilities, as well as nutritional status in later stages of life (3,4). An unbalanced and irregular diet is common among adolescents and is one of the main factors responsible for the high prevalence of nutritional problems in adolescents (5).

According to recent studies, inadequate nutrient intake remains a public health concern in Indonesia. Indonesian adolescents are still reported to have insufficient intake of energy and protein, alongside unhealthy eating behaviors such as breakfast skipping (6). Breakfast skipping among children and adolescents is still commonly found and is associated with poorer diet quality and nutrient adequacy (7). Several studies conducted in Europe and Australia also show similar results where as many as 10-30% of children skip breakfast every day (8, 9). A study among adolescents in Bogor reported that breakfast habits among students were still suboptimal (10). Consistent with these findings, preliminary observations at SMP Negeri 1 Cibungbulang showed that many students still tend to skip breakfast and the school has not implemented any breakfast program. This highlights the importance of assessing students' breakfast habits and their potential impact on cognitive performance and academic achievement.

Breakfast was defined as the activities of consuming foods and or drinks that contain balanced nutrition that are carried out between the time of waking up and 9 a.m. and contribute 15-30% to the fulfillment of total energy needs (11,12). Breakfast is an important thing especially for children and adolescents considering that in

this phase physiologically glucose metabolism occurs almost twice as fast compared to adult age groups so breakfast is considered a necessary condition to provide glucose as the main energy source for optimal activity and thinking (13, 14). Based on previous research, it was found that skipping breakfast can cause the adequacy of daily energy and nutrients to not be fulfilled optimally (13,15). The results of the literature study, found that breakfast affects performance or cognitive function (13). Cognitive performance is generally categorized into several hierarchical functions (16). Attention and processing speed are part of cognitive performance that occupies the basic part of the cognitive hierarchy that determines a person's ability to process information and becomes the foundation of cognitive abilities (17,18).

Regularly skipping breakfast was associated with reduced cognitive performance, particularly among adolescents with overweight or obesity (19). Students who are accustomed to eating breakfast every day have a better level of class participation, memory, and even academic achievement compared to those who are not accustomed to eating breakfast (20). One large-scale empirical study in China also showed that breakfast has a positive effect on cognitive development in elementary and middle school students (21). Taken together, these studies indicate that breakfast consumption may play an important role in supporting cognitive function and academic performance among adolescents (21).

Based on the previous description, breakfast habits may indirectly affect cognitive performance and academic achievement in adolescents. Nevertheless, in Indonesia, only a limited number of studies have examined this relationship. Therefore, this study aims to determine the association between breakfast habits, cognitive performance, and academic achievement among adolescents in Bogor District.

MATERIALS AND METHODS

This research used a cross-sectional study design and was conducted at State Junior High Schools 1 Cibungbulang, Bogor Regency which was selected by purposive sampling based on consideration of the large number of students, the accessibility, and the permissions of the school. The study was carried out from May to July 2024. The subjects in this study were male and female students at SMPN 1 Cibungbulang. Inclusion criteria set were 7th grade students, willing to be research subjects and follow the entire research stages. Exclusion criteria were not allowed to be a research subject, not present at the time of data collection, resigning for academic or other reasons.

The determination of the minimum sample size was based on the prevalence of adolescents who skipped breakfast in Indonesia, reported at 26.1% (Riskesdas, 2018), and calculated using the Lemeshow formula for cross-sectional studies. The confidence level (Z) was set at 1.96 for a 95% confidence interval, the estimated prevalence (p) was 0.261, and the precision (d) was 0.1. In addition, the final number of participants was also adjusted according to administrative permission from the school. The school allowed only 7th-grade students to participate, and of the 10 available classes, 2 classes were granted permission to take part in the study. Based on this calculation, the minimum required sample size was 55 students.

Data collection consisted of several components. Information regarding subject characteristics and breakfast habits was obtained through self-administered questionnaires completed by the participants under the supervision of the researcher. Subject characteristics included age, gender, and daily pocket money. Breakfast habits included breakfast frequency and types of foods consumed, this data were collected through filling out a questionnaire given to the subject with the researcher's guidance.

Socio-economic data included parents' education and occupation, family income, and number of family members. To ensure data accuracy, the socio-economic questionnaire was allowed to be taken home and completed together with the parents so that the responses reflected actual household conditions. The categorization of family size was defined as follows: families were classified as small if they consisted of ≤ 4 members, medium if they consisted of 5–6 members, and large if they consisted of ≥ 7 members, based on the classification from previous study (21). This categorization was used

to describe the socio-economic characteristics of the study subjects.

Data of energy intake was obtained directly through subject interviews using 2x24 hour food recall questionnaire on weekdays and weekends. Cognitive performance data were collected using the Letter Cancellation Test (LCT) questionnaire for attention and Digit Letter Substitution Test (DLST) for processing speed which had been validated (22,23). The cognitive performance questionnaires (measuring attention and processing speed) were tested for readability before use, and the results indicated that the research instrument had a good level of readability.

The categorization of cognitive performance and academic achievement was defined as follows: cognitive performance, which included attention and processing speed, was classified as poor if the score was below the mean (< mean) and good if the score was equal to or above the mean (≥ mean) based on the data distribution. Academic achievement was determined from the average scores of Mathematics, Language, and Science subjects, and categorized as poor if the average score was below 80 (< 80) and good if it was equal to or above 80 (≥ 80), following the criteria established by the Ministry of Education and Culture of Indonesia (24).

Data processing in this study was carried out using several tools including the Nutrisurvey computer program, Microsoft Excel 2019, and IBM Statistical Program for Social Sciences (SPSS) version 25.0. Nutritional intake data obtained from the 24-hour food recall were entered and analyzed using Nutrisurvey to calculate the energy and nutrient intake of each subject. The results were then compared with the calculated individual requirements, which were estimated based on age, sex, body weight, height, and physical activity level of each subject. Further statistical analyses were conducted using SPSS, employing the Spearman rank correlation test, Pearson correlation, and Independent T-test. A significance level of 0.05 was applied, and all results were reported with 95% confidence intervals where applicable. This research was approved by the Ethics Commission for Research Involving Human Subjects at IPB University with number 1177/IT3.KEPMSM-IPB/SK/2024.

RESULTS AND DISCUSSIONS

Characteristics of Subjects

According to UNICEF, the adolescent age category ranges from 10 to 19 years (1). Based on **Table 1**, the age distribution of the subjects was between 12-14 years, with the majority of subjects being 13 years old (65%). The results also showed that there were more female subjects (69%) than male subjects (31%). In this study, pocket money was defined as the amount of money the subjects received daily to buy food and drinks. The amount of pocket money in school children will affect their purchasing power and food consumption outside the home (24). Most subjects (84%) had pocket money ranging from IDR 10.000 – IDR 20.000 with an average of IDR 16.736.4±5.174.6 16.736. According to previous study, students with good academic achievement had a larger amount of daily pocket money than those with poor academic achievement (25). This suggests that socioeconomic factors, such as the availability of pocket money, may influence not only food choices but also access to learning resources or opportunities that support academic success. These findings underscore the importance of considering economic capacity as a determinant of both nutritional behavior and educational outcomes in adolescents.

The data showed that most of the subjects parents graduated from high school (64% of fathers, 42% of mothers). Nearly all of the subjects fathers were employed (98%), while the majority of mothers (84%) were housewives or unemployed. Family income in this study was defined as the total income of all working family members and was measured based on Bogor District's regional minimum wage in 2024, namely IDR 4.479.541. Three-quarters of the families (75%) had an income below the regional minimum wage, with an average income of IDR 3.300.000. Most of the subjects' families (75%) were categorized as medium-sized, with 5-6 family members.

Socioeconomic status (SES) is positively associated with breakfast consumption (26). Research indicates that families with higher SES are more likely to maintain regular breakfast habits than those with lower SES, as they typically have greater access to food resources (27). Furthermore, studies suggest that SES indirectly

influences cognitive performance, motivation, and academic achievement in children (28,29). Additionally, socioeconomic status can shape the level of cognitive stimulation children receive, including the number of books they are exposed to and the quality of education provided (30). Thus, the low socioeconomic status of most families in this study may influence students' breakfast habits and learning outcomes.

Table 1. Distribution of subjects characteristics (n = 55)

Variables	n	%	Mean±SD
Age (year)			12.80 ± 0.60
12	14	25	
13	36	65	
14	5	9	
Gender			
Male	17	31	
Female	38	69	
Pocket money (IDR/day)			16,736.40 ± 5,174.60
<IDR 10.000,00	5	9	
IDR 10.000,00 – IDR 20.000,00	46	84	
>IDR 20.000,00	4	7	
Father education level			
Never attends school	1	2	
Elementary school	7	13	
Junior high school	9	16	
Senior high school	35	64	
Academy/college	3	5	
Mother education level			
Never attends school	1	2	
Elementary school	10	18	
Junior high school	10	18	
Senior high school	23	42	
Academy/college	11	20	
Father working status			
Do not work	1	2	
Work	54	98	
Mother working status			
Do not work	46	84	
Work	9	16	
Family income (IDR/month)			3,300,000.00±1,689,702.90
< UMK Bogor District's (<4.579.541)	41	75	
≥ UMK Bogor District's (≥4.579.541)	14	25	
Family size (person)			4.90±1.60
Small (≤ 4)	8	15	
Middle (5-6)	41	75	
Large (≥ 7)	6	11	

The Relationship between Breakfast Habits and Cognitive Performance and Academic Achievement

According to the data, 60% of the subjects had good breakfast habits, with a frequency of five or more times per week. Previous studies define habitual breakfast as having breakfast at least 5 times per week (25,31). However, 40% of the subjects were still not habitually eating breakfast this can be attributed to several factors, including time constraints, lack of appetite, dissatisfaction with available food choices, food insecurity, concerns about weight management, and body image issues (32,33,34). However, this study

showed slightly different results, as more than half (59%) of the subjects who did not habitually eat breakfast cited stomach pain as the reason for skipping it, whereas previous studies have reported that lack of time was the most common reason adolescents skipped breakfast (33,35). Thus, health-related barriers such as stomach pain appear to be a key factor influencing breakfast habits in this study.

This difference may be influenced by variations in dietary habits, social, or cultural factors specific to the study population (36). Additionally, 45% of the subjects who regularly ate breakfast consumed only staple foods, primarily rice, while 36% paired staple foods with animal-based side dishes. This finding aligns with research by Hardinsyah and Aries (2012), which reported that 28.5% of school-age children in Indonesia consume rice for breakfast (11). These results suggest that breakfast patterns among adolescents are still dominated by staple foods, which may limit dietary diversity and overall nutrient adequacy (**Table 2**).

Table 3 shows the cognitive performance scores of the subjects, which include attention and processing speed. The intake of nutrients obtained through breakfast plays a crucial role in brain activity and function, as glucose serves as the brain's primary energy source, supporting neurotransmitter production and cognitive processes such as memory, attention, and problem-solving (13).

Table 2. Subject's distribution based on breakfast habits

Breakfast – related variables	n	%
Breakfast habits		
Good	33	60
Poor	22	40
Breakfast frequency		
Frequent (≥ 5 times/week)	33	60
Never/Rare (≤ 5 times/week)	22	40
Reasons for skipping breakfast		
Laziness	2	9
Nausea	6	27
Stomachache	13	59
Lack of time	1	5
Type of breakfast		
SF[1)]	15	45
SF[1)] + VSD[2)]	0	0
SF[1)] + ASD[3)]	12	36
SF[1)] + VSD[2)] +ASD[3)]	4	12
SF[1)] + VSD[2)] + V[4)]	0	0
SF[1)] + ASD[3)] + V[4)]	0	0
SF[1)] + VSD[2)] +ASD[3)] + V[4)] + F[5)]	0	0
Snacks	1	3
Others	1	3

[1)] Staple food; [2)] Vegetable side dish;[3)] Animal side dish;[4)] Vegetables;[5)] Fruits

However, the analysis using an Independent T-test indicates no significant difference in cognitive scores across all aspects between subjects with good and poor breakfast habits ($p>0.05$). As shown in Table 3, there is no significant difference in academic achievement between subjects with good and poor breakfast habits, with a p-value of 0.898. This suggests that breakfast habits alone may not fully explain variations in cognitive performance or academic achievement, indicating the possible influence of other contributing factors.

These findings align with previous studies reporting no significant difference in academic achievement between students who consumed breakfast at least five times per week and those who did so four times or less per week (37). Not all research indicates a positive correlation between good breakfast habits and improved cognitive performance (38, 39), while others found higher cognitive scores among habitual breakfast

eaters (40). The discrepancy may be attributed to differences in external factors such as sleep patterns, physical activity, and socioeconomic status, which can also influence cognitive performance (41, 42). These results suggest that while breakfast is important, other lifestyle and environmental factors may play a role in shaping cognitive outcomes. Therefore, this study highlights the need for a more comprehensive approach that considers both dietary and non-dietary factors when examining the relationship between breakfast, cognitive performance, and academic achievement in adolescents.

Table 3. Cognitive performance and academic achievement according to breakfast habits

Variables	Breakfast Habits				p *value*
	Bad		Good		
	n	%	n	%	
Cognitive Performance					
Attention					
Poor	15.00	68.20	17.00	51.50	
Good	7.00	31.80	16.00	48.50	0.30
Mean±SD	30.70 ± 16.40		33.00 ± 16.40		
Processing Speed					
Poor	12.00	54.50	16.00	48.50	
Good	10.00	45.50	17.00	51.50	0.89
Mean±SD	42.50 ± 21.90		42.90 ± 22.00		
Academic Achievement					
Poor	17.00	77.30	25.00	75.80	
Good	5.00	22.70	8.00	24.20	0.90
Mean±SD	55.60 ± 29.80		56.20 ± 29.80		

Breakfast plays a vital role in maintaining adequate blood glucose levels, which serve as the brain's primary energy source for optimal functioning (43). It also ensures sufficient and balanced nutrient intake, which is critical for cognitive performance. Nutrients play a key role in the synthesis of aminergic neurotransmitters such as serotonin, norepinephrine, and dopamine, which are crucial for cognitive processes (44). Disruptions in thinking or other cognitive functions, such as reduced attention, can occur due to a decline in serotonin synthesis caused by inadequate nutrient intake. This is further supported by Kim & Kang (2017), who stated that optimal and adequate nutrient intake contributes to improved brain function and development (45).

Table 4. Correlation between breakfast frequency, energy contribution, and cognitive performance

Variables	Attention		p *value*	Processing speed		p *value*
	Poor	Good		Poor	Good	
	Mean ± SD	Mean ± SD		Mean ± SD	Mean ± SD	
Breakfast frequency (times per week)	3.41 ± 2.42	4.39 ± 2.41	0.22	3.75 ± 2.37	3.89 ± 2.37	0.94
Energy contribution (%)	14.03 ± 9.24	15.74 ± 9.23	0.52	14.62 ± 9.21	14.88 ± 9.20	0.90

The correlation test results (**Table 4**) showed no significant relationship between breakfast frequency, energy contribution, and cognitive performance (p>0.05). However, the correlation test results showed no significant relationship between breakfast frequency, energy contribution, and cognitive performance (p>0.05). Despite this, **Table 5** reveals that subjects with good cognitive performance had a higher average breakfast frequency and energy contribution than those with poor cognitive performance. While the statistical results do not indicate a direct relationship, these

trends suggest that consistent breakfast consumption may still offer cognitive benefits that are not easily captured by simple correlation tests. Therefore, although not statistically significant, the findings highlight the potential importance of breakfast in supporting better cognitive outcomes, underscoring the need for further research with larger samples and more sensitive analytical approaches.

Previous studies have emphasized that the inclusion of protein and complex carbohydrates is essential in an adolescent's breakfast to support optimal cognitive performance (46). In contrast, this study did not specifically control the type or composition of breakfast; instead, it reflected the subjects' habitual breakfast practices. Furthermore, the timing of cognitive performance testing may also influence the outcomes. Prior research typically administered cognitive tests immediately after breakfast, whereas this study included a considerable time gap between breakfast and the cognitive performance assessment, which might have affected the results. These findings contrast with previous research, which has reported a positive association between breakfast habits and cognitive performance (46). The complexity of determining breakfast's true impact on brain function may stem from various influencing factors (46). To better understand this relationship, it is essential to consider variables such as population characteristics, age, intelligence quotient, physical fitness, baseline metabolism, breakfast composition, dietary patterns, and study design (43,47). In conclusion, the relationship between breakfast and cognitive performance is complex and should be interpreted in the context of multiple influencing factors.

Table 5 presents the mean breakfast frequency and energy contribution in relation to academic achievement. Although students with good academic achievement reported slightly higher breakfast frequency and energy contribution compared to those with poor achievement, the differences were not statistically significant ($p > 0.05$). These findings suggest that breakfast habits alone may not be a strong determinant of academic performance.

Table 5. Correlation between breakfast frequency, energy contribution, and academic achievement

Variables	Academic Achievement		p *value*
	Poor	Good	
	Mean ± SD	Mean ± SD	
Breakfast frequency (times per week)	3.79 ± 2.33	3.92 ± 2.33	0.91
Energy contribution (%)	14.64 ± 9.10	15.08 ± 9.11	0.73

Previous research has reported mixed results regarding this relationship. Some studies have found no association between breakfast frequency and academic achievement (25), similar to the present findings. Conversely, other studies highlight that skipping breakfast is associated with reduced learning motivation, lower test scores, and poorer academic performance (29,48). These inconsistencies could be explained by several factors beyond breakfast frequency, such as socioeconomic conditions, parental education, psychological well-being, and lifestyle behaviors, which may play a mediating role in academic outcomes (49).

Another important consideration is that the impact of breakfast on academic achievement may depend on meal quality and nutrient composition rather than frequency alone. Protein, complex carbohydrates, and micronutrients have been shown to influence neurotransmitter synthesis, which supports cognitive function and learning capacity (44, 45). In this study, breakfast composition was not assessed in detail, limiting interpretation of the nutritional quality of meals consumed by participants. Furthermore, other unmeasured factors such as sleep quality, physical activity, and stress levels could have influenced the results.

Despite the lack of a significant association, the observed trend of higher breakfast frequency and energy intake among students with better academic achievement aligns with the hypothesis

that regular breakfast consumption may contribute to improved cognitive and academic outcomes. Nevertheless, this study is not without limitations. The cross-sectional design does not allow for causal inferences, while data on breakfast habits obtained through self-report are subject to recall bias. In addition, potential confounding variables such as sleep quality, physical activity, and socioeconomic status were not fully controlled, which may have influenced the findings.

CONCLUSION AND RECOMMENDATION

This study showed that more than half of the subjects had good breakfast habits, yet no significant association was found between breakfast habits, cognitive performance, and academic achievement. Although students with better cognitive performance and achievement showed a tendency toward higher breakfast frequency and greater energy contribution, these associations did not reach statistical significance. These findings indicate that while breakfast alone may not directly determine academic or cognitive outcomes, it remains a potentially supportive factor for overall well-being. Future studies should employ longitudinal designs, larger and more diverse samples, and objective measurements of dietary intake and cognitive function to clarify causal relationships. From a public health perspective, promoting regular and nutritionally balanced breakfast consumption is still recommended, as it may contribute to healthier eating patterns and improved readiness for learning, even if the direct impact on academic performance remains inconclusive.

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