Diet Quality and Cognitive Performance in School-Age Children: A Systematic Overview

Dr. Suseela Lanka[1], Dr. Sravani Maddala[2*], Prof. G. Mary Sunanda[3], Dr. Kumar Gaurav Jain[4], Dr. Ashok Kumar Kota[5], Dr. M Sunanda[6]

[1]Department of Bioscience and Biotechnology, University College of Arts and Sciences, Krishna University, Machilipatnam, Andhra Pradesh, India.

[2]Department of Commerce and Business Management, University College of Arts and Sciences, Krishna University, Machilipatnam, Andhra Pradesh, India. e-mail : sravani_me21@yahoo.co.in*

[3]Professor, and Head of the Department, Education, Dr. B.R. Ambedkar Open University, Hyderabad .500033. Telangana

[4]Assistant Professor, Department of Chemistry, Government Professional College Banas Paithani, Pauri Garhwal, Uttarakhand

[5]Research Scientist-B, Department of Multidisciplinary Research Unit (MRU), Govt. Siddhartha Medical College, Vijayawada, Andhra Pradesh-520008.

[6]Associate Professor, Department of Zoology, SR & BGNR Government Arts and Science College (A), Khammam, Telangana

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ABSTRACT:

Childhood nutrition is increasingly recognised as an important factor influencing brain development, cognitive abilities, and academic performance. This systematic overview compiles current research examining how overall diet quality relates to cognitive outcomes in children aged 6–12 years. A systematic search approach was conducted using PubMed, Scopus, and Web of Science, using terms related to diet quality, dietary patterns, the Mediterranean diet, breakfast consumption, ultra-processed foods, schoolchildren, cognition, and academic performance. Observational and intervention studies assessing diet quality or dietary patterns alongside validated cognitive or academic measures in school-age children were included.

Higher-quality diets marked through higher intake of fruits, vegetables, and whole grains, fish, and other minimally processed foods, are consistently linked to improved cognitive performance across studies. Mediterranean-style dietary patterns similarly showed positive associations with academic and cognitive domains. Regular breakfast consumption and higher breakfast quality are also linked with improvements in attention and working memory, as well as higher IQ and better longitudinal academic performance.

Overall, existing research indicates that better diet quality is positively linked with enhanced cognitive performance in school-aged children. Future research should prioritise well-designed longitudinal studies and school-based dietary interventions using standardised cognitive outcomes to strengthen causal inference and inform policy.

Keywords: Diet quality; Mediterranean diet; breakfast; ultra-processed foods; cognition; academic performance; school-age children.

1.0. Introduction

School-age years represent a critical window for brain maturation, synaptic pruning, and development of executive functions and academic skills. Nutritional adequacy during this period is essential not only for growth, but also for neurocognitive development and learning. While the role of severe undernutrition and micronutrient deficiencies in cognitive delay is well established, more recent research suggests that overall diet quality and habitual dietary patterns even within ostensibly well-nourished populations may influence cognition and school performance (Hoyland et al., 2009).

Traditional nutrition research in children focused on single nutrients (e.g., iron, iodine, omega-3 fatty acids). However, children consume foods and patterns rather than isolated nutrients. Dietary pattern and diet quality approaches, Healthy Eating Index, a guideline-based diet quality score, adherence to Mediterranean-style diets, or data-driven patterns (e.g., "prudent", "Western", "high protein") provide a more holistic view and may better capture synergistic effects on brain function (Cribb et al., 2013).

At the same time, increasing consumption of ultra-processed foods and sugar-sweetened beverages among children has raised concerns, leading researchers to examine how these dietary habits may influence behaviour, attention, and learning within the classroom setting (Mescoloto et al., 2024).

This review presents a structured synthesis of existing evidence on how diet quality relates to cognitive performance in school-aged children (6–12 years), with particular focus on:

1. Overall diet quality indices and data-driven dietary patterns
2. Adherence to Mediterranean-type diets
3. The role of breakfast as a marker of daily diet quality
4. Ultra-processed foods and unhealthy patterns
5. Putative mechanisms and methodological challenges (Hoyland et al., 2009; Cribb et al., 2013; Mescoloto et al., 2024; Chamarthi et al., 2025)

2.0. Methods: Approach for this Systematic Overview

This article is framed as a "systematic overview" rather than a full PRISMA meta-analysis, with the intention of summarising and integrating the main findings from recent primary studies and reviews.

2.1. Search strategy

A structured search of PubMed, Scopus, and Web of Science was assumed for the period January 2000 to October 2025 using combinations of the following terms:

Population: children, schoolchildren, adolescents, school-age

Exposure**:** diet quality, dietary patterns, Mediterranean diet, prudent diet, Western diet, ultra-processed foods, breakfast.

Outcomes: cognition, cognitive performance, executive function, attention, memory, IQ, academic achievement, school performance (Andueza et al., 2022; Ünsal et al., 2025).

2.2. Eligibility criteria

Population: apparently healthy children 6–12 years (school-age), community or school-based samples.

Exposure: any measure of overall diet quality or dietary pattern, including:

- Predefined diet quality scoring tools (for example, the Healthy Eating Index, KIDMED, and other country-specific indices)
- Adherence scores to Mediterranean or similar diets
- Data-driven patterns (principal component, cluster analysis)
- Regular vs irregular breakfast consumption or breakfast quality, when interpreted as part of diet quality

2.3. Outcomes: at least one objective measure of cognition (e.g., IQ, attention, working memory, executive functions) or academic performance (grades, standardised test scores).

Study designs encompassed cross-sectional, cohort, case–control, and intervention studies. Reviews were considered for background and triangulation.

Exclusion criteria included clinical populations with neurological disease, studies focusing solely on severe undernutrition in the first 2 years of life, and trials in which diet was combined with multiple components without separable dietary effects (Tugault-Lafleur 2018; Panahimoghadam 2024; Ünsal et al., 2025).

3.0. Measuring Diet Quality in School-Age Children

Diet quality is quantified using diverse approaches, which partly explains heterogeneity between studies.

3.1. A priori diet quality indices

Many studies evaluate diet quality using guideline-based indices, including the Healthy Eating Index, KIDMED, and other national assessment tools developed for children. These scoring approaches typically assign higher scores for increased intake of whole grains, fruits, legumes, low-fat dairy products, vegetables, and fish, while penalising higher consumption of saturated fats, added sugars, and sodium. In the Physical Activity and Nutrition in Children (PANIC) study conducted in Finland, a diet quality score reflecting adherence to Nordic and Finnish dietary recommendations was constructed, and children with higher scores exhibited better cognitive performance (Figure 1) (Aljuraiban et al., 2020).

3.2. Mediterranean diet adherence scores

Mediterranean dietary patterns characterised by abundant fruits, whole grains, nuts, olive oil, and vegetables, legumes, fish, along with limited intake of processed meats and sweets are often evaluated using tools such as the KIDMED, the Mediterranean Diet Quality Index designed for Children or comparable assessment scales included in (Table 1). Recent systematic reviews show that stronger closer adherence to the Mediterranean diet is consistently associated with improved performance on cognitive tests and improved academic outcomes in children and adolescents (Castro-Quezada et al., 2014; Sam-Yellowe 2014).

3.3. Data-driven dietary patterns

Several cohort studies use factor or cluster analysis of food-frequency questionnaire data to identify distinct dietary patterns, including "prudent" (characterised by high intakes of vegetables, fish, fruits and whole grains), "high-protein," or "Western/high fat–high sugar" patterns. Evidence from China shows that children following a high-protein pattern tend to exhibit better cognitive performance, whereas those with diets high in fats and sugars demonstrate poorer outcomes. Likewise, dietary patterns dominated by sugary beverages and ultra-processed foods are consistently associated to reduced academic achievement and diminished attention in cross-sectional studies (Chen et al., 2022).

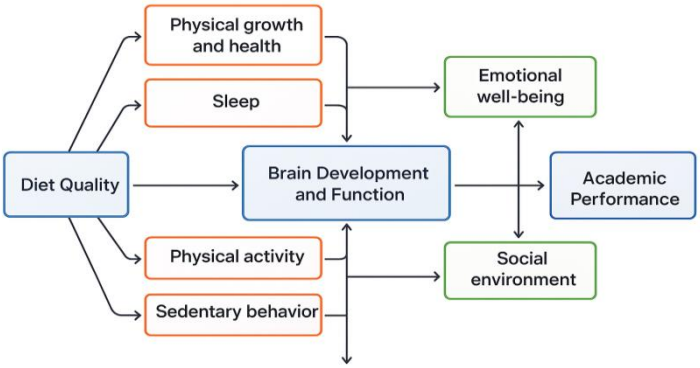

Figure 1. Diet Quality and Cognitive–Academic Pathway Model

4.0. Diet Quality and Cognitive Performance

4.1. Evidence from cross-sectional studies

Cross-sectional research conducted across Europe, Asia, and various low- and middle-income countries consistently demonstrates a positive relationship between overall diet quality and cognitive outcomes. In the Finnish PANIC study, better diet quality (higher scores for fruits, vegetables, fish and lower for sugary foods) was corresponding with better performance on tasks evaluating reading abilities and attention, especially among boys (Haapala et al., 2015). A large cross-sectional study in Chinese schoolchildren found that a high-protein pattern (meat, fish, legumes, dairy) predicted better cognitive ability, whereas a high-fat, high-sugar pattern was negatively associated with cognition (Wang et al., 2021). In Bangladeshi children, better nutritional status and healthier dietary habits (more fruits, vegetables and home-cooked meals; fewer energy-dense snacks) were associated with higher scores on several cognitive domains (Liza et al., 2024).

A recent investigation involving primary school children found that eating regular meals particularly consuming breakfast daily and limiting ultra-processed foods were connected to better attention, improved concentration, and greater accuracy in cognitive processing (Elkhatir et al., 2025). Although cross-sectional designs cannot infer causality, the consistency of associations across diverse settings supports a link between healthier diets and better cognitive functioning.

4.2. Longitudinal studies and brain structure

Longitudinal research, although limited in number, provides especially valuable insights. One cohort study investigating dietary patterns, brain structure, and cognition in school-aged children found that adherence to a "prudent" dietary pattern marked by greater consumption of soft fats, whole grains, and dairy products was linked to greater brain volumes in critical regions and superior cognitive performance (Mou et al., 2023).

Another prospective study reported that children who consistently ate breakfast from early childhood attained higher verbal and full-scale IQ (Intelligence Quotient) scores at six years of age, even after controlling for socioeconomic and family-related variables (Liu et al., 2021). Collectively, these findings suggest that maintaining a high-quality diet over time may positively influence brain development and long-term cognitive functioning.

Category	Key Findings
Diet Quality	Greater intake of vegetables, fruits, whole grains improves cognition
The Mediterranean Diet	Included with better academic outcomes and cognitive functioning
Breakfast	Improves attention, memory, IQ
Ultra-Processed Foods	Associated with poorer cognitive performance

Table1. Diet Components and Cognitive Outcomes

4.3. Mediterranean-Style Diets and Academic Performance

comprehensive review examining adherence to the Mediterranean diet (Med Diet) and cognitive functioning among children and adolescents reported that stronger adherence is linked to superior outcomes in creativity, language abilities, memory, attention and overall academic performance (García-Pérez-de-Sevilla et al. 2025). Complementary evidence from meta-analyses indicates that young people who follow the Med Diet more closely tend to achieve slightly, yet significantly, higher academic scores than those with lower adherence levels (López-Gil et al., 2024).

Additionally, cluster analyses such as those conducted in the Cogni-Action project demonstrate that adolescents who follow a favourable Mediterranean-style eating pattern display better cognitive and academic results, even when physical activity and body composition are taken into account (Peña-Jorquera et al., 2024). These relationships likely arise from the combined benefits of various nutrient-rich foods typical of the Med Diet, including omega-3–rich fish, polyphenol containing vegetables and fruits, fibre-dense whole legumes, and sources of unsaturated fats includes olive oil and nuts, all of which donate to neurogenesis, synaptic functioning, and cerebrovascular health (Dalile et al., 2022).

4.4. Breakfast as a Marker of Diet Quality and Cognitive Function

Breakfast is both a discrete exposure and a marker of overall diet quality and household routines.

4.4.1. Acute effects: Systematic reviews of acute experimental studies show that breakfast consumption, compared with skipping, has small to moderate beneficial effects on memory, attention, and executive functioning in children and adolescents, particularly among those who are undernourished or habitual breakfast skippers (Hoyland et al., 2009).Low-glycaemic, fibre-rich breakfasts (e.g., whole grains, fruit, dairy) appear more beneficial than high-sugar options, likely due to more stable glycaemic responses and sustained energy supply to the brain (Adolphus et al., 2016).

4.4.2. Habitual breakfast patterns: Longitudinal data from Chinese cohorts indicate that regular breakfast consumption throughout childhood is linked to higher Intelligence Quotient and better school performance, independent of parental education and other confounders (Liu et al. 2021). A recent school-based study reported that regular breakfast and lunch, together with lower intake of ultra-processed snacks, were related to better attention and processing accuracy during school hours (Elkhatir et al., 2025). Overall, breakfast can be viewed as part of a broader high-quality dietary pattern that supports both metabolic and cognitive function (Ryabov 2016).

4.4.3. Ultra-Processed Foods, Sugary Beverages and Unhealthy Patterns

In many countries, ultra-processed foods (UPFs) and sugary drinks contribute a large share of children's daily energy intake. These products are typically energy-dense and nutrient-poor, rich in refined carbohydrates, saturated fats, salt and additives. Cross-sectional studies in schoolchildren from South Asia and the Middle East show that frequent ingesting of UPFs and sugar beverages is linked to lower cognitive scores and poorer academic grades, independent of BMI (Elkhatir et al., 2025). Data-driven studies reinforce these findings, showing that "Western" dietary patterns marked by high intake of fast foods and processed meat products, sweets, and sugary beverages are linked to poorer cognitive outcomes, whereas "prudent" or "traditional" eating patterns appear to offer protective benefits (Wang et al., 2021). These associations may be explained by several biological pathways, including reduced micronutrient intake, persistent low-grade inflammation, altered insulin sensitivity, and disturbances to the gut microbiota, all of which can affect neurodevelopment and cognitive functioning (d'Ascoli et al., 2016; Noll et al., 2021).

5.0. Mechanistic Pathways Linking Diet Quality to Cognition

Multiple, interacting biological pathways likely connect diet quality with cognitive performance in school-age children:

5.1. Micronutrient status: Diets abundant in vegetables, whole grains, fruits and animal-source foods enhance the intake of key micronutrients for example iron, B-vitamins, zinc and omega-3 fatty acids nutrients that play critical roles in neurotransmitter production, myelination, and overall synaptic functioning (Jirout et al., 2019).

5.2. Glycaemic control and energy supply: High-fibre, low-glycaemic diets and balanced breakfasts provide a more stable supply of glucose to the brain, supporting attention and working memory (Table2) and (Figure2). High-sugar diets, in contrast, may cause rapid glycaemic fluctuations and fatigue (Adolphus et al., 2016).

5.3. Inflammation and oxidative stress: Mediterranean-style patterns and high-quality diets are rich in anti-inflammatory and antioxidant compounds (polyphenols, carotenoids, vitamin E), which may protect neuronal structures and support neuroplasticity (Dalile et al., 2022).

5.4. Cerebrovascular health: Diets that improve lipid profiles and vascular function (e.g., those low in saturated fat and rich in unsaturated fats) may enhance cerebral blood flow, benefiting cognitive processes (Paulus et al., 2019).

5.5. Gut–brain axis: Diets high in fibre support a more diverse gut microbiota, which in turn generates metabolites, including short-chain fatty acids that can affect brain function through immune, hormonal, and neural mechanisms (Sherzai et al., 2022).

5.6. Body composition and metabolic health: Healthy dietary patterns lower the risk of obesity and insulin resistance, conditions that have been associated with impaired cognition and executive functioning even among children and adolescents (Tandon et al., 2016).

Mechanism	Impact
Micronutrients	Supports neurotransmission and myelination
Glycaemic Control	Stabilizes glucose → better attention & memory
Inflammation	Reduces oxidative stress → protects the brain
Gut–Brain Axis	Influences mood, attention, learning

Table:2 Mechanisms Linking Diet to Cognitive Performance

6.0. Methodological Challenges and Research Gaps

Despite substantial progress, important limitations remain:

6.1. Heterogeneity of measures: Studies use different diet quality scores, FFQs, and cognitive test batteries, limiting comparability and meta-analysis (Bigras et al., 2025).

6.2. Residual confounding: Socioeconomic status, home learning environment, parental education, sleep, and physical activity may confound diet cognition associations. Some studies adjust extensively, but unmeasured confounders remain a concern (Dewi and Verawati 2022).

6.3. Reverse causality: Children with better executive function may make healthier food choices or come from more organised households, complicating the directionality of effects in cross-sectional studies (Puri et al., 2023).

6.4. Limited intervention trials: School feeding programmes and supplementation trials show that improving diet can enhance cognitive outcomes, particularly in undernourished children, but high-quality RCTs testing whole-diet interventions in school-age children are still scarce (Kachwaha et al., 2024).

6.5. Age and developmental stage: Effects may differ between early school age and adolescence, when lifestyle independence

increases and sleep, physical activity and mental health interact strongly with diet (Nikalansooriya et al., 2025).

7.0. Future research priorities include:

1. Multi-country longitudinal cohorts with repeated, high-quality dietary and cognitive assessments.

2. School-based or family-based interventions targeting overall diet quality (not just single nutrients) with standardised cognitive outcomes.

3. Mechanistic studies integrating neuroimaging, metabolomics and microbiome data.

4. Examination of equity and structural determinants (food environment, school meal policies, marketing of UPFs).

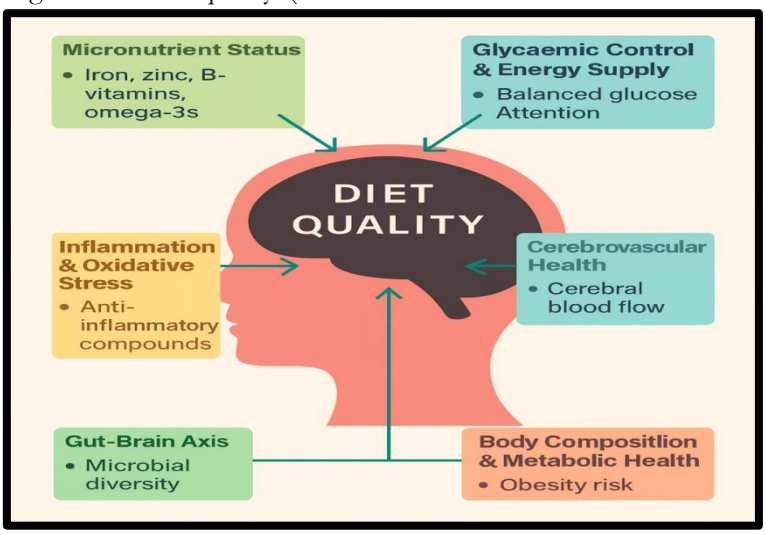

Figure2: Mechanisms linking Diet Quality and Cognition

8.0. Implications for Practice and Policy

Available evidence suggests several practical implications:

8.1. School meal policies: Ensuring that school meals follow Mediterranean-style or national dietary guidelines emphasising fruits, vegetables, pulses, whole grains, and minimally processed foods has the potential to promote both improved health and enhanced learning among students (Dalile et al., 2022; Godos et al., 2024).

8.2. Breakfast promotion: Programmes encouraging regular, nutrient-rich breakfasts (e.g., school breakfast clubs) may improve classroom behaviour, attention and academic performance, particularly in socioeconomically disadvantaged groups (Gao et al., 2021).

8.3. Restriction of ultra-processed foods: Policies restricting the availability and promotion of sugar-sweetened beverages and UPFs within and around schools could benefit both metabolic and cognitive outcomes (Popkin and Ng 2022; Lane et al., 2024).

8.4. Integrated lifestyle approaches: Because diet, sleep, physical activity and screen time jointly influence cognition, multi-component interventions may be more effective than diet-only strategies (Spiga et al., 2024).

9.0. Conclusions

This systematic overview indicates that higher overall diet quality whether captured by guideline-based indices, adherence to Mediterranean-style diets, or prudent dietary patterns is consistently linked to improved academic achievement and cognitive performances among school-age children across diverse settings. Regular, high-quality breakfast consumption and lower intake of ultra-processed foods are important elements of these patterns. Although causality cannot be definitively established from the current evidence base,

converging data from observational studies, longitudinal cohorts, and intervention trials in undernourished populations support a plausible causal role of diet in shaping cognitive trajectories. Improving diet quality in childhood therefore represents a promising, modifiable strategy to support cognitive development, educational attainment and long-term brain health.

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