



The Relationship Between Nutritional Status and Nutritional Intake Towards Intelligence Level (IQ)

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Abstract

Nutritional status plays an important role in children's growth and development, including cognitive development and intelligence. School-aged children are a vulnerable group to nutritional problems that may affect learning ability. An observational analytic study with a cross-sectional design was conducted among 36 students aged 11–12 years. Nutritional status was assessed using Body Mass Index-for-Age (BMI-for-age) based on CDC standards, nutrient intake was measured using a Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ), and intelligence was measured using the Wechsler Intelligence Scale for Children (WISC). Data analysis was performed using univariate, bivariate (One Way ANOVA), and multivariate (linear regression) analyses. Most respondents had normal nutritional status and average IQ scores. There was no significant relationship between nutritional status and IQ ($p = 0.095$). Multivariate analysis also showed no significant effect of nutritional status and nutrient intake on IQ ($p = 0.797$; $R^2 = 0.072$). Nutritional status and nutrient intake were not significantly associated with intelligence levels among school-aged children in this study.

Introduction

In Indonesia, malnutrition remains a major public health problem. The country experiences a high prevalence of nutritional deficiencies, including both macronutrient and micronutrient deficiencies, while at the same time obesity is becoming increasingly common. This phenomenon is known as the Double Burden of Malnutrition (Badan Perencanaan Pembangunan Nasional, 2019).

The quality of life of children in Indonesia is still considerably lower compared to that of children in many other countries (Sitaresmi et al., 2008; Parikesit et al., 2026; Rosemiarti et al., 2026). According to the United Nations Children's Fund (UNICEF), Indonesia ranks as the fifth country with the highest number of children experiencing growth retardation, which significantly affects their ability to fully develop their physical and mental potential. This condition is also reflected in data from the United Nations Development Programme (UNDP),

which reported that in 2018 Indonesia ranked 108th out of 169 countries in the Human Development Index (HDI), lower than several other Southeast Asian countries. Indonesia ranked sixth among ASEAN countries in terms of HDI. The relatively low HDI in Indonesia is strongly influenced by poor nutritional status and health conditions among the population (Zuraini et al., 2019; Zahida et al., 2026; Miharsih, 2026).

Good nutritional status plays an important role in children's growth and development, including the development of intelligence (Nasution et al., 2026; Ernawati et al., 2026; Paramitha et al., 2026). Therefore, during the school-age period, children require adequate intake of nutritious foods to support optimal growth and development. Malnutrition refers to a condition resulting from deficiencies or excesses of protein, energy, and other nutrients that disrupt normal body functions, clinical outcomes, and tissue structure, including changes in body shape, size, and composition (Armin et al., 2024; Rocha et al., 2026; Kurhaluk et al., 2026).

School-age children represent a critical period for physical and cognitive development (Guyon et al., 2026; Latino et al., 2024; Fenesi et al., 2022). At this stage, adequate nutritional status is essential for supporting brain development, learning ability, and intellectual capacity. Malnutrition, including chronic energy deficiency, anemia, and deficiencies of micronutrients such as iron and iodine, can interfere with optimal brain development. Nutritional deficiencies during this critical period may not only affect intelligence levels but may also have implications for children's academic performance (Khadem et al., 2024; Guan et al., 2025; Tanziha et al., 2025).

A study conducted by Universitas Muslim Indonesia involving 88 second-grade students from four elementary schools in Makassar used a quantitative approach with a cross-sectional design. The analysis showed that there was no significant association between nutritional status ($p = 1.000$), maternal education ($p = 0.583$), and parental income ($p = 0.898$) with students' intelligence levels. However, the researchers emphasized the importance of parental attention to children's dietary patterns in order to prevent undernutrition (Sumiaty & Hardi, 2018).

Another study conducted at SDN 219 Inpres Pannambungan, Maros, using an observational cross-sectional design found a significant relationship between nutritional status and children's intellectual intelligence. Statistical analysis using the Spearman correlation test showed a p -value of 0.035, which was lower than the significance level of 0.05, indicating that nutritional status had a significant influence on children's IQ (Bulkis et al., 2024; Mediani et al., 2022; Gaston et al., 2022).

Based on these findings, the researchers were interested in conducting this study because nutrition is known to be an essential factor for brain growth and development. Therefore, this study aimed to determine the relationship between nutritional status and intelligence quotient (IQ) among elementary school children.

Methods

This study was an observational analytic study with a cross-sectional approach conducted at SD Negeri Pajjajiang from April to May 2025. The study population consisted of all students aged 11–12 years, and a total of 36 respondents were selected as the study sample using a random sampling technique according to predetermined inclusion and exclusion criteria.

The independent variables in this study were nutritional status and nutrient intake (including protein, fat, carbohydrates, and fiber), while the dependent variable was the intelligence quotient (IQ). Nutritional status was assessed using Body Mass Index-for-Age (BMI-for-age) based on Centers for Disease Control and Prevention (CDC) standards. Body weight was measured using a digital scale, and height was measured using a microtoise.

Nutrient intake data were obtained through interviews using a Semi-Quantitative Food Frequency Questionnaire (SQ-FFQ). Intelligence level was measured using the (Wechsler Intelligence Scale for Children (WISC) in order to minimize cultural bias.

The collected data were analyzed using univariate analysis to describe the frequency distribution of each variable. Bivariate analysis was performed using the One Way ANOVA test to determine the relationship between nutritional status and IQ. Furthermore, multivariate analysis was conducted using multiple linear regression to examine the effect of nutritional status and nutrient intake on IQ scores. The level of statistical significance was set at $p < 0.05$.

Result and Discussion

To determine the characteristics of respondents based on age, a frequency distribution analysis was conducted for all study participants. The distribution of respondents by age among school-aged children (11–12 years) at SD Negeri Pajjaiang is presented in Table 1 below.

Table 1. Frequency Distribution of Respondents' Age

Gender	Frequency (n)	Percentage (%)
11 tahun	16	44,4
12 tahun	20	55,6
Total	36	100,0

Sumber: Data Primer

Based on the distribution of respondents by age group, out of a total of 36 study subjects, the majority were in the >143 months age group, consisting of 20 respondents (55.6%). Meanwhile, respondents aged 132–143 months accounted for 16 individuals (44.4%). These findings indicate that most of the study samples belonged to the age group above 143 months.

The distribution of respondents by sex was analyzed to determine the proportion of male and female participants in this study. The frequency distribution of respondents by sex is presented in Table 2 below.

Table 2. Frequency Distribution of Respondents by Sex

Jenis Kelamin	Frekuensi (n)	Persentase (%)
Laki laki	25	69,4
Perempuan	11	30,6
Total	36	100,0

Sumber: Data Primer

Based on Table 2, the distribution of respondents by sex shows that the majority were male, with 25 respondents (69.4%), while female respondents accounted for 11 individuals (30.6%). This indicates that the proportion of male respondents in this study was higher than that of female respondents.

The nutritional status of respondents in this study was determined using Body Mass Index-for-Age (BMI-for-age) according to CDC standards. The frequency distribution of respondents' nutritional status was conducted to determine the proportion of nutritional status categories among school-aged children who participated in the study. The results of this distribution are presented in Table 3 below.

Table 3. Distribusi Frekuensi Status Gizi Responden

Status Gizi	Frekuensi (n)	Persentase (%)
Underweight	8	22,2
Healthy Weight	15	41,7

Overweight	7	19,4
Obese	6	16,7
Total	36	100,0

Sumber: Data Primer

Based on Table 3, the distribution of respondents' nutritional status according to CDC standards shows that the majority of respondents were classified in the Healthy Weight (normal) category, with 15 individuals (41.7%). Respondents in the Underweight category accounted for 8 individuals (22.2%), those in the Overweight category were 7 individuals (19.4%), and those classified as Obese were 6 individuals (16.7%).

Overall, most children in this study had a normal nutritional status; however, there were still proportions of children with both undernutrition and overnutrition that require attention.

To determine the distribution of respondents' intellectual intelligence levels, a frequency distribution analysis was conducted based on Intelligence Quotient (IQ) score categories. The distribution of respondents' intelligence levels according to IQ categories is presented in Table 4 below.

Table 4. Frequency Distribution of Respondents' IQ Characteristics

Karakteristik IQ	Frekuensi (n)	Persentase (%)
Superior (120 sampai 129)	1	2,8
Above Average (110 sampai 119)	1	2,8
Average (90 sampai 109)	17	47,2
Below Average (80 sampai 89)	8	22,2
Borderline (70 sampai 79)	5	13,9
Intellectual Deficient (<69)	4	11,1
Total	36	100,0

Sumber: Data Primer

Based on the distribution of Intelligence Quotient (IQ) characteristics, the majority of respondents were classified in the Average (90–109) category, comprising 17 individuals (47.2%). The Below Average (80–89) category was found in 8 respondents (22.2%), while the Borderline (70–79) category included 5 respondents (13.9%). Respondents categorized as Intellectually Deficient (<69) accounted for 4 individuals (11.1%). Meanwhile, the Superior (120–129) and Above Average (110–119) categories were each represented by only 1 respondent (2.8%).

Overall, most research subjects had IQ levels within the average range, with smaller proportions in both the above-average and below-average categories.

A univariate analysis of nutrient intake was conducted to describe the average consumption of energy and macronutrients among respondents, obtained through the Semi Quantitative Food Frequency Questionnaire (SQ-FFQ) method. The descriptive analysis results for energy, protein, fat, carbohydrate, and fiber intake are presented in Table 1.5 below.

Table 5. Frequency Distribution of Respondents' Characteristics

Variabel	Mean ± SD	Median	Min–Maks
Energi (kkal/hari)	825,13 ± 621,94	949,93	0,00 sampai 2090,02
Protein (g/hari)	32,69 ± 21,70	32,69	0,00 sampai 71,89
Lemak (g/hari)	10,80 ± 7,73	10,34	0,00 sampai 27,40
Karbohidrat (g/hari)	149,63 ± 131,36	149,41	0,00 sampai 406,41
Serat (g/hari)	1,40 ± 1,31	1,38	0,00 sampai 5,06

Based on the analysis of nutrient intake obtained through the FFQ, the mean energy intake of respondents was 825.13 ± 621.94 kcal/day, ranging from 0.00 to 2090.02 kcal/day. The mean protein intake was 32.69 ± 21.70 g/day, fat intake 10.80 ± 7.73 g/day, carbohydrate intake 149.63 ± 131.36 g/day, and fiber intake 1.40 ± 1.31 g/day.

The large standard deviation observed in energy and carbohydrate intake indicates substantial variability in dietary consumption among respondents. The minimum value of 0.00 for several variables reflects the absence of consumption during the measurement period according to the FFQ results.

Based on the study results, the majority of respondents were in the >11 years age group (55.6%), while 44.4% were aged 11–12 years. This indicates that the age distribution in this study was relatively balanced, although slightly higher in the older age group (Johnson, 2003; UNICEF, 2023).

The age range of 11–12 years represents the late childhood stage transitioning into early adolescence. During this period, rapid cognitive development occurs, including improvements in logical thinking, problem-solving ability, and executive function maturation. Theoretically, increasing age is associated with maturation of brain structure and function, which may influence intellectual achievement (Johnson, 2003; UNICEF, 2023).

Differences in age distribution are important to consider because age is one of the factors that may influence cognitive test outcomes. Older children tend to have more learning experience, which theoretically may result in better performance in intelligence testing (Johnson, 2003; UNICEF, 2023).

The mean BMI of 20.46 kg/m^2 with a BMI percentile of 50.60 indicates that most respondents were classified in the healthy weight category. This suggests that the study population was not dominated by severe malnutrition.

Recent reports from WHO and UNICEF indicate that among school-aged children, the double burden of malnutrition remains a global challenge, particularly in developing countries. However, the impact of nutritional status on cognitive function is more evident in cases of chronic undernutrition or stunting occurring during early childhood (Black et al., 2017; Prado & Dewey, 2014).

Recent longitudinal studies also show that the effect of nutritional status on intelligence is stronger during early life stages than during school age (Tucker-Drob & Bates, 2016).

The distribution of IQ levels showed that the majority of respondents were in the Average category (47.2%), indicating that nearly half of the participants had intellectual abilities within the normal population range. This finding is consistent with the normal distribution of IQ in the general population, where most individuals fall within the average category (Casey et al., 2018; Nyaradi et al., 2013).

However, there were respondents categorized as Below Average (22.2%), Borderline (13.9%), and Intellectual Deficient (11.1%), indicating that nearly half of the respondents were below the average intellectual range. This condition may be influenced by various factors, including nutritional status, family environment, cognitive stimulation, socioeconomic conditions, as well as biological and genetic factors (Casey et al., 2018; Nyaradi et al., 2013).

Meanwhile, the Above Average and Superior categories were each represented by 2.8% of respondents. The small proportion in these categories reflects that intellectual ability in this sample tended to be concentrated within the average range (Casey et al., 2018; Nyaradi et al., 2013).

Overall, the results indicate that most children had intellectual abilities within normal limits; however, a considerable proportion fell below the average category, which requires attention, particularly regarding educational intervention and cognitive development stimulation (Nyaradi et al., 2013).

The mean energy intake of 825.13 kcal/day showed substantial variation among respondents. However, recent studies suggest that the relationship between macronutrient intake and cognitive function in school-aged children tends to be weak, except in cases of severe nutritional deficiency (Waber et al., 2014).

Protein intake in this study did not indicate extreme deficiency. Protein plays a role in neurotransmitter synthesis, but the cognitive impact of protein deficiency is more evident in cases of severe or chronic malnutrition. Fat intake, particularly essential fatty acids, contributes to brain myelination, although its effects are more dominant during early developmental stages (Adolphus et al., 2016; Innis, 2014).

Carbohydrate intake is associated with glucose availability as the primary energy source for the brain. However, its effects are more evident in short-term cognitive performance rather than long-term IQ scores, which reflect intellectual capacity. Fiber intake does not have a direct relationship with cognitive function but is more closely related to metabolic health (Cusick & Georgieff, 2016; Reynolds et al., 2019).

When compared with the Recommended Dietary Allowance (RDA) for children aged 10–12 years, the recommended daily energy intake ranges from 2000–2100 kcal/day, protein 55–60 g/day, fat 65–70 g/day, carbohydrates 300–350 g/day, and fiber 25–30 g/day. These nutritional requirements are necessary to support physical growth, daily activities, and brain development in school-aged children (Johnson, 2003).

Based on this comparison, the average intake of energy and macronutrients among respondents was below the recommended daily intake. This condition may be influenced by several factors, including irregular eating habits, limited food variety, children's food preferences, and family environmental factors affecting dietary patterns (Johnson, 2003).

Although inadequate nutrient intake can influence metabolic processes and cognitive function, the analysis in this study showed no significant association between nutrient intake and IQ scores. This indicates that children's intelligence results from complex interactions among multiple factors, including genetics, family environment, educational stimulation, and socioeconomic conditions (UNICEF, 2023).

The relatively homogeneous characteristics of respondents (mostly healthy weight and average IQ) may explain why the relationship between nutritional status and IQ was not statistically significant.

Recent studies suggest that the influence of nutrition on cognitive development is most critical during the first 1000 days of life, while environmental and educational factors become more dominant during school age (Johnson et al., 2016; Prado & Dewey, 2014).

The One Way ANOVA test showed that there was no significant difference in mean IQ scores across nutritional status categories ($p = 0.095$). Although descriptively children with healthy weight had higher mean IQ scores than underweight and obese groups, these differences were not statistically significant.

Several factors may explain this result, including the relatively homogeneous distribution of nutritional status, limited sample size, and the stronger influence of environmental factors during school age.

Linear regression analysis showed that nutritional status and nutrient intake (protein, fat, carbohydrate, and fiber) simultaneously had no significant effect on IQ scores ($p = 0.797$). The

coefficient of determination ($R^2 = 0.072$) indicates that only 7.2% of IQ variation could be explained by variables included in the model, while 92.8% was influenced by other unmeasured factors.

These findings suggest that during school age, current nutritional status and macronutrient intake are not the primary determinants of IQ scores. Environmental stimulation, educational exposure, and socioeconomic conditions likely play a more dominant role in determining cognitive outcomes.

Conclusion

Based on the results of this study conducted among school-aged children (11–12 years) at SD Negeri Pajjaiang, it can be concluded that no significant relationship was found between nutritional status and intelligence level (IQ). In addition, nutrient intake including protein, fat, carbohydrates, and fiber did not show a significant effect on IQ scores.

The variables examined in this study explained only a small proportion of the variation in intelligence, as indicated by the low coefficient of determination. This suggests that children's intelligence is influenced more strongly by other factors such as genetics, environmental conditions, education, and cognitive stimulation.

Nevertheless, nutritional status remains an important factor for supporting overall child growth and development, and efforts to ensure balanced nutritional intake should continue to be emphasized.

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