

Effect of nutritious snacks provision on breakfast adequacy and nutritional status of elementary school students

Salwa Inayah Huda MA Parewasi¹, Hardinsyah Hardinsyah^{1*}, Ikeu Ekayanti¹

¹ Nutrition Study Program, Faculty of Medicine and Nutrition, IPB University, Indonesia

Corresponding Author Email: hardinsyah2010@gmail.com

Copyright: ©2026 The author(s). This article is published by Media Publikasi Cendekia Indonesia.

ORIGINAL ARTICLES

Submitted: 26 July 2025

Accepted: 10 December 2025

Keywords:

Breakfast Adequacy, GENIUS Program, Nutritional Status, School-aged Children, Snack Provision

OPEN ACCESS



This work is licensed under a [Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License](https://creativecommons.org/licenses/by-nc-sa/4.0/)

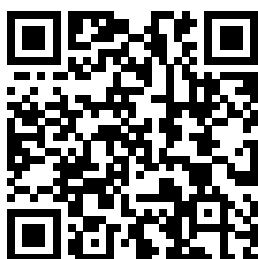
ABSTRACT

Inadequate breakfast intake and malnutrition remain significant public health concerns among school-aged children in Indonesia, particularly in regions with a high Prevalence of Undernourishment (PoU). To address this, the National Food Agency (BAPANAS) implemented the GENIUS program (Gerakan Edukasi dan Pemberian Pangan Bergizi untuk Siswa), which integrates nutrition education with the provision of standardized nutritious snacks. This study aims to analyze the impact of the GENIUS program on breakfast adequacy and nutritional status among elementary school students in ten Indonesian provinces with PoU exceeding 5%. A pre-experimental pre-post study design was employed, involving 4,953 students in grades 4-6. The intervention consisted of 20 nutrition education sessions and the daily provision of standardized snacks (250–300 kcal per serving) and UHT milk over a two-month period. Breakfast adequacy was assessed using 24-hour breakfast recalls. Snack compliance was also monitored daily. The intervention led to significant improvements in breakfast nutrient intake ($p < 0.05$). Mean energy intake increased from 141.9 kcal to 393.5 kcal, protein from 4.0 g to 11.5 g, fat from 5.6 g to 14.9 g, and carbohydrates from 17.7 g to 48.9 g. Substantial gains were also observed for key micronutrients, including calcium, phosphorus, and iron. Despite these dietary improvements, BMI-for-age z-scores showed no meaningful change (-0.2 ± 1.4 at baseline vs. -0.2 ± 1.5 at endline), consistent with the short duration of the intervention. Snack compliance was notably high, with 93.5% of students achieving high adherence ($\geq 70\%$). The GENIUS program effectively enhanced the quality and adequacy of breakfast among students in food-insecure regions. While the two-month duration was sufficient to improve nutrient intake, it was inadequate to produce measurable changes in nutritional status. Future programs should consider longer implementation periods and strengthened school-family engagement to support sustained improvements in growth outcomes.

Key Messages:

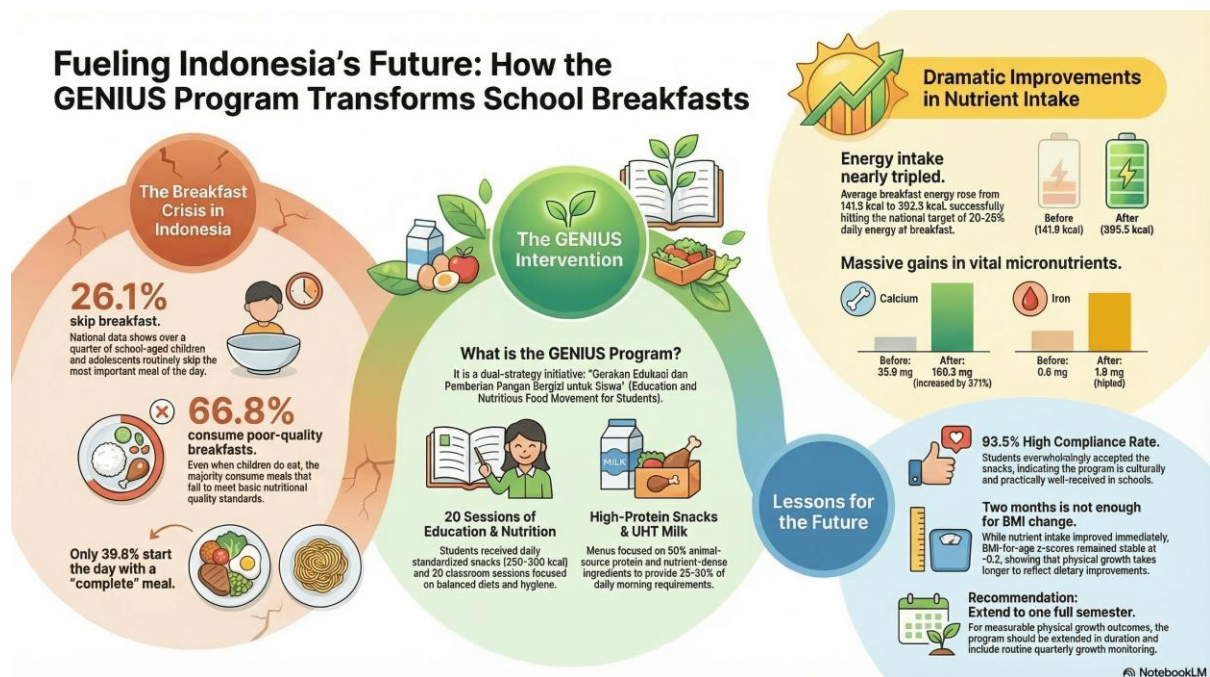
- The GENIUS program significantly improved breakfast quality by increasing the intake of energy, macronutrients, and micronutrients among primary school students.
- Despite improved dietary quality, the two-month intervention period was insufficient to produce measurable changes in BMI-for-age z-scores, underscoring the need for longer-term programs

Access this article online



Quick Response Code

GRAPHICAL ABSTRACT



INTRODUCTION

Malnutrition among school aged children remains a critical public health concern in Indonesia. According to the 2023 Indonesian Health Survey, 18.7% of children aged 5–12 years were classified as stunted, 11% as underweight, and 7.8% as overweight (1). These figures underscore the persistence of malnutrition beyond early childhood, continuing into the school-age years. One of the contributing factors is the inadequate quality and quantity of breakfast intake. Breakfast is essential in fulfilling 15-30% of children's daily energy requirements (2). Riset Kesehatan Dasar (Riskesdas) 2018 reported that 26.1% of school-aged children and adolescents in Indonesia routinely skip breakfast (3). Furthermore, the 2020 Total Diet Survey indicated that 47.7% of children aged 6–12 failed to meet minimum energy requirements at breakfast, while 66.8% consumed a breakfast of poor nutritional quality (4). These inadequacies are associated with reduced concentration, impaired academic performance, and suboptimal growth and development (5).

Breakfast insufficiency is closely linked to household food insecurity. The Prevalence of Undernourishment (PoU), which reflects the proportion of individuals consuming energy below minimum dietary requirements, remains high in Indonesia. In 2022, approximately 28.1 million Indonesians were classified as undernourished, underscoring persistent barriers to accessing nutritious foods (6). This situation places school-aged children that nutritionally vulnerable group undergoing rapid cognitive and physical development at particular risk (7).

In response to these issues, the National Food Agency launched the GENIUS program (*Gerakan Edukasi dan Pemberian Pangan Bergizi untuk Siswa*), a school-based initiative that integrates nutrition education with the provision of standardized nutritious snacks. This dual strategy is intended not only to supply an immediate source of nutrient-dense food but also to strengthen students' nutritional literacy. Improved knowledge and awareness may subsequently influence food choices at home, potentially encouraging children to select or request more adequate breakfasts. Thus, the program is theorized to enhance breakfast adequacy both directly, through snack provision that contributes to morning nutrient intake and indirectly, through behaviour change resulting from nutrition education.

Evidence from previous school-based interventions supports the potential of combining education with food provision to improve dietary behaviour and nutritional outcomes (8,9). However, many earlier programs have been limited by short implementation periods or inadequate monitoring of students' compliance with the provided foods, making it difficult to fully assess their effectiveness. Addressing these

gaps is essential for understanding how integrated interventions can produce sustainable improvements in children's dietary patterns.

This study aims to analyze the impact of the GENIUS program on breakfast adequacy and nutritional status among primary school students in ten provinces with PoU above 5%. Focusing on regions with higher undernourishment allows for an assessment of the program's relevance and effectiveness among the most nutritionally vulnerable populations, thereby strengthening its public health significance. This study gives more complete insight into how school nutrition programs work in practice and their impact on breakfast intake.

METHODS

This study employed a pre-experimental pre-post design without a control group. A comparison group could not be established because the GENIUS Program was implemented simultaneously across all selected schools by mandate of the National Food Agency. The study relied on secondary data that collected through the program, which introduces inherent limitations such as potential risks of reporting bias, variation in data completeness across provinces, and dependency on the accuracy of teacher and enumerator-recorded forms. The intervention was implemented over two months, from August to September 2024, in ten Indonesian provinces identified as having a Prevalence of Undernourishment (PoU) exceeding 5%, which consist of Aceh, West Sumatra, North Sumatra, South Sumatra, Lampung, East Java, West Java, South Sulawesi, West Sulawesi, and North Sulawesi. The study population comprised elementary school students in grades 4 to 6 enrolled in the targeted schools. From approximately 15,000 participating students, a total of 4,953 were purposively selected for analysis based on completeness of baseline and endline data and full participation in the intervention. Students were included if they were actively enrolled in the program, attended all components of the intervention, and obtained written informed consent from a parent or guardian, while those absent during data collection or withdrawing from participation were excluded.

The intervention consisted of integrated school-based nutrition education and the provision of standardized nutritious snacks. In line with the GENIUS program design, nutrition education was delivered in the classroom over 20 sessions using flip charts and leaflets developed at national level. Enumerators, classroom teachers, and local food agency representatives alternated as facilitators, following structured lesson plans. The curriculum covered four main themes: 1) the three functions of food (energy, growth, and regulation); 2) recommended meal frequency, the importance of breakfast, and how to choose a healthy snacks; 3) reducing food waste through wiser food consumption ("Yuk Stop Boros Pangan"); and 4) hygiene and healthy living behaviours (Perilaku Hidup Bersih dan Sehat, PHBS). Alongside education, students received one to two of a high-protein GENIUS snack and a box of UHT Milk on each school day during the 20-session intervention. Snacks were prepared by local suppliers following National Food Agency specifications and were designed to supply approximately 25-30% of recommended morning energy requirements. Menus followed a fixed cycle with an emphasis on 50% animal-source protein and nutrient-dense ingredients with additional of UHT Milk. The average energy and nutrient content of snacks was derived from standardized recipes.

The study analysis used secondary data collected routinely within the GENIUS program. Individual-level information on age, sex, daily pocket money, breakfast habits, and household sociodemographic characteristics (parental education and occupation) was obtained from structured questionnaires completed by students and their parents with guidance from trained field staff. Breakfast intake was assessed at baseline and endline using a 24-hour breakfast recall, in which students reported all foods and beverages consumed at breakfast on the previous day, including types and approximate quantities of each item. The recall was self-reported in the classroom using standardized forms, with enumerators and classroom teachers present to clarify questions and improve recall accuracy. Anthropometric measurements (body weight and height) were taken at baseline and endline by trained enumerators using digital scales and stadiometers according to standard procedures, and body mass index-for-age z-scores (BMI-for-age) were calculated to classify nutritional status (underweight, normal, overweight). Snack consumption compliance was recorded daily by classroom teachers using Comstock

observation forms; for each feeding day, the amount of leftover snack was noted, and cumulative leftovers across the 20 sessions were converted to a percentage of snack consumed (0–100%) for each student. This continuous percentage score was used in Spearman's rank correlation analyses with BMI-for-age z-scores, while descriptive analyses also categorized compliance as low (<50%), moderate (50–70%), and high (>70%).

Nutrition knowledge, attitudes, and practices were measured at baseline and endline using validated, structured KAP questionnaires developed at national level for the GENIUS program. Data were entered and cleaned in Microsoft Excel 2019 and analysed using IBM SPSS Statistics version 25.0. Data management included coding of all variables, range and consistency checks, and exclusion of records with missing or implausible values on key outcomes (breakfast intake, snack compliance, anthropometry). Descriptive statistics (means, standard deviations, and proportions) were used to characterise the study population and summarise breakfast adequacy and nutritional status at baseline and endline. Paired t-tests were applied to assess pre–post differences in energy and nutrient intake, breakfast adequacy, and BMI-for-age z-scores; for variables with markedly skewed distributions, non-parametric alternatives were considered. The association between snack compliance and nutritional status was examined using Spearman's rank correlation coefficient.

A two-sided p-value <0.05 was considered statistically significant. Considering this analysis relied on secondary program data, several methodological limitations should be acknowledged: the research team had limited control over the timing and standardisation of data collection across sites, the completeness and accuracy of routine records, and the ability to adjust for unmeasured confounders. Incomplete or inconsistent records were excluded from analysis, which may introduce selection bias, and self-reported breakfast recall data are subject to recall and social desirability bias.

CODE OF HEALTH ETHICS

Ethical approval for secondary analysis of the GENIUS program data was obtained from the Health Research Ethics Committee of Universitas Muhammadiyah Semarang (Approval No. 519/KE/07/2024). Participation in the program was voluntary, and written informed consent was obtained from parents or legal guardians of all participating students.

RESULTS

Participant Characteristics

A total of 4,953 elementary school students participated in the study (Table 1). The gender distribution was nearly equal, with 49.8% boys and 50.2% girls. In terms of age, 46.7% of students were 10 years or younger, 34.4% were 11 years old, and 18.9% were 12 years or older, representing a typical upper-primary school profile.

More than half of the students (52.2%) reported receiving a daily allowance of IDR 5,001–10,000, while 33.3% received more than IDR 10,000. Only 5.0% reported receiving less than IDR 2,500 per day. Breakfast habits also varied: 63.7% reported eating breakfast daily (≥ 5 times/week), 29.3% reported eating breakfast less regularly, and 7.0% reported never having breakfast.

The nutritional completeness of breakfast was generally low. A total of 60.4% of students consumed nutritionally incomplete breakfasts consisting solely of staple foods, or staple foods with protein but without vegetables or fruit. Only 39.6% consumed nutritionally complete breakfasts that included carbohydrates, protein, vegetables, and fruit. Snack consumption compliance during the intervention was notably high. A total of 93.5% of students achieved high compliance ($\geq 70\%$), 3.4% showed moderate compliance (50–70%), and 3.1% had low compliance (<50%), indicating strong acceptability of the standardized snacks.

Table 1. Participants' Characteristics

Characteristic	n	%
Gender		
Male	2466	49.8
Female	2487	50.2
Total	4953	100.0
Age (Years Old)		
<=10	2315	46.7
11	1701	34.4
>=12	937	18.9
Total	4953	100.0
Pocket money		
< IDR 2500	249	5.0
IDR 2500 - IDR 5000	472	9.5
IDR 5001 - IDR 10000	2583	52.2
> IDR 10000	1649	33.3
Total	4953	100.0
Breakfast habit		
Always (≥ 5 times/week)	3153	63.7
Sometimes (< 5 times/week)	1451	29.3
Never	349	7.0
Total	4953	100.0
Breakfast quality		
Carbohydrate only (staple food)	481	9.7
Carbohydrate, protein (side dish)	984	19.9
Carbohydrate, protein, vegetables	1527	30.8
Carbohydrate, protein, vegetables, fruit	1961	39.6
Total	4953	100.0
Snack Compliance (%)		
Low (<50)	155	3.1
Moderate (50-70)	167	3.4
High (≥ 70)	4631	93.5
Total	4953	100.0

Nutrient Adequacy of Breakfast Before and After the Intervention

Table 2 presents baseline breakfast nutrient intake. Breakfast contributed only a small proportion of daily nutrient requirements. Mean energy intake was 141.9 ± 76.1 kcal, representing 7.7% of the daily RDA and falling below the recommended 20–25% morning energy contribution for school-aged children. Protein, fat, and carbohydrate intakes each contributed less than 10% of daily requirements. Micronutrient intake was also low, particularly calcium (3.2% of RDA) and vitamin C (3.5% of RDA). These findings indicate that most students began the day with breakfasts that were insufficient in both energy and essential nutrients.

Table 2. Mean Breakfast Nutrient Intake and Contribution to Recommended Intake at Baseline

Variable	Breakfast Intake (Mean \pm SD)	Breakfast RDA (%)	Daily RDA (%)
Energy (kcal)	141.9 \pm 76.1	34.1	7.7
Protein (g)	4.0 \pm 3.3	36.8	8.3
Fat (g)	5.7 \pm 4.3	41.1	9.2
Carbohydrate (g)	17.7 \pm 13.4	28.4	6.4
Vitamin A (RE)	149.4 \pm 193.3	124.5	28.0
Vitamin C (mg)	1.7 \pm 5.1	15.6	3.5
Calcium (mg)	35.9 \pm 74.9	14.1	3.2
Phosphorus (mg)	60.9 \pm 59.8	27.1	6.1
Iron (mg)	0.6 \pm 0.8	30.7	6.9

Breakfast intake after the intervention is summarized in Table 3. All nutrient categories showed substantial increases compared with baseline values. At endline, the breakfast recall reflected both foods consumed at home and the nutrient-dense snack provided at school. Mean energy intake increased to 393.5 ± 387.9 kcal, contributing 21.3% of daily requirements, which aligns with national breakfast recommendations. Protein, fat, and carbohydrate intakes each contributed more than 17% of daily requirements.

Micronutrient intake also improved. Notable increases were observed for calcium, phosphorus, iron, and vitamin A, although vitamin C intake remained low. Overall, these results suggest that the combined education sessions and standardized snack provision improved the nutrient quality of students' breakfast intake. However, because dietary intake was measured using a single 24-hour recall at each time point, some degree of recall bias is possible.

Table 3. Mean Breakfast Nutrient Intake and Contribution to Recommended Intake at Baseline

Variable	Breakfast Intake (Mean \pm SD)	Breakfast RDA (%)	Daily RDA (%)
Energy (kcal)	393.5 \pm 387.9	94.5	21.3
Protein (g)	11.5 \pm 13.1	105.8	23.8
Fat (g)	14.9 \pm 16.5	107.3	24.1
Carbohydrate (g)	48.9 \pm 51.0	78.5	17.7
Vitamin A (RE)	195.3 \pm 625.3	162.8	36.6
Vitamin C (mg)	1.4 \pm 3.9	12.9	2.9
Calcium (mg)	169.3 \pm 527.6	66.4	14.9
Phosphorus (mg)	198.2 \pm 315.1	88.1	19.8
Iron (mg)	1.9 \pm 3.9	97.1	21.8

Table 4 shows clear improvements of nutrient intake before and after the intervention. All nutrients increased significantly ($p < 0.05$). Large effect sizes were observed for energy ($d = 0.9$) and the major macronutrients: protein ($d = 0.8$), fat ($d = 0.7$), and carbohydrates ($d = 0.8$), indicating substantial improvements in morning dietary intake. Micronutrient improvements varied: phosphorus ($d = 0.6$) and iron ($d = 0.5$) showed moderate effects, calcium ($d = 0.3$) showed a smaller effect, and vitamin A and vitamin C showed minimal changes. These patterns indicate that the standardized snack contributed meaningfully to increasing the overall nutrient density of students' breakfasts.

Table 4. Nutrient Adequacy of Breakfast Before and After the GENIUS Program Intervention

Variable	Baseline (Mean \pm SD)	Endline (Mean \pm SD)	<i>p</i> -value	Adjusted effect size (Cohen's <i>d</i>)
Energy (kcal)	141.9 \pm 76.1	393.5 \pm 387.9	0.000	0.9
Protein (g)	4.0 \pm 3.3	11.5 \pm 13.1	0.000	0.8
Fat (g)	5.6 \pm 4.3	14.9 \pm 16.5	0.000	0.7
Carbohydrate (g)	17.7 \pm 13.4	48.9 \pm 51.0	0.000	0.8
Vitamin A (RE)	149.4 \pm 193.3	195.3 \pm 625.3	0.000	0.1
Vitamin C (mg)	1.7 \pm 5.1	1.4 \pm 3.9	0.002	0.1
Calcium (mg)	35.9 \pm 74.9	169.3 \pm 527.6	0.000	0.3
Phosphorus (mg)	60.9 \pm 59.8	198.2 \pm 315.1	0.000	0.6
Iron (mg)	0.6 \pm 0.8	1.9 \pm 3.9	0.000	0.5

Nutritional Status Changes of Participants

The mean BMI-for-age z-scores of students before and after the intervention are shown in Table 5. The baseline mean z-score was -0.2 ± 1.4 and remained -0.2 ± 1.5 at endline. Despite the statistically significant *p*-value produced by the paired *t*-test ($p = 0.000$), the near-identical means and overlapping standard deviations indicate no meaningful change in nutritional status over the two-month period. This suggests that the intervention duration may have been too short to produce measurable anthropometric change at the population level.

Spearman's rank correlation was used to examine the association between snack compliance and BMI-for-age z-scores. A weak positive correlation was observed ($r = 0.035$, $p = 0.015$), indicating that students with higher snack compliance tended to have slightly higher BMI-for-age values, although the magnitude of this association was very small. This corrected estimate reflects an expected weak relationship and suggests that while high compliance supported improved dietary intake, its short-term effect on growth outcomes was limited.

Table 5. Mean BMI-for-Age z-Scores of Students Before and After the Intervention

Variable	Baseline	Endline	<i>p</i> -value	Correlation Coefficient (<i>r</i>) with Compliance	<i>p</i> -value
	(Mean ± SD)	(Mean ± SD)			
Z-Score (IMT/U)	-0.2 ± 1.4	-0.2 ± 1.5	0.000	0.035	0.015

DISCUSSION

Breakfast Habits and Quality Among Participants

This study shows a clear gap between the high frequency of breakfast consumption and the low nutritional completeness of students' morning intake. Although most students reported eating breakfast regularly, many consumed nutritionally incomplete breakfasts, typically consisting of staple foods alone or staple foods with protein but without vegetables or fruit. This pattern indicates that the issue is not whether students eat breakfast, but the quality of the foods they consume. Such patterns may be influenced by limited food access, low dietary literacy, rushed morning routines, and household food insecurity, especially in economically vulnerable families (10).

Given these constraints, school-based programs that combine nutrition education with practical food support are highly relevant. The GENIUS program addresses both challenges simultaneously: nutrition education improves understanding of balanced morning intake, while the standardized nutritious snack offers a direct, accessible example of what a nutrient-dense breakfast component looks like. This combination may help students form healthier preferences over time, particularly in areas where access to nutritious foods is limited. Long-term gains may be strengthened through parental involvement and a supportive school food environment, which together influence children's daily dietary behaviour.

These findings are supported by previous studies showing that many Indonesian school-aged children consume breakfasts that lack key food groups (11,12). Other evidence indicates that nutritious breakfasts paired with nutrition education can improve dietary behaviour and support academic performance (13,14).

Breakfast Nutrient Adequacy Among Participants

The GENIUS program produced substantial improvements in breakfast nutrient intake, demonstrating the effectiveness of structured, school-based interventions. As reflected in Tables 2–4, energy intake increased from 141.9 kcal at baseline to 393.5 kcal at endline, alongside meaningful increases in protein, fat, carbohydrates, and key micronutrients. These results indicate that the intervention successfully raised breakfast nutrient intake to levels closer to national recommendations. This improvement is particularly important given that Table 1 shows more than 60% of students consumed nutritionally incomplete breakfasts before the program began.

The combination of direct food provision and nutrition education appears central to these improvements. Although the study design does not separate the independent effects of education and snack provision, the great improvement suggests a synergistic effect. The nutritious snack likely reinforced the educational messages students received. Students learned what a balanced breakfast should include and then immediately experienced it through daily consumption of the standardized snack. This combination may have contributed to the high compliance rate and the substantial nutrient gains observed.

These findings align with previous research indicating that combining food provision with nutrition education can effectively improve dietary quality among school-aged children (15). Schools play a pivotal role in shaping dietary behaviour, especially in settings where household food security may be limited. For many students, school-provided foods may represent one of the few reliable sources of

balanced nutrition. Programs such as GENIUS should be viewed not merely as supplementary but as integral to broader public health strategies aimed at improving child nutrition. Even though the intervention duration was short, the marked improvements in morning nutrient intake underscore the potential of well-structured programs to yield meaningful dietary benefits, especially in vulnerable populations. School-based food provision when implemented consistently and supported by nutrition education, can substantially enhance dietary quality (5).

Nutritional Status of Participants

Despite significant improvements in nutrient intake, BMI-for-age z-scores did not change meaningfully during the two-month intervention (Table 5).

The baseline mean BMI-for-age was -0.2 ± 1.4 and remained -0.2 ± 1.5 at endline, indicating no detectable change in growth status. Although the paired t-test produced a statistically significant p-value ($p = 0.000$), the nearly identical means and overlapping standard deviations show that the intervention did not result in meaningful anthropometric improvement. This outcome is expected given the short program duration. Anthropometric indicators such as BMI-for-age generally reflect longer-term patterns of energy balance, growth velocity, illness, and physical activity. Because these indicators change slowly, short-term increases in nutrient intake are unlikely to translate into measurable shifts in BMI within a limited timeframe. This finding aligns with previous research indicating that meaningful changes in anthropometric measurements typically require longer intervention durations and sustained dietary improvements (16). As a result, short-term interventions may not produce immediate or statistically significant effects on growth indicators, even when dietary intake improves (17).

The dietary improvements observed in this study should therefore be viewed as an essential early step toward improving nutritional status. To detect meaningful anthropometric changes, children would likely require sustained access to nutrient-dense foods and continued improvements in dietary habits over several months. Future evaluations of the GENIUS program would benefit from longer implementation periods and extended follow-up to capture gradual changes in growth outcomes. Incorporating additional indicators such as dietary diversity, physical activity patterns, or family support may also provide valuable insights into the broader impact of school-based nutrition programs (18–20).

This finding is consistent with prior research showing that short-term school-based nutrition interventions rarely produce rapid changes in BMI, while multi-component programs lasting six months or more are more effective in improving anthropometric indicators which concluded that short-term school-based interventions are unlikely to produce significant changes in body mass index (BMI) or related anthropometric measures(16) These results reinforce the need for sustained, multi-component interventions that combine nutrition education, improvements in program delivery, and active family engagement to achieve meaningful long-term improvements in children's nutritional status.

Association Between Snack Compliance and Nutritional Status

This study identified a positive but weak correlation between snack compliance and BMI-for-age z-scores ($r = 0.035$; $p = 0.015$). Although the effect size was small, the direction of association suggests that students who consumed a greater proportion of their provided snacks tended to have slightly better nutritional status. Several factors may influence individual compliance, including food preferences, the consistency of program delivery within schools, teacher support, and peer dynamics(21,22). External factors such as access to non-program snacks and socioeconomic conditions may also affect both compliance and nutritional status, making the relationship between these variables more complex (23,24).

These findings highlight the need to strengthen program delivery and student engagement to support consistently high compliance. Ensuring that snacks are distributed reliably, remain appealing to students, and are reinforced through supportive messaging from teachers and families may help improve adherence and enhance the nutritional impact of the intervention. Although the correlation between compliance and BMI-for-age was statistically significant, the very small effect size and the absence of meaningful change in average BMI-for-age z-scores indicate that short-term increases in dietary intake are unlikely to produce measurable anthropometric improvements at the population level.

The two-month duration of the intervention likely limited its ability to influence anthropometric outcomes. Evidence from previous research indicates that meaningful improvements in BMI-for-age typically emerge from longer interventions, often six months or more, combined with sustained behavioural and environmental support (25) Although the average z-scores for BMI-for-age did not change significantly, the correlation between snack compliance and nutritional status suggests that the intervention may have a more noticeable effect on individual students over time.

Evidence from earlier research also indicates that greater adherence to school meal programs and healthier eating patterns is associated with better nutritional outcomes among children and adolescent (25,26). These findings reinforce that school-based nutrition initiatives can positively influence children's nutritional status, particularly when students consistently participate and compliance is maintained throughout the intervention period.

CONCLUSION

The GENIUS program effectively improved the nutritional adequacy of breakfast among elementary school students living in provinces with high undernourishment prevalence. After the two-month intervention, students showed substantial increases in breakfast energy intake as well as notable gains in protein, fat, carbohydrates, and key micronutrients. These results indicate that combining nutrition education with the provision of standardized, nutritious snacks can meaningfully enhance the quality of children's morning dietary intake, particularly in populations where breakfasts are nutritionally incomplete.

No meaningful change in BMI-for-age z-scores was observed over the intervention period, with mean values remaining at stable from baseline to endline. This outcome aligns with the understanding that anthropometric indicators change gradually and require sustained improvements in dietary intake and energy balance. Snack compliance demonstrated a statistically significant but very weak positive correlation, indicating minimal practical influence on short-term growth outcomes. While higher adherence may support individual nutritional gains, a two-month exposure is insufficient for population-level anthropometric improvement.

These findings highlight that improving dietary quality is an essential foundation for achieving longer-term gains in nutritional status. To strengthen future implementation, extend the GENIUS program to at least one academic semester and incorporate routine growth monitoring such as quarterly BMI assessments. Reinforcing school-family engagement and maintaining strong educational components may further enhance behavioural change and support sustained improvements in child nutrition. Through these refinements, the GENIUS program can more effectively support long-term anthropometric improvements in vulnerable regions.

FUNDING

This research was funded by the National Food Agency of Indonesia (Badan Pangan Nasional).

ACKNOWLEDGMENTS

The authors would like to express their sincere gratitude to the Indonesian Association of Nutrition Higher Education Institutions (AIPGI) and the National Food Agency (BAPANAS) as the organisers of the GENIUS program, whose support made this research possible.

CONFLICTS OF INTEREST

The authors declare no conflict of interest.

REFERENCES

1. Kebijakan Pembangunan B, Kementerian K, Ri K. Survei Kesehatan Indonesia (SKI) dalam Angka. 2023.

2. Harahap H, Widodo Y, Sandjaja S, Khouw I, Deurenberg P. Quantity And Quality Of Breakfast Of Children Aged 2.0 To 12.9 Years In Indonesia. *Gizi Indonesia* [Internet]. 2 Juli 2019;42(1):31. Tersedia pada: https://persagi.org/ejournal/index.php/Gizi_Indon/article/view/355
3. Kemenkes. Riskesdas 2018 dalam angka, Indonesia [Internet]. 2018 [dikutip 13 Juli 2024]. Tersedia pada: https://efaidnbmnnnibpcajpcgglefindmkaj/https://dinkes.babelprov.go.id/sites/default/files/dokumen/bank_data/20181228%20-%20Laporan%20Riskesdas%202018%20Nasional-1.pdf
4. Badan Pangan Nasional. Siapkan Generasi Emas 2045, NFA Dorong Budaya Sarapan Bergizi Sejak Usia Dini. 2023.
5. Indriasari R, Nadjamuddin U, Arsyad DS, Iswarawanti DN. School-based nutrition education improves breakfast-related personal influences and behavior of Indonesian adolescents: A cluster randomized controlled study. *Nutr Res Pract*. 1 Oktober 2021;15(5):639–54.
6. BAPPENAS. Laporan Pelaksanaan Pencapaian Tujuan Pembangunan Berkelanjutan/ Sustainable Development Goals (TPB/SDGs) Tahun 2023 [Internet]. Jakarta; 2023. Tersedia pada: <https://sdgs.bappenas.go.id/website/wp-content/uploads/2023/11/Laporan-tahunan-SDGs-2023.pdf>
7. Royer MF, Guerithault N, Braden BB, Laska MN, Bruening M. Food Insecurity Is Associated with Cognitive Function: A Systematic Review of Findings across the Life Course. *International Journal of Translational Medicine*. 9 November 2021;1(3):205–22.
8. Zenebe M, Gebremedhin S, Henry CJ, Regassa N. School feeding program has resulted in improved dietary diversity, nutritional status and class attendance of school children. *Ital J Pediatr* [Internet]. 23 Desember 2018;44(1):16. Tersedia pada: <https://ijponline.biomedcentral.com/articles/10.1186/s13052-018-0449-1>
9. Andueza N, Navas-Carretero S, Cuervo M. Effectiveness of Nutritional Strategies on Improving the Quality of Diet of Children from 6 to 12 Years Old: A Systematic Review. Vol. 14, *Nutrients*. MDPI; 2022.
10. Dykstra H, Davey A, Fisher JO, Polonsky H, Sherman S, Abel ML, dkk. Breakfast-skipping and selecting low-nutritional-quality foods for breakfast are common among low-income urban children, regardless of food security status. *Journal of Nutrition*. 2016;146(3):630–6.
11. Hardinsyah, Aries M. Jenis Pangan Sarapan Dan Perannya Dalam Asupan Gizi Harian Anak Usia 6-12 Tahun Di Indonesia (Type of food for breakfast and its roles in daily nutrient intakes of school age children 6-12 years in Indonesia). Juli 2012;2(7).
12. Perdana F, Hardinsyah H. Analisis Jenis, Jumlah, Dan Mutu Gizi Konsumsi Sarapan Anak Indonesia. *Jurnal Gizi dan Pangan* [Internet]. 29 November 2013;8(1):39. Tersedia pada: <http://journal.ipb.ac.id/index.php/jgizipangan/article/view/7251>
13. Jiang Z, Song C, Shi M, Chen R, Hong Y, Zhang C, dkk. Effect of Customized Nutritious Breakfast and Nutrition Education on Nutritional Status of Preschool Children in Economically Underdeveloped Multi-Ethnic Areas: A Cluster Randomized Clinical Trial in Linxia, China. *Nutrients*. 1 Juli 2024;16(14).
14. Ong RT, Lao S, Seow SK, Dav VS, Ling MH. Systematic Review of PubMed Articles Prior to 2023 on Effects of Breakfast on School Performance. *Medicon Medical Sciences* [Internet]. 26 Desember 2023; Tersedia pada: <https://themedicon.com/pdf/medicinalsciences/MCMS-06-183.pdf>
15. Liao SF, Tseng HM, Chen JD, Chen CM, Li SC. A Pilot Evaluation of a School-Based Nutrition Education Program with Provision of Fruits and Vegetables to Improve Consumption Among School-Age Children in Palau. *Nutrients*. 1 Maret 2025;17(6).
16. Nally S, Carlin A, Blackburn NE, Baird JS, Salmon J, Murphy MH, dkk. The effectiveness of school-based interventions on obesity-related behaviours in primary school children: A systematic review and meta-analysis of randomised controlled trials. *Children*. 1 Juni 2021;8(6).
17. Millward DJ. Nutrition, infection and stunting: the roles of deficiencies of individual nutrients and foods, and of inflammation, as determinants of reduced linear growth of children. *Nutr Res Rev*

- [Internet]. 23 Juni 2017;30(1):50–72. Tersedia pada: https://www.cambridge.org/core/product/identifier/S0954422416000238/type/journal_article
18. Schultz L, Ruel-Bergeron J. Considerations for Monitoring School Health and Nutrition Programs. *Front Public Health*. 16 Juli 2021;9.
 19. Karpouzis F, Anastasiou K, Lindberg R, Walsh A, Shah S, Ball K. Effectiveness of School-based Nutrition Education Programs that Include Environmental Sustainability Components, on Fruit and Vegetable Consumption of 5–12YearOld Children: A Systematic Review. *J Nutr Educ Behav*. 1 Juli 2025;57(7):627–42.
 20. Barnes C, Mccrabb S, Stacey F, Nathan N, Yoong SL, Grady A, dkk. Improving implementation of school-based healthy eating and physical activity policies, practices, and programs: a systematic review. Vol. 11, *Translational Behavioral Medicine*. Oxford University Press; 2021. hlm. 1365–410.
 21. Cotton W, Dudley D, Peralta L, Werkhoven T. The effect of teacher-delivered nutrition education programs on elementary-aged students: An updated systematic review and meta-analysis. *Prev Med Rep*. 1 Desember 2020;20.
 22. Devine LD, Gallagher AM, Briggs S, Hill AJ. Factors that influence food choices in secondary school canteens: a qualitative study of pupil and staff perspectives. *Front Public Health*. 2023;11.
 23. Bila S, Rahma C. The Relationship Between Snacks Consumption Patterns And Nutritional Status In Paya Peunaga Elementary School Children In Meureubo Sub-District. 2024;25–6.
 24. Erda R, Hamidi D, Desmawati D, Rasyid R, Sarfika R. Evaluating socio-demographic, behavioral, and maternal factors in the dual burden of malnutrition among school-aged children in Batam, Indonesia. *Narra J* [Internet]. 21 Februari 2025;5(1):e2049. Tersedia pada: <https://narraj.org/main/article/view/2049>
 25. Katsagoni CN, Psarra G, Georgoulis M, Tambalis K, Panagiotakos DB, Sidossis LS. High and moderate adherence to Mediterranean lifestyle is inversely associated with overweight, general and abdominal obesity in children and adolescents: The MediLIFE-index. *Nutrition Research* [Internet]. Januari 2020;73:38–47. Tersedia pada: <https://linkinghub.elsevier.com/retrieve/pii/S0271531719305135>
 26. Mohammed B, Belachew T, Kedir S, Abate KH. Effect of school feeding program on body mass index of primary school adolescents in Addis Ababa, Ethiopia: A prospective cohort study. *Front Nutr* [Internet]. 9 Januari 2023;9. Tersedia pada: <https://www.frontiersin.org/articles/10.3389/fnut.2022.1026436/full>