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# Evaluating the Impact of Nutritional and Socioeconomic Factors on Cognitive and Academic Performance in age 6-13 years

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## Abstract

Nutritional and socioeconomic status is a critical health concern in childhood due to its direct impact on cognitive and academic performance. This study aimed to examine the relationship between nutritional status, cognition, and socioeconomic factors among schoolchildren in different regions of Faisalabad, Pakistan. The study included 225 students aged 6-11 years from both urban and rural areas. Anthropometric measurements and z-scores for weight-for-age, height-for-age, and BMI-for-age were calculated using WHO growth standards. Socioeconomic status and dietary history were assessed through a general questionnaire, food frequency questionnaire, and food group records. Cognitive and academic performance was measured using the ASER method, focusing on reading, math, and grade levels. Data analysis included both descriptive and inferential statistics.

The study found that 26% of the children were malnourished, with higher rates among older children. A significant 79.6% of the children were classified as middle class due to low income levels and large family sizes. Malnutrition was more prevalent among children whose parents had secondary rather than tertiary education. Over half of the children did not meet their daily requirements for cereals, fruits, and meat. Healthy children generally performed better academically, with 93% of them achieving A grades. The relationship between weight, height, and BMI varied by age. These findings suggest a strong association between nutritional status, socioeconomic factors, and the cognitive and academic performance of children. The study also revealed that many children had dietary intakes below the recommended levels.

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## Introduction

Nutritional status is an important public health concern all over the world for children. The “double burden” of malnutrition including under-nutrition and over-nutrition is now faced by developing world [1], as the prevalence of overweight in children has increased 8.1-12.9% in boys and 8.4-13.4% in girls in 2013. The prevalence has also increased in developed countries 16.9-23.8% in boys and 16.2-22.6% in girls from 1980-2013. The burden of under-nutrition is also very high in developing countries, as almost 2 lac deaths in children has occurred due to protein energy malnutrition. Prevalent cases of iron deficiency anemia among children are almost 600 million in 2013, that’s why it is the leading cause of years [2].

Development of children is important concern for individual’s cognitive achievement because it effects child’s lifelong health, socioeconomic status (SES), and productivity. Cognitive and academic performances involve the mental processes of reading, reasoning, problems solving abilities and grade level of children. Poor cognitive achievement among children may ultimately lead to mental health issues, physical health, social development as well as peer relationship, that eventually later affect the quality of life [3].

Several risk factors are linked with poor cognitive achievement among children including low socioeconomic status (SES) such as education level of both mother and father, micronutrient as well as macronutrient deficiencies, malnutrition specially protein energy malnutrition, stunting, poor quality food intake such as fruits and vegetables, unstimulating environment, infections in children and loss of hearing. These factors affect the mental health of a child, that’s why they must be controlled because childhood is very crucial period for growth of brain and a child can face mental health problems later in his/ her life [4].

Occupation, income and education typically characterize a multidimensional concept of socioeconomic status of an individual. Nutritional status, socioeconomic status and cognitive performance are interlinked with each other as their relation is greatly supported by outcomes of developing as well as developed world [5]. Cognitive and academic performances can also be assessed through nutritional status. Functioning of brain and development of nervous system requires a good nutrition. Cognitive and academic performance is effected in both under-nutrition and over-nutrition. Intelligence level of children can’t be affected due to nutritional as well as socioeconomic status because hereditary is mainly responsible for intelligence. Intelligence is a complex combination of environmental impacts and genetic [6]. Childhood is an important period for physical growth and neural as well as psychologic development. Adequate nutrition, as the basis for growth and development in children, can decrease the occurrence of many infectious diseases in this stage of life by improving immunity and chronic diseases in adults’ life. Additionally, promotion of a healthy diet is linked with ultimate benefits [7]. Malnutrition in Childhood stage decreases individual’s income and social output in adulthood, and thus, induces overall socioeconomic improvement [8]. Nutritional status of a child is an indicator of socioeconomic improvement of a nation, thus it ensures that well-nourished and healthy children contribute to high quality human resources. In developing countries, there should be focused on public health awareness and improvement of food’s quality at national level to achieve the desire nutritional status of children [9].

Healthy eating is a source of growth as well as development of children as it participates in overall health. Health

behaviors and eating habits that are adopted by a child helps in determining his/her overall health which also effects later in life [10]. A healthy nutrition for a child is defined as the adequate intake of all the nutrients including macro- as well as micronutrients. However, high energy foods intake declines micronutrient consumption in diet. In other words, low nutritious and caloric dense foods are used to consumed by children now a day while high fiber and nutrient dense foods such as fruits and vegetables are not preferred which gives an unbalanced space to child's plate [11]. Fruits as well as vegetables consumption ensures the intake of adequate vitamins, minerals and high fiber which play beneficial role in nutritional status and prevention of chronic diseases as well as constipation among children [12].

The purpose of current study was to assess the nutritional and socioeconomic status of school going children and their relation with cognitive and academic performances because children face problems in cognition and academic achievements in a developing country due to low nutritional status. Nutritional status of a child is affected by socioeconomic factors such as poor education level of parents, low income, and poor households.

## Materials and methods

### Setting

This study conducted was quantitative which analyzed the nutritional status of both public and private school going children in urban and rural areas of Faisalabad. The data obtained included the age, height, weight, BMI, number of meals per day, sleep cycle, educational level of father, educational level of mother, number of siblings and number of family members, residential area, profession of mother, profession of father, monthly income of parents and food frequency from six food groups. According to the Pakistan Bureau of Statistics, the population of Faisalabad District was estimated to be 8.29 million. Out of this, 4.91 million people live in the urban areas whereas, 3.38 million people reside in the rural areas. The Population of the Tehsil City and Tehsil Saddar were estimated to be 2.67 million and 1.05 million respectively. The schools were selected using the purposive stratified sampling technique.

### Study design

A total of 225 students from urban and rural areas were included in the study. The age group of the respondents was 6-11 years. The consent was obtained from the students, school administration and the parents using a structured consent form.

### Outcome variables

The scores of students in reading and mathematics and the current grade level used as three dependent variables in the study. The tests for reading and mathematics were developed by Pratham, an Indian NGO, and are annually implemented in Pratham's Annual Status of Education Report (ASER) Survey throughout India. The existing survey was followed the same procedure as the ASER survey [13].

## Explanatory variables

The main independent variables of nutritional assessment were anthropometric measurements. Anthropometric data (height as well as weight) was composed for every child from an expert evaluator. This data was used to measure mean and z-scores of height-for-age, weight-for-age and BMI-for-age based on WHO standards growth charts 2006 [14], with the exclusion of weight-for-age for children 11 years old, which was measured by WHO growth standards UK [15]. The socioeconomic status of the respondents was assessed by asking about their residence number of siblings, number of family members, educational status of father, educational status of mother, profession of father, profession of mother and monthly income of parents. Dietary history was assessed by using food frequency questionnaire and food group's record.

## Statistical analysis

Data collected from all schools including all parameters were recorded in a Microsoft Excel sheet. Descriptive statistics including the means, frequencies, percentages and standard deviations were used to characterize and summarize all the parameters of the study. Inferential statistics including the ANOVA, t-tests, chi-square tests, SPSS and reference value charts were used [16].

## Results

### Descriptive statistics

Age of students was categorized into three groups 6-7, 8-9, and 10-11 years. The average weight of 6-7, 8-9 and 10-11 was 22.35, 26.62 and 34.16 kg respectively. The weight of students increased with the age. The height of 6-7, 8-9 and 10-11 was 47.27, 50.98 and 54.94 inches respectively. The average BMI of children falls in normal ranges according to WHO standards. About 70% children in Faisalabad were healthy that had BMI with normal range and lie between 5 - <85<sup>th</sup> percentile. 11% had <5<sup>th</sup> percentile and remaining 14% had >85<sup>th</sup> percentile. The average child aged 6-11 years had completed grade three and had a reading score of 2.73, meaning the child was not able to read a paragraph but close to being able to read four words (Table 1). The average child was close to being able to solve simple subtraction with 3.45 math score. About 30.7% of children had three siblings and 26.7% had two. While 10.7% and 11.2% had four and more than four siblings respectively. More than 58% of students had 6-10 members in their families. Most of them lived in joint family. Around 30% fathers and 33.8% mothers of respondents attained primary or zero education which leads towards low economic level. 79.6% of respondents were assessed as middle class in Faisalabad. More than half of the children didn't meet their daily requirements of cereals, fruits and meat. 60% children meet their daily requirements of milk group.

**Table 1.** Children aged 6-11 anthropometrics, outcome measures, and socioeconomic characteristics (N = 225).

Variables	Obs.	Mean or %	S.D	Range
Explanatory variables				

<b>Weight-for-age (WAZ)</b>				
6-7 years		22.35 (-0.1 SD)	4.13	
8-9 years		26.62 (-0.13 SD)	5.3	
10-11 years		34.16 (-0.2 SD)	3.45	
<b>Height-for-age (HAZ)</b>				
6-7 years		22.35 (0.14 SD)	2.4	
8-9 years		26.62 (0.09 SD)	2.63	
10-11 years		34.16 (-0.3 SD)	3.4	
<b>BMI-for-age (BAZ)</b>				
6-7 years		15.3 (-0.3 SD)	1.81	
8-9 years		16.1 (-0.31SD)	3.4	
10-11 years		17.7 (-0.7 SD)	2.11	
<b>Nutritional status</b>				
Healthy	166	73.8%		
Obese	12	5.3%		
Overweight	21	9.3%		
Underweight	26	11.6%		
<b>Outcome variables</b>				
Reading level		2.73	1.55	1-5
Math level		3.45	1.29	1-5
Academic grade level		3.29	1.79	1-6
<b>Control variables</b>				
<b>Age</b>				
6-7	87	38.6%		
8-9	69	30.7%		
10-11	69	30.7%		
<b>Father's education</b>				
Primary or No	68	30.2%		
Secondary	71	31.6%		
Tertiary	86	38.2%		
<b>Mother's education</b>				
Primary or No	76	33.8%		
Secondary	61	26.2%		
Tertiary	86	38.2%		
<b>Income levels of parents</b>				
Low	16	7.1%		
Middle	179	79.6%		
High	30	13.3%		
<b>Number of siblings</b>		3.51	1.59	0-7
<b>Number of family members</b>		7.85	4.29	4-20

<b>Residence</b>				
Rural	112	49.7%		
Urban	113	50.3%		
<b>Number of meals/day</b>		2.96	0.59	2-4
<b>Sleep cycle</b>		8.78	1.14	6-11

## Multivariate analysis

Odds ratios for the ordered logit analysis, coefficients for the OLS analysis, and standard errors from the regression are presented in Table 2. Table 2 showed that about 32% of healthy children scored 5. Around 40% of malnourished children were not able to read or recognize at least four word from a paragraph. More than 50% of healthy students scored 4-5 in math. 29% and 16.5% of malnourished students got 1 and 2 scores respectively. 93% of children were healthy who got A grade. Around 20% malnourished children got F grade. The current study determined that nutritional status was greatly linked with cognition.

It was found that healthy children were more associated with higher reading and math level while obese were associated with lower scores. There was positive relationship among fathers' education and math and grades levels of children while the association between mothers' primary education and grades levels increased thrice than reading and math levels. There was negative association among current grade levels and all the food groups.

**Table 2.** Adjusted models for the association between cognitive achievement and nutritional and socioeconomic status of children

Outcomes →	Reading level		Math level		Grade level	
	Odds ratio	95% CI	Odds ratio	95% CI	Coefficients from OLS	95% CI
<b>Age (Ref= G3)</b>						
<b>G1</b>	0.466	1.84, 2.42	1.812	2.68, 3.2	0.258	3.48, 4.19
<b>G2</b>	3.127	2.38, 3.13	3.816	3.02, 3.62	0.049	2.97,3.81
<b>Nutritional Status</b>						
<b>Healthy</b>	0.460	2.25, 2.71	0.276	3.14, 3.54	1.024	3.15, 3.7
<b>Obese</b>	3.904	4.3, 4.98	2.198	3.9, 5.01	0.001	0.82, 1.91
<b>Overweight</b>	1.110	3.91, 4.8	0.563	3.86, 5.08	0.390	1.34, 2.66
<b>Father's Education</b>						
<b>Primary</b>	0.173	1.6, 2.14	1.966	2.73, 3.22	1.435	3.91, 4.57
<b>Secondary</b>	1.229	2.33, 3.05	0.941	2.97, 3.71	0.061	2.69, 3.58
<b>Mother's Education</b>						

<b>Primary</b>	0.168	1.84, 2.35	0.029	2.84, 3.27	3.019	3.42, 4.07
<b>Secondary</b>	0.104	1.96, 2.76	0.005	2.66, 3.49	2.742	3.43, 4.46
<b>Income Level</b>						
<b>High</b>	0.315	2.95, 3.97	0.209	3.17, 4.05	1.152	2.37, 3.58
<b>Low</b>	1.205	2.18, 2.89	8.605	3.1, 3.66	0.040	3.09, 3.9
<b>Cereals Group</b>						
<b>2 servings/day</b>	0.005	1.44, 2.56	0.004	2.62, 3.57	0.651	3.43, 4.85
<b>3 servings/day</b>	0.057	2.24, 2.86	0.013	2.89, 3.38	1.160	3.07, 3.77
<b>4 servings/day</b>	0.063	2.09, 2.95	0.075	2.89, 3.67	1.224	3.15, 4.13
<b>Vegetable Group</b>						
<b>1 serving/day</b>	2.087	1.39, 2.79	1.120	2.22, 3.96	0.054	2.96, 5.04
<b>2 servings/day</b>	1.833	2.18, 2.88	1.650	2.82, 3.41	0.073	3.0, 3.83
<b>3 servings/day</b>	2.237	2.43, 3.08	0.346	3.24, 3.75	0.306	2.97, 3.7
<b>Fruit Group</b>						
<b>1 serving/day</b>	0.054	2.21, 3.15	0.008	3.65, 4.2	0.542	2.68, 3.62
<b>2 servings/day</b>	0.009	2.12, 3.11	0.015	2.75, 3.66	0.089	2.3, 3.4
<b>3 servings/day</b>	0.005	3.56, 4.52	0.081	4.47, 4.97	0.164	1.19, 2.17
<b>4 servings/day</b>	0.067	3.9, 4.01	0.006	1.9, 2.0	0.024	3.9, 4.02
<b>Meat Group</b>						
<b>0 serving/day</b>	0.002	2.21, 2.73	3.810	3.13, 3.58	0.005	3.31, 3.94
<b>1 serving/day</b>	0.004	2.2, 3.01	2.207	3.01, 3.68	0.431	2.68, 3.52
<b>2 servings/day</b>	0.001	3.07, 3.96	2.415	3.23, 4.18	0.027	2.16, 3.47
<b>3 servings/day</b>	0.160	4.89, 5.0	0.065	4.89, 5.0	0.098	1.0, 1.05
<b>Milk Group</b>						
<b>0 serving/day</b>	3.494	2.13, 3.0	3.544	2.95, 3.77	0.265	2.91, 3.91
<b>1 serving/day</b>	2.309	2.08, 2.86	2.914	2.8, 3.5	0.494	2.83, 3.78
<b>2 servings/day</b>	3.317	1.99, 2.02	1.878	3.98, 4.02	0.636	3.41, 4.14
<b>3 servings/day</b>	3.693	3.68, 4.66	0.162	4.43, 4.81	0.044	1.22, 2.02
<b>Fat Group</b>						

1 serving/day	3.755	2.11, 3.08	0.947	2.94, 3.75	0.469	3.05, 4.14
2 servings/day	1.012	2.08, 2.74	1.077	2.58, 3.21	0.500	3.53, 4.41
3 servings/day	2.772	2.14, 2.89	3.205	3.11, 3.8	0.176	2.67, 3.57

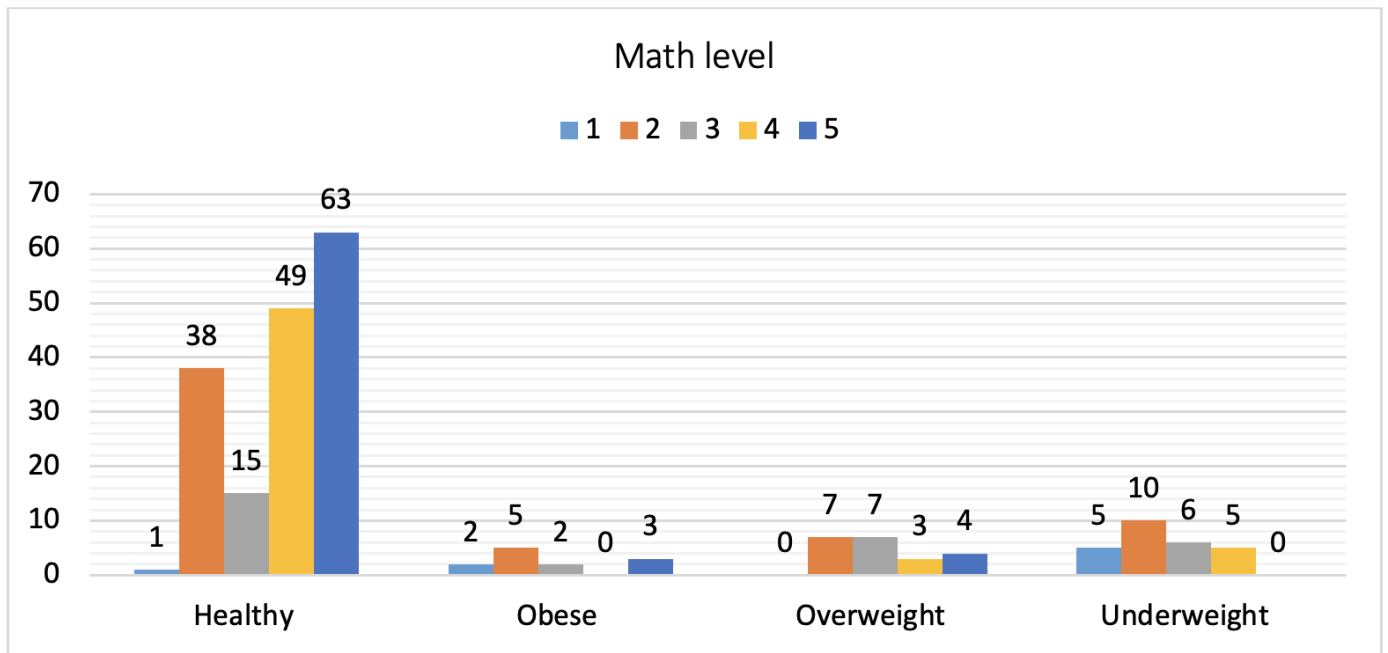
There were associations among nutritional status and reading, math and grade levels of children shown in figure 1, 2 and 3 respectively. Figure 1 showed that healthy children were abler to read paragraph as compared to unhealthy. About 28% of healthy children scored 5. Around 40% of malnourished children are not able to read or recognize at least four word from a paragraph. The association among reading level and nutritional status of students is significant with each other.



Figure 1. Association among reading level and nutritional status of students

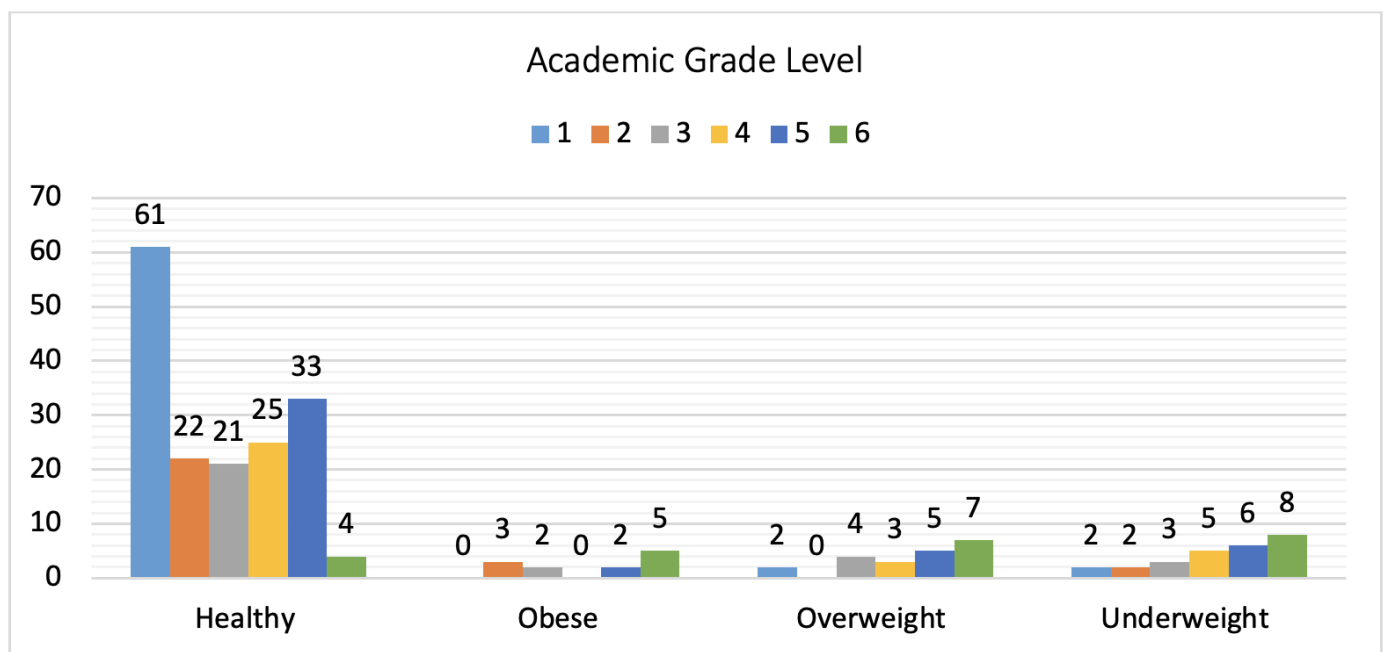
Figure 2 showed that more than 50% of healthy students scored 4-5 in math. 29% and 16.5% of malnourished students got 1 and 2 scores respectively. The ratio of healthy students was higher among those who solved division problems. The ratio of malnourished was higher among those who had 2nd and 3rd levels. The association among math level and nutritional status of students is significant with each other.





**Figure 2.** Association among math level and nutritional status of students

The results show that 93% of children were healthy who got A grade. Around 20% malnourished children got F grade. Figure 3 determined that nutritional status is greatly linked with cognition. There was significant association among the academic grade and nutritional status of the respondents.



**Figure 3.** Association among academic grade level and nutritional status of students

## Discussion

The results of current study confirm the association between low nutritional as well as socioeconomic status and poor cognitive functioning in school going children of Faisalabad aged 6-11 years.

A study was done in Pakistan in 2012. The sample was taken from primary school children 5-12 years which shows that the mean for weight, height and BMI are 26.9 kg, 128.4 cm and 16.0 kg/m<sup>2</sup> [17]. Another study was conducted in Karachi in 2016 among children aged 5-15 years which concluded that overall 1.5% children were underweight [18]. According to another cross-sectional study was done in an Indian Army School, the prevalence of underweight was 9.87%. there was a significant association among parental education, family size and nutritional status [19]. A research was carried out in Islamabad to assess the nutritional status of children aged 5-10 years. The study indicated that 35% of 6-7 years and 59% of 8-9 years were malnourished. Socioeconomic status (including family size and monthly income) was also greatly associated with nutritional status [20].

According to United Nations 2017, about 40% of families have 6 or more people in Pakistan 2012 [21]. The current data analyses that only 38% of male acquired tertiary education and only 26% and 38% of female acquired secondary and tertiary education respectively in Faisalabad. According to the World Bank recent data, literacy rate of Pakistan in 2019 is 58% with about 70% of male and less than 46.5% of female ages 15 or above.

Those who took adequate macronutrients (met RDA's) performed better than those who didn't. The study concluded that nutritional intake and BMI are significantly associated with cognitive as well as academic achievement among children. The school performance is greatly affected by dietary intake of children [22]. Another study was conducted in a rural area of south India among children of 8-11 years. The results of that study indicated that underweight and stunted children were linked with lower scores of math, reading and grade level. It revealed that both acute and chronic malnutrition is linked with poor cognition and grade level of children and adequate nutrition is important for overall health [23].

A research was conducted from Agha Khan University which reported low protein, fruit and vegetable intake among children. A low-carbohydrate, high-protein diet was associated with better growth and development in children. The importance of a balanced diet in children's nutrition a balanced diet that includes a variety of foods is essential for maintaining optimal nutritional status in children. Children who consumed a balanced diet that included a variety of fruits, vegetables, and whole grains had a better nutritional status compared to children who consumed a diet that was low in these foods [24].

## Conclusion

Malnutrition in children is a significant public health issue worldwide, especially in low-income countries. This study found that the relationship among weight, height, and BMI varied by age. Malnutrition was more common among children from middle-class families and those whose parents had lower levels of education. Many children reported nutritional intakes below recommended levels, with over half not meeting their daily requirements for cereals, fruits, and meat. Children within a healthy weight range performed better academically than those who were underweight, overweight, or obese. These findings highlight the need for further research into the interconnected impacts of socioeconomic status and health,

as well as public and environmental factors that can improve the nutritional status and cognitive health of children.

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