

Food and Nutrition Knowledge and Its Correlation with Breakfast Energy Intake Among Schoolchildren: A Cross-Sectional Study on the GENIUS Programme in Binjai

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ABSTRACT

Evaluating the determinants of school age children dietary habits under national intervention initiatives is essential to address childhood malnutrition. Within the framework of the national Gerakan Edukasi dan Pemberian Pangan Bergizi untuk Siswa (GENIUS) programme, exploring how cognitive attributes influence actual dietary behaviors remains a critical research priority. The purpose of this study was to investigate food and nutrition knowledge and its correlation with breakfast energy intake among schoolchildren participating in the GENIUS programme in Binjai City, North Sumatra, Indonesia. This study used a cross-sectional design, analyzing secondary data compiled from 62 upper-grade students (grades 4-6) at SDN 023893 Binjai who participated in the national GENIUS programme in 2023. Samples were selected using a non-probability purposive sampling technique. Dietary intake was measured via a breakfast food recall form and processed using NutriSurvey software based on the Indonesian Food Composition Table. Food and nutrition knowledge was evaluated using a validated 10-item structured questionnaire. Univariate analysis indicated that while 53.2% of the children possessed moderate nutritional knowledge, a critical 75.8% suffered from a severe breakfast energy deficit. Bivariate analysis using the Spearman rank correlation test revealed a statistically significant relationship between the variables ($p = 0.013$, $r = 0.314$), demonstrating a positive, weak-to-moderate correlation. In conclusion, higher food and nutrition knowledge is positively correlated with better breakfast energy intake adequacy among the schoolchildren. These findings underscore that despite the structural support of the GENIUS programme, reinforcing structured school-based dietary education is vital to improve cognitive insights and mitigate the pervasive morning energy insufficiency observed among these student.

Key Messages:

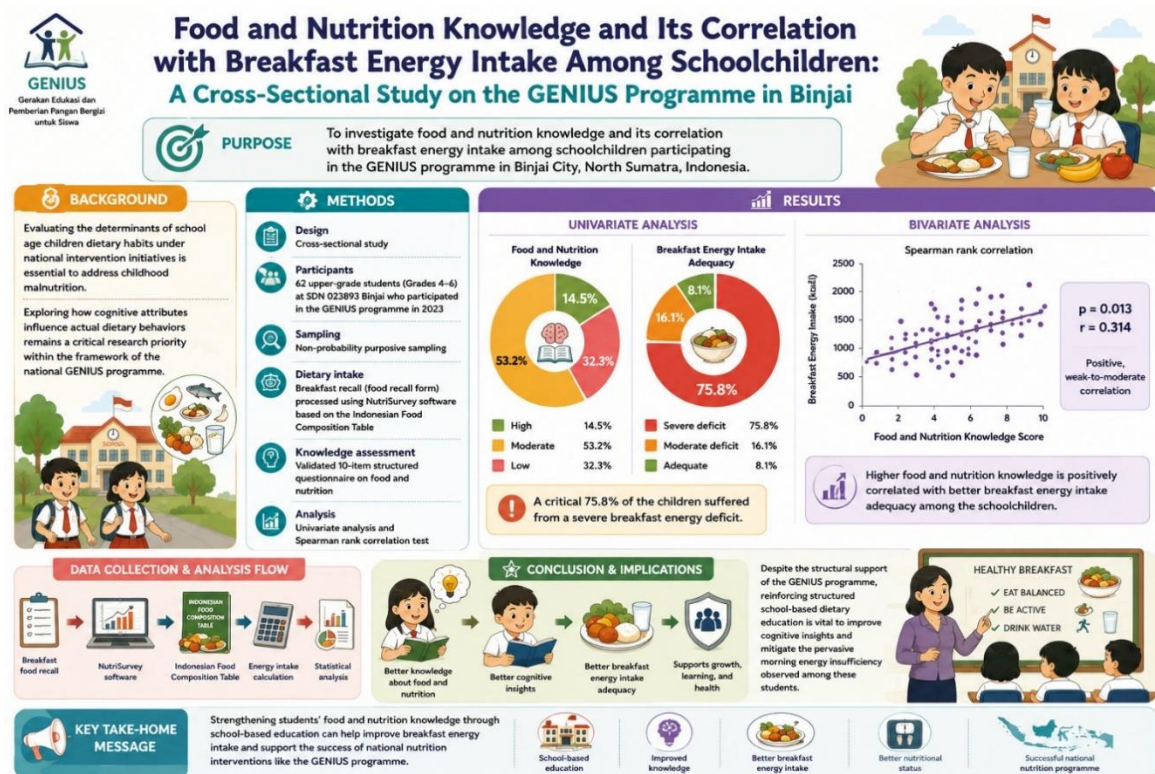
- Nutritional literacy serves as a critical determinant of dietary habits, directly driving morning caloric fulfillment among primary school children.
- National school-based feeding programs must transition from a passive meal distribution model into a holistic framework that actively pairs physical food aid with continuous education.

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GRAPHICAL ABSTRACT



INTRODUCTION

The metabolism of macronutrients generates the essential energy required by school-aged children for physical activity, growth, and cognitive development (1–3). Ideally, a balanced breakfast should satisfy 15% to 30% of daily energy needs, functioning as a critical driver for classroom concentration and academic performance (4,5). Conversely, inadequate morning intake poses high nutritional risks that are rarely compensated for in later meals (6). Data from the South East Asian Nutrition Surveys II (SEANUTS II) indicate that the breakfast quality of Indonesian children remains suboptimal, highlighting persistent concerns regarding the adequacy and quality of breakfast consumption among school-aged children (7).

Breakfast intake may also be related to food and nutrition knowledge, as nutritional understanding can influence food choices and dietary practices (8). However, nutrition knowledge among Indonesian schoolchildren remains suboptimal and has been linked to poor dietary patterns and meal quality (9–11). This knowledge gap is evident in neighboring districts such as Batang Kuis (10.3% poor knowledge) and Sunggal (61.40% poor knowledge) (12,13). These findings highlight the importance of integrating nutrition education with school-based food and nutrition interventions to encourage healthier dietary practices among school-aged children.

Indonesia has implemented several school-based nutrition programmes that combine food provision with educational components. The Program Gizi Anak Sekolah (ProGAS), launched nationally by the Ministry of Education and Culture in 2016, initially prioritized schools in food- and nutrition-insecure areas. ProGAS incorporated three main components: breakfast provision, nutrition education focusing on balanced and safe diets, and hygiene and character education. The programme also emphasized community participation and the use of locally sourced foods in meal preparation (14). More recently, the Indonesian National Food Agency (Badan Pangan Nasional/Bapanas) implemented the Gerakan Edukasi dan Pemberian Pangan Bergizi untuk Siswa (GENIUS) Programme. Similar to ProGAS, GENIUS integrates food provision with nutrition education; however, GENIUS is implemented under Bapanas as part of its efforts to improve access to nutritious food and strengthen food and nutrition knowledge among schoolchildren. In 2023, GENIUS was implemented across 10 provinces, including five regencies/cities in North Sumatra, one of which was Binjai City (15).

Evidence from previous Indonesian school-based nutrition interventions highlights the importance of combining food provision with sustained nutrition education. The evaluation of ProGAS demonstrated its

contribution to improving schoolchildren's dietary intake and learning environment (16). Furthermore, the GESIT study in Bogor showed that improvements in nutrition knowledge and breakfast nutrient intake following a school breakfast intervention may diminish after the intervention ends, emphasizing the importance of sustained educational reinforcement (17). Nevertheless, evidence examining the correlation between schoolchildren's food and nutrition knowledge and their actual breakfast energy intake within the context of an ongoing government-supported nutrition programme remains limited, particularly in North Sumatra. The GENIUS implementation in Binjai therefore provides a relevant context for examining whether differences in food and nutrition knowledge correlate with breakfast energy adequacy among programme participants. Therefore, this study aimed to analyze the correlation between food and nutrition knowledge and breakfast energy intake among schoolchildren participating in the GENIUS Programme at SDN 023893 Binjai. We hypothesized that food and nutrition knowledge would be correlated with breakfast energy adequacy among schoolchildren participating in the GENIUS Programme.

METHODS

This cross-sectional study was conducted at SDN 023893 Binjai, Binjai City, North Sumatra Province, Indonesia, using secondary data from the national Gerakan Edukasi dan Pemberian Pangan Bergizi untuk Siswa (GENIUS) Programme managed by the Indonesian National Food Agency (Badan Pangan Nasional/Bapanas). The GENIUS Programme was implemented and primary data were collected from October to November 2023, while data cleaning, dietary data entry, and statistical analyses for the present study were conducted between July and August 2024. To ensure the quality and consistency of the primary data collection, enumerators received training before data collection, including instructions on the administration of the study instruments and standardized procedures for completing the breakfast food recall form. During field data collection, enumerators were also supervised to ensure adherence to the established data collection procedures and consistency in recording participants' responses and dietary information.

The reference population comprised all 117 primary school children enrolled in the upper grades (grades 4, 5, and 6) at SDN 023893 Binjai. To select the analytical sample from this population, a non-probability purposive sampling method was employed. The inclusion criteria required participants to be active students in grades 4-6 at SDN 023893 Binjai, registered as official recipients of the GENIUS program, present at the school during the designated screening days, and having obtained written informed consent from their parents or legal guardians. To determine the required sample size, the established sample size formula for correlation studies was utilized, where the type I error was set at 5% for a two-tailed hypothesis ($Z_\alpha = 1.96$), the type II error was set at 20% ($Z_\beta = 0.84$), and the minimum clinically meaningful correlation coefficient (r) was pre-specified at 0.36 based on prior pediatric literature. Although the calculation yielded a minimum required sample of 60 students, a total of 62 respondents were successfully selected and analyzed. Out of the initial population of 117 students, 55 were strictly excluded due to incomplete mandatory background data. Comparisons between included and excluded students could not be performed due to incomplete data; therefore, potential selection bias from the high exclusion rate was acknowledged as a study limitation.

Data collection instruments captured socio-demographic characteristics, food and nutrition knowledge, and breakfast dietary intake. Socio-demographic variables included the student's sex, parents' highest educational attainment, parental occupation, and daily school pocket money. Parental occupation referred to the occupation of the parent who completed the questionnaire, either the father or the mother; therefore, the variable represents the responding parent's occupation rather than separate paternal and maternal occupations. Occupational categories included civil servant/military/police, honorary teacher, private-sector employee, entrepreneur/self-employed, manual worker, housewife, and others. Daily school pocket money was categorized as IDR2,500-5,000, IDR5,001-10,000, and > IDR10,000. Food and nutrition knowledge was measured using a multiple-choice test consisting of 10 items designed for the GENIUS campaign. The questionnaire covered six essential nutritional indicators: breakfast habits (1 item), healthy snacks (1 item), dietary nutrient sources (3 items), food waste (2 items), healthy school-vended foods (2 items), and handwashing practices (1 item). Each correct answer was assigned a score of 1 and incorrect answers received a score of 0. The food and nutrition knowledge score was determined by dividing the total number of correct answers achieved by each participant by the total number of items presented in the questionnaire, with the resulting quotient subsequently multiplied by 100 to yield a final score on a scale from 0 to 100. The scores were classified into three ordinal categories: good (> 80), moderate

(60-80), and poor (< 60) in accordance with Khomsan (18). Breakfast energy intake was retrieved using a breakfast food recall form. This form detailed all foods and beverages consumed by the students from waking up until remaining in the classroom at 10:00 AM, noting specific preparation methods, commercial brands, and portion sizes. Recalled dietary portions were converted into grams, and the total energy content was determined using NutriSurvey software integrated with the Indonesian Food Composition Table based on the raw weight and the edible portion factor. Breakfast energy adequacy was calculated by dividing the participant's total breakfast energy intake (kcal) by 25% of the participant's total daily energy requirement and multiplying the result by 100. The 25% reference was used as the operational benchmark for breakfast energy adequacy because it lies within the recommended breakfast contribution of approximately 15–30% of total daily energy requirements. The level of breakfast energy adequacy was classified into four ordinal groups: severe deficit ($< 70\%$), deficit (70% to $< 100\%$), adequate (100% to $< 130\%$), and excess ($\geq 130\%$) (19).

Statistical analysis comprised both univariate and bivariate structures. Univariate analysis was applied to summarize descriptive frequencies and percentage distributions for the baseline characteristics, categorical food knowledge, and breakfast energy intake groups. Therefore, the bivariate relationship between food and nutrition knowledge and breakfast energy adequacy was examined using the Spearman Rank Correlation test via IBM SPSS Statistics software. The statistical significance threshold was set at a p-value < 0.05 to evaluate the null hypothesis against the alternative hypothesis. Missing data were handled by case-deletion during the sampling phase to avoid potential bias in the statistical correlation.

RESULTS

The socio-demographic and nutritional characteristics of the 62 primary school children enrolled in the study are presented in Table 1. The socio-demographic profile highlights a predominantly male student (61.3%) whose parents are mostly high school graduates (70.9%). Regarding household characteristics, more than half of the mothers as housewives (59.7%), while private sector employment constitutes the next largest occupational group (19.3%). In terms of economic characteristics, the participants generally had low-to-moderate daily purchasing power. Nearly all respondents receive a daily pocket money allowance of IDR 10,000 or less, with exactly half of the sample constrained to a low allowance of IDR 2,500-5,000.

Table 1. Subject characteristics

Characteristics	n	%
Sex		
Boy	38	61.3
Girl	24	38.7
Parent Education		
Primary School	2	3.2
Junior High School	9	14.5
Senior High School	44	70.9
University	7	11.2
Parent Occupation		
Civil servant/Military/Police	1	1.6
Honorary teacher	1	1.6
Private sector employee	12	19.3
Entrepreneur/Self-employed	3	4.8
Manual worker	4	6.4
Housewife	37	59.7
Others	4	6.4
Pocket money (IDR)		
IDR 2.500-5.000	31	50.0
IDR 5001-10.000	27	43.5
>IDR 10.000	4	6.4
Food & Nutrition Knowledge		
Good	2	3.2
Moderate	33	53.2
Poor	27	43.5
Breakfast Energy Intake		

Characteristics	n	%
Severe deficit	47	75.8
Deficit	10	16.1
Adequate	3	4.8
Excess	2	3.2

Assessments of food and nutrition knowledge, coupled with breakfast energy intake, reveal a critical public health landscape within this study. In terms of food and nutrition knowledge evaluation indicates that the student is highly characterized by suboptimal dietary insight, as the majority possess only moderate-to-poor food and nutrition knowledge, led by a dominant moderate-knowledge group (53.2%). This widespread baseline deficiency closely aligns with severely compromised morning eating behaviors. An overwhelming majority of the schoolchildren fail to meet their minimum morning nutritional requirements, driven by a highly prevalent severe breakfast energy deficit that affects more than three-quarters of the participants (75.8%). Consequently, adequate or excess breakfast consumption is restricted to a minor fraction of the population, highlighting a pervasive state of morning energy insufficiency among the targeted students.

Table 2. Correlation between food and nutrition knowledge and breakfast energy intake

Food and Nutrition Knowledge	Breakfast Energy Intake								p value	r
	Severe deficit		Deficit		Adequate		Excess			
	n	%	n	%	n	%	n	%		
Poor	23	37.1	4	6.4	0	0	0	0	0.013	0.314
Moderate	24	38.7	4	6.4	3	4.8	2	3.2		
Good	0	0	2	3.2	0	0	0	0		
Total	47	75.8	10	16.1	3	4.8	2	3.2		

Bivariate analysis reveals a statistically significant correlation between the students' food and nutrition knowledge and their breakfast energy adequacy (Table 2). Cross-tabulation indicates that critical dietary deficits are heavily clustered among participants within the lower food and nutrition knowledge; notably, all respondents with poor knowledge failed to meet adequate breakfast thresholds, with a substantial proportion experiencing a severe energy deficit (37.1%). Conversely, the limited instances of adequate or excess energy consumption were observed exclusively within the moderate-knowledge stratum. Inferential analysis confirms this positive trajectory, as the Spearman rank correlation test yielded a significant relationship ($p = 0.013$, $r=0.314$). These statistical metrics denote a positive, weak-to-moderate correlation, indicating that higher food and nutrition knowledge is positively correlated with enhanced breakfast energy intake adequacy within this primary school students.

DISCUSSION

The socio-demographic profile of the primary school children highlights a highly vulnerable economic baseline, characterized by low-to-moderate daily purchasing power where exactly half of the sample is constrained to a low allowance of IDR 2,500-5,000. This severe economic constraint directly limits children's autonomous food choices outside the home, forcing them to rely almost entirely on domestic dietary provisions. When family purchasing power is restricted, the quality and macro-nutritional density of the first meal of the day may also be affected, potentially contributing to morning energy gaps (20). Consequently, skipping breakfast or consuming an energy-deficient morning meal due to financial limitations drastically reduces total daily energy and essential micronutrient intakes among schoolchildren (21). However, pocket money was not statistically tested in relation to breakfast energy adequacy in the present study. Therefore, this socio-economic characteristic should be interpreted as contextual information rather than as a factor directly associated with the observed breakfast energy deficit.

This economic vulnerability is further structuralized by household characteristics, where 70.9% of the parents are high school graduates and 59.7% of the mothers act as housewives. Although the presence of stay-at-home mothers provides a domestic opportunity for home-prepared meals, the actual nutritional adequacy of these breakfasts is heavily mediated by parental capacity. Empirical literature confirms that parental nutrition knowledge and attitudes serve as the strongest predictors of a child's healthy food knowledge and subsequent

dietary quality (22). However, because a majority of the parents in this study achieved only a high school education, their baseline understanding of child macro-nutritional requirements may be limited, directly impacting the nutrient distribution within the household. Socioeconomic challenges and low parental self-efficacy frequently act as significant barriers that prevent parents from executing ideal dietary practices, even when they are physically present at home (23). Nevertheless, parental education and occupation were not statistically examined in relation to breakfast energy adequacy in this study. Thus, these characteristics are discussed as contextual factors based on previous literature rather than as relationships demonstrated by the present analysis.

Consequently, these socio-demographic realities suggest the potential importance of the domestic environment in supporting school-based nutritional interventions. Evidence from school breakfast initiatives, such as the GESIT program in Indonesia, demonstrates that physical food distribution programs only yield short-term dietary intake improvements unless they are continuously paired with robust, continuous nutritional education (17). To effectively mitigate the severe morning energy deficits within this low-income study, the national GENIUS programme may benefit from integrating parents as collaborative partners through parent-supported nutrition education (PSNE) (24). Interactive home-based reinforcement components, such as culturally and economically tailored meal-planning simulations, may help parents optimize available household resources and reinforce healthy breakfast practices at home. However, the effectiveness of such an approach requires further evaluation through intervention studies.

The evaluation of food and nutrition knowledge within this study reveals a critical landscape dominated by suboptimal dietary insight, as 53.2% of the schoolchildren possess only a moderate level of nutritional literacy. This widespread cognitive deficiency represents a significant threat to pediatric public health, as limited nutritional understanding in primary school students may be related to irregular eating patterns and unsupportive dietary choices. Children who exhibit a weak conceptual grasp of dietary priorities frequently struggle to make informed decisions regarding nutrient selection and portion control (25). Global empirical data confirms that low nutrition knowledge among young learners systematically correlates with poor dietary practices, including erratic meal patterns and suboptimal nutrient densities (25,26). Conversely, when children are equipped with robust, targeted breakfast and nutritional insights, they tend to demonstrate significantly higher protein consumption and superior overall nutritional status (27).

This baseline cognitive deficit closely mirrors the severely compromised morning eating behaviors quantified in this cohort, where an alarming 75.8% of the participants suffer from a severe breakfast energy deficit. Such a high prevalence of morning energy insufficiency is highly problematic because skipping breakfast or under-consuming calories in the morning drastically depresses total daily energy intakes and leaves children vulnerable to severe micronutrient inadequacies (21). Healthy breakfast consumers typically secure approximately 32% to 41% of their total daily energy requirements from their morning meal alone, highlighting the massive nutritional gap experienced by the energy-deficient majority in this study (20). In this study, breakfast energy adequacy was calculated using 25% of daily energy requirements, which falls within the recommended 15-30% range, other values reported in the literature were used only as contextual references. Furthermore, these findings emphasize that physical food distribution under the national GENIUS programme framework cannot independently solve pediatric malnutrition without addressing cognitive attributes. Evidence from similar school-based breakfast programs, such as the GESIT initiative in Indonesia, demonstrates that the introduction of free school meals only yields short-term improvements in breakfast nutrient intake unless it is systematically reinforced with continuous nutritional education. Therefore, to transform the current reality where adequate breakfast intake is restricted to a minor fraction of the population, structural meal programs must be heavily paired with continuous educational interventions designed to elevate the students' dietary literacy and long-term energy regulation habits (17).

The inferential analysis in this study demonstrated a statistically significant positive correlation between students' food and nutrition knowledge and breakfast energy adequacy ($p = 0.013$, $r = 0.314$). This weak-to-moderate positive correlation indicates that higher food and nutrition knowledge tended to correspond with better breakfast energy adequacy among primary school students. Previous study supports this finding, demonstrating that pediatric nutritional knowledge serves as a major driver that positively shapes actual breakfast habits and daily nutrient intake profiles (27). Conversely, a weak cognitive understanding of dietary concepts acts as a significant operational barrier, directly leading to poor dietary practices and irregular breakfast consumption patterns among young learners (25). When children are systematically equipped with a robust understanding of

morning meal priorities, they exhibit a significantly higher likelihood of maintaining adequate nutritional status and proper dietary habits (27). These findings suggest that strengthening children's understanding of healthy dietary practices may support more appropriate breakfast behaviors. However, because of the cross-sectional design, the observed correlation should not be interpreted as evidence of a causal relationship.

The clustering of dietary deficits among participants in the lower knowledge stratum, where all respondents with poor knowledge failed to achieve adequate breakfast thresholds and 37.1% of the total sample experienced both poor knowledge and severe energy deficit, further illustrates the pattern underlying the observed correlation. This energy insufficiency is consistent with previous evidence showing that skipping breakfast or consuming a macro-nutritionally inadequate morning meal is related to inadequate daily nutrient and essential mineral intakes (21,28). Because healthy breakfast consumers routinely secure between 32% and 41% of their entire daily energy requirements from the morning meal alone, any cognitive deficiency that disrupts this habit leaves children highly vulnerable to severe, chronic caloric deficits (20,28). Furthermore, the observation that adequate or excess energy consumption occurred exclusively within the moderate-knowledge stratum is consistent with the positive direction of the observed correlation, although it should not be interpreted as evidence that nutrition knowledge directly determines breakfast energy intake. This interpretation is particularly important because the good-knowledge group comprised only two participants, limiting subgroup-level conclusions. Therefore, within the GENIUS Programme framework, physical food provision may be complemented by continuous school-based nutrition education to strengthen students' nutrition knowledge and support appropriate breakfast practices (17,29).

This study has several limitations. The cross-sectional design allows the identification of correlations but does not permit causal inference. The use of secondary GENIUS Programme data also limited the researchers' control over the original data collection process, although enumerators received prior training and were supervised during field data collection. In addition, 55 of the initial 117 students (47.0%) were excluded because of incomplete required data, which may have introduced selection bias. The study was conducted in a single school, limiting the generalizability of the findings to other populations and GENIUS implementation settings. Finally, only two participants were classified as having good food and nutrition knowledge, which limits interpretation of this subgroup. Future studies involving larger and more diverse samples and longitudinal or intervention designs are needed to confirm these findings.

CONCLUSION

This study found a statistically significant, weak-to-moderate positive correlation between food and nutrition knowledge and breakfast energy adequacy among schoolchildren participating in the GENIUS Programme in Binjai ($p = 0.013$, $r = 0.314$). Despite most students having moderate nutrition knowledge, 75.8% experienced severe breakfast energy deficits. Given the cross-sectional design, these findings indicate a correlation rather than a causal relationship, while socio-demographic characteristics should be considered contextual factors rather than determinants of breakfast energy adequacy. The findings support the potential value of complementing food provision and nutrition education within the GENIUS Programme with structured parental engagement and economically tailored home-reinforcement activities to promote healthier breakfast practices.

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CONFLICTS OF INTEREST

The authors declare no conflict of interest.

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