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A Interrelationship between Food Quality and Intellectual Performance

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ABSTRACT

This review article explores the complex relationship between food quality and intellectual performance in children and adolescents. Drawing upon six selected studies published between 2002 and 2020, the review examines how various aspects of nutrition—including malnutrition, diet quality, breakfast consumption, and micronutrient intake—affect cognitive development, intelligence quotient (IQ), and academic achievement. The analysis reveals that both under nutrition and overnutrition can impair brain function and learning outcomes, with early-life dietary deficiencies having particularly lasting effects. Additionally, the review highlights the role of breakfast in enhancing short-term memory and attention, especially among nutritionally at-risk children. Despite differences in research settings and methodologies, a consistent theme emerges: nutrient-rich, balanced diets positively influence academic performance, while poor dietary habits are linked to cognitive limitations. Socioeconomic status plays a critical moderating role, influencing access to nutritious food and educational opportunities. The findings support the need for integrated nutrition and education policies, emphasizing that early nutritional interventions are vital for cognitive health and academic success.

Keywords: Nutrition, Academic Performance, Cognitive Development, Diet Quality, Breakfast, Malnutrition, IQ, Socioeconomic Status, Brain Development, School Nutrition

INTRODUCTION

Nutrition plays a fundamental role in the physical and cognitive development of children, with growing evidence linking dietary habits to academic performance and learning capacity. Across various disciplines—including nutritional neuroscience, psychology, and education—researchers have explored how diet quality, meal frequency (particularly breakfast), and early-life nutritional status influence children's cognitive functions such as memory, attention, and problem-solving. While malnutrition, especially during critical developmental periods, has been shown to impair brain growth and reduce IQ, even suboptimal diets in well-nourished populations may limit academic potential. Moreover, both under nutrition and over nutrition have been associated with poor school performance, suggesting that both insufficient and excessive caloric intake can have detrimental effects on learning. Several studies emphasize that improving diet quality through increased intake of nutrient-dense foods like fruits, vegetables, and whole grains may enhance school outcomes. However, the impact of nutrition cannot be fully understood without considering socioeconomic factors, which influence food access, quality, and overall educational opportunity. Despite ongoing methodological challenges in establishing causality, a clear consensus emerges: good nutrition is not only essential for health but also a critical determinant of academic success and cognitive development.

Nutrition is increasingly recognized as a key factor influencing children's cognitive development and academic achievement. As the brain undergoes rapid

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growth and structural changes during early childhood and adolescence, it requires a steady supply of energy and essential nutrients to function optimally. Research across disciplines—including public health, neuroscience, psychology, and education—has established that diet quality and nutritional status are closely linked to cognitive functions such as attention, memory, executive functioning, and learning efficiency. Studies have demonstrated that malnutrition, particularly during critical periods such as prenatal development and the first few years of life, can lead to irreversible deficits in brain development and lower intelligence quotient (IQ), which in turn affect school performance. Furthermore, even in populations not experiencing clinical malnutrition, dietary inadequacies—such as low consumption of fruits, vegetables, and whole grains—are associated with decreased academic performance.

Breakfast consumption has been identified as especially important, with multiple studies showing that children who regularly eat breakfast tend to perform better on tasks requiring attention and memory, particularly in the late morning. On the other hand, overnutrition and childhood obesity have also been associated with lower academic achievement, potentially due to both biological and psychosocial consequences. Despite these associations, the influence of socioeconomic status emerges as a strong moderator in nearly all studies, shaping dietary habits, access to nutritious food, and educational opportunities. The evidence suggests that while improving nutrition is not a standalone solution, it is a critical and modifiable factor that can contribute significantly to children's academic success and long-term cognitive health. As such, the integration of nutrition into educational and public health policies is essential to support holistic child development and reduce disparities in learning outcomes.

Objective:

This study aims to review the literature on the "A review of how nutrition affects children's cognitive development and academic performance, considering the roles of diet quality, breakfast consumption, malnutrition, and socioeconomic factors.

METHODOLOGY

Information sources and search strategy:

A literature review, with the support of Google Scholar, Science Direct, Springer Link, JSTOR, and Research Gate was conducted with keywords Nutrition, Academic Performance, Cognitive Development, Diet Quality, Breakfast, Malnutrition, IQ, Socioeconomic Status, Brain Development, School Nutrition

Eligibility criteria:

Qualitative articles published in English between 2002 and 2020 that analyzed and evaluated the association between Food quality and intellectual performance. Thus, 9 articles were found relevant to this topic, but only 6 were suitable according to the eligibility criteria

RESULTS AND DISCUSSION

This study provides strong empirical evidence linking overall diet quality with academic performance, showing that children with more nutritious, well-balanced diets perform better in literacy tests. It reinforces the idea that diet quality independently affects cognition, even after controlling for socioeconomic factors. This supports policies that promote dietary diversity and adequacy in school-aged children (Florence *et al.,* 2008).

This systematic review reveals that breakfast consumption, particularly among nutritionally at-risk children, improves attention and memory. However, effects in well-nourished children are more variable. The findings underline the importance of consistent breakfast intake, though more rigorous and standardized research is needed to define what kind of breakfast works best and under what conditions (Hoyland *et al.,* 2009).

This study emphasizes the lasting effects of early-life nutrition on brain structure, IQ, and academic performance. IQ emerged as the dominant factor influencing academic outcomes, but brain volume and early undernutrition were strong predictors of IQ. The implication is that prenatal and early postnatal nutrition are critical windows for interventions to enhance cognitive development and academic success, particularly in disadvantaged populations (Ivanovic *et al.,* 2002).

Benton synthesizes diverse literature and concludes that both macro- and micronutrient sufficiency (especially in early development) are crucial for optimal brain function and learning. The review points out that while severe deficiencies have dramatic effects in developing countries, even subclinical deficiencies in developed countries may subtly impair cognitive performance. Emphasis is placed on preventative nutrition strategies

Table 1 : Summary of Reviewed Studies on the Relationship between Nutrition and Cognitive Performance in Children

Sr. No	Title of the study	Author and year	Aim of the study	Methodology	Findings/outcomes
1.	The Relationship of Food and Academic Performance: A Preliminary Examination of the Factors of Nutritional Neuroscience, Malnutrition, and Diet Adequacy	Allison *et al.* (2012)	To preliminarily examine how nutritional neuroscience, malnutrition (under- and over-nutrition), and overall diet quality influence academic performance in children.	The researchers conducted a literature review Theoretical review and synthesis on Nutritional neuroscience and the brain's dietary needs. Effects of malnutrition during different developmental stages. Impact of diet quality (measured by DQI and HEI) on academic performance **Theoretical Frameworks Used:** Maslow's hierarchy of needs, Vygotsky's sociocultural theory, and cognitive neuroscience .	**Malnutrition (Under- and Over-nutrition):** • Under nutrition, particularly in early development, can impair long-term cognitive potential. • Over nutrition (e.g., obesity) is linked with reduced school attendance and lower academic performance, though causality is unclear. **Diet Quality:** • Diets high in nutrient-dense foods (fruits, vegetables, whole grains) are associated with better academic outcomes. • High consumption of fast food and low diet variety negatively impacts cognition.
2	Nutritional Status of Primary School Children: Association with Intelligence Quotient and Academic Performance	Akubuilo *et al.* (2020)	To determine the association between nutritional status, intelligence quotient (IQ), and academic performance of primary school children in Enugu, Nigeria.	**Design:** Cross-sectional study **Participants:** 1122 children aged 6–12 years from public and private schools **Sampling:** Proportionate multistage random sampling **Tools and Measures:** **Nutritional status:** WHO Anthro Plus to determine underweight, stunting, wasting, overweight, and obesity **IQ:** Raven's Standard Progressive Matrices **Academic performance:** Average scores from three academic terms across four subjects **Analysis:** Chi-square tests and logistic regression, adjusted for socio-economic status and gender	Prevalence: underweight (2.0%), wasting (3.6%), stunting (2.1%), overweight (6.7%), and obesity (4.2%) Overweight **and obesity** were significantly associated with higher IQ and better academic performance in unadjusted models. These associations **disappeared after controlling for socioeconomic status**, indicating that socioeconomic factors mediate the effect. Wasting showed a trend toward lower IQ, but was not statistically significant. Stunting had no significant association with IQ or academic performance, possibly due to its low prevalence in the sample.
3.	The influence of dietary status on the cognitive performance of children	David *et al.* (2010)	To review the impact of dietary status, including both macronutrients and micronutrients, on the cognitive development and performance of children in both developing and industrialized countries.	**Type:** Narrative review **Sources:** Various studies, including randomized controlled trials and observational studies **Scope:** Examined influence of early-life nutrition (e.g., during pregnancy, infancy) Evaluated short-term cognitive effects of meals (e.g., breakfast) Covered micronutrients (iron, iodine, zinc, vitamin B12, folate, vitamin D, choline) Reviewed both developing and developed world contexts	**Critical periods:** Early brain development (especially last trimester and first 2 years of life) is highly vulnerable to dietary deficiencies. **Micronutrient Deficiencies:** **Iodine and iron** deficiencies in infancy have lasting, often irreversible effects on cognitive function. **Zinc**, **vitamin B12**, **folate**, and **choline** deficiencies also impair brain development and function. **Short-term Effects:** **Skipping breakfast** impairs attention and memory, particularly late in the morning. **Low glycemic index (GI) meals** provide more sustained cognitive benefits. **Industrialized Countries:** Evidence of benefit from multivitamin/ mineral supplementation exists, especially for non-verbal intelligence and behavior (e.g., reduced aggression). Effects are usually more subtle than in developing countries.

Table 1 contd.

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4.	Nutritional Status, Brain Development and Scholastic Achievement of Chilean High-School Graduates from High and Low Intellectual Quotient and Socio-Economic Status	Ivanovic *et al.* (2002)	To examine the relationships between past and current nutritional status, brain development, and scholastic achievement in Chilean high school graduates with differing levels of intellectual quotient (IQ) and socio-economic status (SES).	**Design:** Comparative cross-sectional study **Participants:** 96 high school graduates (aged ~18 years) categorized by high or low IQ (WAIS-R scores) and SES **Measurements:** **IQ:** Wechsler Adult Intelligence Scale – Revised (WAIS-R) **Nutritional status:** Birth weight, BMI, anthropometrics (e.g., head circumference) **Brain development:** MRI to measure brain volume (BV), corpus callosum, cortical thickness **Academic performance:** Scholastic Achievement (SA) test (language + math) and Academic Aptitude Test (AAT) **Statistical Analysis:** Multiple regression to determine predictors of IQ, SA, AAT	• **Maternal IQ**, **brain volume**, and **severe under nutrition during the first year of life** were the strongest independent predictors of child IQ ($R^2 = 0.707$). • **Child IQ** was the only significant predictor of **scholastic achievement** ($R^2 = 0.848$) and **academic aptitude** ($R^2 = 0.876$), regardless of sex or SES. • Students with high IQ had higher birth weights, brain volumes, and academic outcomes than those with low IQ, **independent of SES**. • Head circumference was confirmed as a key anthropometric indicator of early nutrition and brain development. • **Under nutrition in infancy** significantly impaired brain development and academic outcomes, especially in low-SES participants. • Even in high-SES children with low IQ, brain volume and SA were similar to those in low-SES children with low IQ, highlighting the dominant role of **IQ over SES** in academic outcomes.
5.	A Systematic Review of the Effect of Breakfast on the Cognitive Performance of Children and Adolescents	Hoyland *et al.* (2009)	To systematically review and evaluate the effects of breakfast consumption on cognitive performance in children and adolescents, focusing on both well-nourished and nutritionally at-risk groups.	**Type of Study:** Systematic review **Data Sources:** Medline, PsycInfo, Web of Science (from 1950 to January 2009) **Included Studies:** 45 studies from 41 publications **Participants:** Children and adolescents aged 4–18 years **Inclusion Criteria:** Studies comparing breakfast with no breakfast, and differing breakfast types, involving objective measures of cognitive performance **Study Categories:** Acute experimental studies School breakfast program interventions Studies on habitual breakfast consumption Nutritional status–based subgroup analysis **Quality Assessment:** An 18-item custom rating tool was developed and used to assess methodological quality	Breakfast consumption generally benefits cognitive performance compared to skipping breakfast, especially in children at nutritional risk. Cognitive domains most positively affected include memory and attention, particularly late in the morning. Well-nourished children showed more variable effects; benefits were more pronounced under demanding cognitive tasks. There is limited and inconsistent evidence on the effects of breakfast type, composition, energy content, and glycaemic index. Few studies included adolescents or directly compared types of breakfast. School breakfast programs appeared to improve academic performance, though effects may partly be due to improved attendance. The review highlights significant methodological variability and a need for more rigorous, standardized future research.

Table 1 contd…

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6.	Diet Quality and Academic Performance	Florence *et al.* (2008)	To examine the association between overall diet quality and academic performance among grade 5 students in Nova Scotia, Canada.	**Study Design:** Cross-sectional study **Participants:** 5200 grade 5 students and their parents (from the 2003 Children's Lifestyle and School-performance Study) **Diet Assessment Tool:** Harvard Youth/Adolescent Food Frequency Questionnaire (YAQ); Diet Quality Index–International (DQI-I) and Healthy Eating Index (HEI) were used to measure diet quality. Academic **Performance Assessment:** Linked to results from a provincial standardized literacy test (reading and writing components). Analysis**:** Multilevel logistic regression adjusting for gender, socioeconomic status, residential neighborhood income, and school performance.	• Students with higher overall diet quality (measured by DQI-I and HEI) were significantly less likely to perform poorly on literacy assessments. • Diet components such as dietary **adequacy** (e.g., intake of fruits, vegetables, grains, protein) and **variety** were most strongly associated with better academic performance. • Socioeconomic advantages, including higher parental income and education, also positively influenced academic outcomes. • Gender differences were observed: girls performed better than boys. • Diet quality had an independent effect on academic performance even after adjusting for socioeconomic and school-related factors.

like fortification and supplementation (Benton *et al.,* 2010).

This Nigerian study challenges conventional assumptions by finding no significant association between under nutrition and IQ/academic performance after adjusting for confounders. However, over-nutrition (obesity and overweight) initially appeared associated with better IQ and performance, which disappeared after controlling for socioeconomic status. This suggests that SES is a powerful mediator in the nutrition–cognition–achievement link, especially in rapidly transitioning societies (Akubuilo *et al*., 2020).

As a theoretical and interdisciplinary review, this article integrates nutritional neuroscience, developmental psychology, and learning theory (e.g., Maslow, Vygotsky) to argue that nutrition underpins cognitive ability. While acknowledging a lack of conclusive causal evidence, the article posits that consistent, quality food intake is essential for educational success. It also highlights the practical importance of school-based nutritional programs and policy reform (Woodhouse *et al.,* 2012).

DISCUSSION

The synthesis of six research articles reveals a robust yet multifaceted relationship between nutrition and academic performance among children and adolescents. Across varying methodologies and settings, there is consistent evidence that both the quality and adequacy of nutrition significantly influence cognitive function and learning outcomes. Nutrient-rich diets—high in fruits, vegetables, whole grains, and essential micronutrients—are associated with improved memory, attention, and school performance, while early-life under nutrition is linked to reduced brain volume, lower IQ, and long-term academic disadvantages. The importance of specific dietary behaviors, such as eating breakfast, is highlighted in several studies, showing benefits in short-term cognitive performance, especially among nutritionally at-risk populations. However, the relationship is not linear; over nutrition, particularly childhood obesity is also associated with poor academic results, potentially due to social stigma, absenteeism, or underlying metabolic impacts on brain function. A recurring theme in all studies is the influential role of socioeconomic status, which can both confound and moderate the effects of nutrition—suggesting that while healthy diets are important, they must be understood within broader social and economic contexts. Despite methodological differences and limitations, these studies collectively support the view that investing in children's nutrition, particularly through early-life interventions and school-based programs, holds significant potential to enhance educational achievement and cognitive development

Conclusion:

In conclusion, the combined evidence from the six

studies underscores the essential role of nutrition in supporting children's cognitive development and academic performance. A well-balanced, nutrient-rich diet positively influences brain function, memory, attention, and learning capacity, while early under nutrition can lead to lasting cognitive and academic deficits. Regular consumption of breakfast and improvements in overall diet quality are particularly beneficial, especially for children from disadvantaged backgrounds. However, socioeconomic factors significantly influence both nutritional access and academic outcomes, indicating that nutrition-focused interventions must be part of broader efforts to address inequality. Although causality is difficult to establish due to methodological challenges, the collective findings strongly advocate for early, sustained nutritional support—particularly through school programs and public health policies—as a vital strategy for promoting academic success and long-term cognitive health.

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