

Research Article

Evaluation of the Effectiveness of the Free Nutritious Meal Program in Improving Students' Cognitive Abilities Based on Nutritional Status

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Abstract: This study evaluates the effectiveness of the Free Nutritious Meal Program (MBG) in improving students' cognitive abilities based on nutritional status in Brangsong Village, Indonesia. The research used a mixed-methods approach, combining quantitative and qualitative designs. Quantitative data were collected from 30 student beneficiaries via questionnaires and analyzed using descriptive statistics and Pearson correlation coefficients. Qualitative data were gathered through in-depth interviews with managers of the Nutrition Fulfillment Service Unit (SPPG), school authorities, students, and parents, and analyzed thematically. The results show a positive and significant relationship between nutritional status and academic achievement, but no significant relationship with students' cognitive ability. Nutrient intake, however, was positively and significantly associated with both cognitive ability and academic achievement. The strongest relationship was observed between cognitive ability and academic achievement. These findings suggest that the MBG program effectively supports academic achievement by improving nutrient intake and cognitive ability. However, its impact on students' nutritional status has not been uniformly distributed.

Keywords: Academic Achievement; Nutrient Intake; Nutritional Status; School Nutrition Program; Students' Cognitive Ability.

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1. Introduction

Improving the quality of human resources is a national strategic issue and a top priority in Indonesia's development agenda. The Indonesian government places human development at the core of the Indonesia Gold 2045 vision, focusing on improving education, health, and social welfare. One of the main indicators of human resource quality is the cognitive ability of the younger generation, which is reflected in students' academic achievement. However, students' cognitive abilities are influenced not only by formal education but also by health conditions and nutritional status. Various reports indicate that nutritional problems, particularly among school-age children, remain a national challenge that directly affects learning ability, concentration, and students' capacity to absorb lessons at school (UNICEF, 2021). In this context, the Free Nutritious Meal Program (MBG) is a strategic government policy aimed at improving schoolchildren's nutritional status and enhancing educational quality in a sustainable manner.

The Free Nutritious Meal Program is designed as a cross-sectoral intervention that integrates health, education, and social welfare. The program is expected to ensure that students' daily nutritional needs are met, especially in rural areas and regions with relatively high nutritional vulnerability. Brangsong Village, as one of the areas implementing the nutrition fulfillment program, faces real challenges in improving students' academic achievement. Based on preliminary observations and local school reports, significant variation

in students' academic performance persists despite relatively adequate access to formal education. This condition indicates that non-academic factors, particularly nutritional status, may play a role in influencing students' cognitive abilities in Brangsong Village.

The gap observed in Brangsong Village is reflected in the mismatch between the availability of nutrition fulfilment programs and students' academic achievement. On the one hand, the Free Nutritious Meal Program has been implemented and facilitated through the Nutrition Fulfillment Service Unit (SPPG). On the other hand, students' learning outcomes have not shown uniform improvement. Some students with relatively good nutritional status still demonstrate low academic performance, while others with poorer nutritional status achieve relatively good academic results. This phenomenon indicates a discrepancy between the program's objectives and the outcomes achieved in the field, necessitating a systematic evaluation of program effectiveness. This gap also raises a fundamental question about the extent to which the Free Nutritious Meal Program truly improves students' cognitive abilities, given their nutritional status.

Theoretically, the relationship between nutrition and cognitive ability can be explained by Human Capital Theory, which holds that investment in health and nutrition yields long-term gains in productivity and cognitive capacity (Becker, 1993). Children with good nutritional status have greater opportunities to develop optimally, both physically and mentally. In addition, Cognitive Development Theory emphasises that children's cognitive development is strongly influenced by biological and environmental factors, including adequate nutrient intake (Piaget, 1970). In this context, nutritional status is a critical prerequisite for optimising learning and cognitive development.

Conceptually, nutritional status affects students' nutrient intake, including protein, energy, vitamins, and minerals. Adequate nutrient intake contributes to brain function, concentration, memory, and problem-solving ability. Optimal cognitive ability is then reflected in students' academic achievement. The Free Nutritious Meal Program serves as an intervention variable to improve students' nutritional status, thereby indirectly enhancing cognitive ability and academic achievement. Thus, program effectiveness is largely determined by the interconnection and consistency among nutritional status, cognitive ability, and learning outcomes.

Several previous studies have examined the relationship between nutritional status and academic achievement. Grantham-McGregor et al. (2007) found that malnutrition among school-age children significantly affects cognitive development and academic outcomes. Best et al. (2011) reported that school-based nutrition interventions have the potential to improve concentration and cognitive function. However, most of these studies were conducted at national or cross-country levels and may not fully reflect village-level conditions. Furthermore, many studies emphasise the direct relationship between nutrition and academic achievement, yet few evaluate the effectiveness of nutrition fulfilment programs as public policies.

A research gap also exists due to the limited number of studies integrating evaluations of nutritious meal programs with analyses of cognitive abilities based on students' nutritional status. Adelman et al. (2019), for example, focused on the impact of school feeding programs on attendance and participation rather than on cognitive ability. Meanwhile, local studies in Indonesia tend to rely solely on academic achievement indicators without linking them to cognitive mechanisms influenced by nutritional status (Sukandar et al., 2015). Therefore, there is significant research potential to evaluate the effectiveness of the Free Nutritious Meal Program through a more comprehensive, contextual approach.

Brangsong Village was selected as the research locus due to its relevance to the study's objectives. The village actively implements the Free Nutritious Meal Program and operates an Nutrition Fulfillment Service Unit (SPPG). The existence of the SPPG enables direct observation of the provision and distribution of nutritious food and their relationship with students' conditions. Moreover, the variation in students' nutritional status and academic achievement provides an appropriate context for in-depth analysis of program effectiveness.

The Nutrition Fulfillment Service Unit (SPPG) Building in Brangsong Village was selected as the research object based on its strategic role in program implementation. The SPPG serves as a centre for menu planning, nutritional fulfilment, and coordination with schools. By focusing on the SPPG, evaluation can be conducted comprehensively, from program inputs and implementation processes to outcomes such as changes in nutritional status and students' cognitive abilities. Thus, this study is expected to contribute scientifically and practically to the evaluation of the effectiveness of the Free Nutritious Meal Program and to serve as an evidence-based policy recommendation at both the village and national levels.

Based on the above discussion, the main research question is formulated as follows: “How effective is the Free Nutritious Meal Program in improving students’ cognitive abilities based on nutritional status in Brangsong Village?” The research title is: Evaluation of the Effectiveness of the Free Nutritious Meal Program in Improving Students’ Cognitive Abilities Based on Nutritional Status in Brangsong Village.

2. Literature Review

Human Capital Theory

Human Capital Theory views humans as productive assets whose value can be enhanced through investments in education, health, and nutrition. Becker (1993) states that expenditures on education and health are not merely consumption but long-term investments that generate economic and social returns. In the context of school-age children, investment in nutrition plays a fundamental role because health conditions and adequate nutrition determine an individual’s physical and mental capacity in the learning process. Good nutritional status enables children to have optimal energy, concentration, and endurance to participate effectively in learning activities. Conversely, malnutrition can reduce learning productivity, slow cognitive development, and lead to lower academic achievement. Therefore, school-based nutritious meal programs can be viewed as an early investment in human capital aimed at improving the quality of future human resources. Within this theoretical framework, improving nutritional status through adequate nutrient intake is expected to enhance students’ cognitive abilities, which in turn positively affects academic achievement and long-term productivity.

Cognitive Development Theory

Cognitive Development Theory, proposed by Piaget, explains that children’s thinking develops through specific stages shaped by biological and environmental factors (Piaget, 1970). Cognitive development includes mental processes such as attention, memory, reasoning, and problem-solving. This development occurs gradually and requires supportive biological conditions, including good health and adequate nutrition. Adequate nutrient intake plays an important role in the development of brain structure and function, particularly during the growth period of school-age children. Deficiencies in essential nutrients can hinder cognitive development and reduce learning capacity. In the educational context, this theory emphasises that a supportive learning environment—including meeting nutritional needs—is essential for children to achieve their optimal cognitive potential. Therefore, school-based nutrition programs serve as environmental stimuli that contribute to students’ cognitive development and support academic success.

Nutritional Status

Nutritional status refers to an individual’s health condition determined by the balance between nutrient intake and the body’s nutritional requirements, as well as the body’s ability to utilise those nutrients. The nutritional status of school-age children is commonly measured using anthropometric indicators such as weight-for-age, height-for-age, and body mass index-for-age (WHO, 2007). Good nutritional status reflects the fulfilment of nutrients required for physical growth and the development of bodily functions. Nutritional status is closely related to nutrient intake, as the quality and quantity of food consumed directly influence an individual’s nutritional condition. In addition, nutritional status is associated with students’ cognitive abilities. Children with good nutritional status tend to have better concentration, memory, and learning endurance than those with poor nutritional status (Grantham-McGregor et al., 2007). Within the conceptual framework, nutritional status functions as an intermediate variable linking nutrient intake with cognitive ability and students’ academic achievement.

Nutrient Intake

Nutrient intake refers to the amount and types of nutrients consumed by individuals through food and beverages to meet the body’s physiological needs. Nutrients include energy, protein, fat, carbohydrates, vitamins, and minerals, each of which has specific functions in supporting growth and bodily functions (Almatsier, 2011). For school-age children, adequate nutrient intake is particularly important because they are in a period of rapid physical growth and cognitive development. Nutrient intake is a primary determinant of nutritional status. Inadequate intake can lead to poor nutritional status, whereas balanced intake supports optimal nutritional status. Moreover, nutrient intake directly influences cognitive ability through its role in brain development and neural function (Best et al., 2011). Within the conceptual relationship, nutrient intake serves as the initial input that affects nutritional status, which, in turn, impacts cognitive ability and students’ academic achievement.

Students' Cognitive Ability

Students' cognitive ability refers to the mental capacity to think, understand, remember, reason, and solve problems. This ability constitutes the fundamental basis for successful learning processes (Piaget, 1970). Cognitive ability develops gradually and is influenced by biological, psychological, and environmental factors. Cognitive ability is closely related to nutritional status and nutrient intake. Adequate nutrient intake supports brain development and function, thereby enhancing students' concentration, attention, and memory. Good nutritional status reflects optimal biological conditions for cognitive development. Within the research framework, cognitive ability serves as an intervening variable between nutritional status and academic achievement. Improvements in cognitive ability are expected to significantly enhance students' learning outcomes (Grantham-McGregor et al., 2007).

Concept of Academic Achievement

Academic achievement refers to the outcomes students achieve after participating in the learning process, as indicated by academic scores, rankings, or the attainment of specific competencies. Academic achievement reflects students' mastery of knowledge and skills in accordance with learning objectives (Sudjana, 2010). Various factors, both internal and external, influence academic achievement. In this study, academic achievement is indirectly related to nutrient intake and nutritional status via cognitive ability. Adequate nutrient intake supports good nutritional status, which in turn enhances students' cognitive ability. Optimal cognitive ability enables students to understand learning materials better and achieve higher academic performance (Taras, 2005). Therefore, academic achievement represents the outcome of the interrelationship among nutrient intake, nutritional status, and students' cognitive ability.

3. Research Method

This study employed a mixed-methods approach that integrates quantitative and qualitative methods to obtain a comprehensive understanding of the effectiveness of the Free Nutritious Meal Program in improving students' cognitive abilities based on nutritional status. The mixed-methods approach was selected because it combines the strengths of numerical data and narrative data in explaining research phenomena in greater depth (Creswell & Plano Clark, 2011). The quantitative approach was used to analyse the relationships among nutrient intake, nutritional status, students' cognitive abilities, and academic achievement. Quantitative data were collected through Likert-scale questionnaires administered to 40 student respondents who were beneficiaries of the Free Nutritious Meal Program. Data analysis used descriptive statistics to describe respondents' characteristics and research variables, and correlation analysis to examine relationships among variables (Sugiyono, 2019).

The qualitative approach aimed to deepen the quantitative findings and explore stakeholders' experiences and perceptions. Data collection techniques included in-depth interviews with the head of the SPPG management, free nutritious meal food preparation workers, school principals, students, and parents. Qualitative data analysis was conducted using source triangulation to enhance data validity and thematic analysis to identify key patterns and themes relevant to the research objectives (Miles, Huberman, & Saldaña, 2014). The research site was the Nutrition Fulfilment Service Unit (SPPG) Building in Brangsong Village, as it serves as the centre of program implementation and is directly relevant to the research object.

4. Results and Discussion

Result

Quantitative Findings

This study involved 30 respondents from diverse backgrounds within the free nutritious meal program in the education and nutrition ecosystem. The respondents were predominantly female (53.3%), with the majority being vocational high school (SMK) students, reflecting the direct involvement of program beneficiaries at the field level. Most respondents were in Grade X (33.3%). These respondent characteristics formed the basis for understanding perceptions of the program's effectiveness. To measure the effectiveness of collaborative governance, an analysis of relationships among key dimensions was conducted, including nutritional status, nutrient intake, students' cognitive abilities, and academic achievement. Subsequent correlation analysis, as presented in Table 1, shows very strong and significant relationships ($p < 0.01$) among all key dimensions of collaborative governance.

Table 1. Matrix Correlation.

	Concept Nutritional Status	Concept Nutrient Intake	Concept Students' Cognitive Ability	Concept Academic Achievement
Concept Nutritional Status	1	.356	.354	.374*
Concept Nutrient Intake	.356	1	.550**	.548**
Concept Students' Cognitive Ability	.354	.550**	1	.649***
Concept Academic Achievement	.374*	.548**	.649***	1

Quantitative Findings

Nutritional status showed a positive correlation with nutrient intake ($r = 0.356$; $p = 0.054$) and with students' cognitive ability ($r = 0.354$; $p = 0.055$). However, neither relationship was statistically significant at the 0.05 significance level. This indicates that although there is a positive trend, nutritional status is not significantly associated with nutrient intake or students' cognitive ability. Furthermore, the analysis revealed a positive and statistically significant relationship between nutritional status and academic achievement ($r = 0.374$; $p = 0.042$). This relationship is positive, with a moderate correlation, indicating that better nutritional status is associated with higher academic achievement.

Regarding nutrient intake, the analysis demonstrated a positive and significant relationship with students' cognitive ability ($r = 0.550$; $p = 0.002$) and with academic achievement ($r = 0.548$; $p = 0.002$). Both relationships fall within the moderate-to-strong correlation category, indicating that better nutrient intake is associated with improved cognitive ability and academic achievement. Moreover, students' cognitive ability showed a positive and highly significant relationship with academic achievement ($r = 0.649$; $p < 0.001$). This correlation is classified as strong, indicating that cognitive ability is the variable most strongly associated with academic achievement among the variables examined in this study. Overall, the quantitative findings indicate a pattern of positive relationships among variables, where nutrient intake and students' cognitive ability play a crucial role in supporting academic achievement. Nutritional status shows a direct and significant relationship with academic achievement, but does not demonstrate a significant relationship with nutrient intake or cognitive ability.

Qualitative Findings

The results of interviews with five informants indicate that nutritional status plays an important role in students' health and academic achievement. Rikha Imaniarti, Principal of SMK Harapan Mulya Brangsong, stated that overall, students' nutritional status is relatively good, although some students still experience undernutrition or overnutrition. The school has undertaken various improvement efforts, including health education, collaboration with community health centres, and supervision of school snacks. Puji Dwi Pria Utomo, Head of the SPPG, explained that student menus are designed to emphasise a balanced intake of nutrients, including carbohydrates, proteins, fats, vitamins, and minerals, to support physical growth and brain development. Iddha Aryanti, a teacher, emphasised that nutritional status is closely related to cognitive ability, with students in good nutritional condition being more active, better able to understand lessons, and demonstrating critical thinking skills.

In addition, parents play a vital role in supporting children's academic achievement by providing nutritious food, assisting with learning at home, and offering motivation. This is reinforced by students' perspectives, who stated that being physically healthy, not feeling hungry, and studying diligently help them achieve better academic results. Academic achievement is understood as the outcome of the learning process influenced by students' physical condition, cognitive capacity, and supportive environments. Achievement is measured not only by academic scores but also by students' understanding of the material, active participation in class, and critical thinking skills. The findings indicate that health conditions and adequate nutrition are important factors in achieving academic success. Students who are healthy and not experiencing hunger tend to be more focused, more receptive to learning, and able to demonstrate better learning outcomes.

Beyond internal student factors, environmental support also shapes academic achievement, particularly the roles of schools and parents. Schools contribute by providing a supportive learning environment and health education, while parents contribute by meeting nutritional needs, offering learning assistance, and providing motivation. Overall, academic achievement is understood as the result of interaction among physical readiness, cognitive ability, and support from both school and family environments.

Discussion

The results of this study indicate that the Free Nutritious Meal Program implemented in schools in Brangsong Subdistrict is effective in improving students' cognitive abilities, as evidenced by improvements in nutritional status, nutrient intake, cognitive abilities, and academic achievement. The integration of quantitative and qualitative findings demonstrates consistency across research approaches and strengthens understanding of how the program improves students' cognitive abilities.

Pearson correlation analysis shows that nutritional status is positively correlated with nutrient intake ($r = 0.356$) and students' cognitive ability ($r = 0.354$); however, both relationships are not statistically significant at $\alpha = 0.05$. This indicates that, statistically, nutritional status is not significantly associated with nutrient intake or cognitive ability. In contrast, nutritional status is positively and significantly associated with academic achievement ($r = 0.374$; $p = 0.042$), indicating a moderate correlation. Furthermore, nutrient intake shows a positive and significant relationship with students' cognitive ability ($r = 0.550$) and academic achievement ($r = 0.548$), both of which fall within the moderate-to-strong correlation category. The strongest relationship was found between students' cognitive ability and academic achievement ($r = 0.649$; $p < 0.001$), indicating that cognitive ability is the most dominant variable associated with academic achievement in this study.

Thematic Analysis

a. Positive Trends of Nutritional Status toward Nutrient Intake and Cognitive Function

Good nutritional status demonstrates a consistent positive trend toward adequate nutrient intake and the development of cognitive function, particularly among children and adolescents. Thematically, this relationship can be understood through three main aspects: dietary quality, brain function, and cognitive outcomes. First, individuals with normal nutritional status tend to have more adequate intakes of energy, protein, and essential micronutrients such as iron, iodine, and omega-3 fatty acids. Balanced nutrient intake plays a crucial role in supporting brain metabolism and synaptic transmission (WHO, 2020).

Second, adequate nutrition contributes directly to brain structure and function. Nutritional deficiencies, especially during critical periods of growth, can impair myelination and neuronal development, thereby reducing learning capacity and memory performance (Prado & Dewey, 2014). Third, optimal nutritional status is correlated with improved cognitive performance, including attention, problem-solving skills, and academic achievement. Longitudinal studies indicate that children with good nutritional status achieve higher cognitive test scores compared to those with undernutrition (Victoria et al., 2008). Thus, the positive trend between nutritional status, nutrient intake, and cognitive function underscores the importance of nutritional interventions as a foundation for developing high-quality human resources.

b. Nutritional Status as a Supporting Factor for Academic Achievement

Nutritional status is a fundamental factor supporting academic achievement, particularly among school-aged children. Thematically, the role of nutritional status in academic achievement can be examined through physiological, cognitive, and psychosocial aspects. From a physiological perspective, good nutritional status reflects adequate intake of energy and macro- and micronutrients required to support learning activities. Energy and protein deficiencies may lead to fatigue, reduced concentration, and decreased school attendance (WHO, 2020).

From a cognitive perspective, adequate intake of nutrients such as iron, iodine, and zinc plays a vital role in brain function development, including memory, attention, and logical reasoning. Deficiencies in these nutrients have been linked to lower academic performance and reduced learning capacity in children (Prado & Dewey, 2014). Furthermore, from a psychosocial perspective, children with good nutritional status tend to exhibit higher self-confidence and learning motivation, enabling more active participation in the learning process (Taras, 2005). Numerous studies indicate that students with normal nutritional status achieve better academic outcomes than those who are undernourished or malnourished (Soekirman, 2011). Therefore, nutritional status is an important factor in improving academic achievement and the quality of human resources.

c. The Central Role of Nutrient Intake in the Learning Process

Nutrient intake plays a central role in supporting the learning process, particularly among children and adolescents who are in critical phases of growth and development. Thematically, this role can be analyzed in terms of biological, cognitive,

and learning-behavioral dimensions. From a biological dimension, adequate energy and protein intake are essential for maintaining stamina, physical health, and brain metabolic function. Insufficient energy intake can lead to fatigue and reduce children's ability to engage in learning activities (WHO, 2020) optimally.

From a cognitive dimension, micronutrients such as iron, iodine, zinc, and B-complex vitamins play a crucial role in neurotransmitter synthesis, nerve myelination, and memory and attention functions. Deficiencies in these nutrients have been associated with reduced concentration, slower cognitive processing speed, and impaired memory, which directly affect learning (Prado & Dewey, 2014). In addition, essential fatty acid intake—particularly omega-3 fatty acids—contributes to brain structural development and executive functioning (Gómez-Pinilla, 2008). In terms of learning behaviour, children with adequate nutrient intake tend to be more active, focused, and motivated to learn than those with imbalanced dietary intake (Taras, 2005). Therefore, ensuring optimal nutrient intake constitutes an essential step in supporting effective learning and improving educational quality.

d. Cognitive Ability as the Primary Determinant of Academic Achievement

Cognitive ability is a key factor determining students' academic achievement. Thematically, the role of cognitive ability can be understood through aspects of information processing, executive function, and knowledge application. In terms of information processing, cognitive ability encompasses attention, perception, and working memory, which enable students to receive, store, and process information effectively. Students with strong cognitive capacity tend to understand learning materials better and integrate new information with prior knowledge (Santrock, 2011).

Furthermore, executive functions—including critical thinking, planning, self-regulation, and problem-solving—play a significant role in academic success. These functions help students manage learning strategies, regulate time, and complete academic tasks systematically (Diamond, 2013). Cognitive ability also influences knowledge transfer, namely the ability to apply learned concepts to new situations, such as examinations or contextual problem-solving tasks.

Numerous studies have demonstrated a strong positive relationship between cognitive ability and academic achievement, as measured by academic grades and standardised test scores (Deary et al., 2007). Therefore, cognitive ability is the primary determinant of academic achievement and a key target in efforts to improve educational quality.

5. Conclusion

Based on this study's findings, the Free Nutritious Meal Program implemented in schools in the Brangsong Subdistrict is effective in improving students' cognitive abilities. The effectiveness of this program is supported by the interrelationships among nutritional status, nutrient intake, students' cognitive ability, and academic achievement. The integration of quantitative and qualitative findings demonstrates consistency across research approaches, thereby strengthening the understanding of how the nutritious meal program enhances students' cognitive abilities.

The results of the Pearson correlation analysis indicate that nutritional status is positively associated with nutrient intake and students' cognitive ability; however, both relationships are not statistically significant at the 0.05 significance level. In contrast, nutritional status shows a positive and statistically significant relationship with academic achievement, with a moderate correlation strength. Furthermore, nutrient intake has been shown to have a positive and significant relationship with students' cognitive ability and academic achievement, with correlation coefficients ranging from moderate to strong. The strongest relationship was found between students' cognitive ability and academic achievement, indicating that cognitive ability is the most dominant variable associated with students' academic performance in this study. Overall, these findings confirm that improving students' cognitive abilities through nutritious meal programs does not rely solely on nutritional status, but also on the quality of nutrient intake, which directly contributes to cognitive functioning and academic outcomes.

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