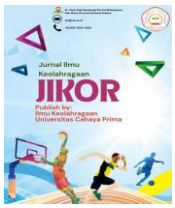

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Narrative Review: Analysis of Nutritional Intake on The Quality of Students Learning

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ABSTRACT

Nutritional intake plays a vital role in supporting cognitive processes, particularly learning concentration among school-aged children. This narrative review examines the relationship between nutritional intake, learning concentration, and academic achievement. A systematic search through Google Scholar, PubMed, and Scimago identified 56 articles published between 2015 and 2024, of which nine met the inclusion criteria. The selected studies were analyzed thematically based on nutritional status, energy and protein adequacy, and the effects of nutrition education. The findings show that daily nutritional intake especially adequate energy and protein consumption and regular breakfast habits has a more direct and consistent influence on learning concentration than anthropometric nutritional status. Energy adequacy contributed 36.2% to concentration levels, and nutrition education significantly improved students' energy and protein intake ($p = 0.005$). In contrast, several studies reported no significant association between nutritional status and academic achievement, indicating that concentration depends more on immediate nutrient availability than long-term health indicators. This review concludes that adequate nutritional intake is essential for sustaining attention and improving students' learning outcomes. Schools should implement structured nutrition education, promote regular breakfast consumption, and support access to balanced meals. Future research should explore interactions between nutrition, sleep, physical activity, and socioeconomic factors to better understand the multifactorial determinants of concentration.

INTRODUCTION

The success of a nation is determined by the quality of its human resources, which in turn depends on the health and intellectual capacity of its younger generation. Optimal nutrition during childhood is one of the fundamental determinants of physical growth, brain development, and learning potential (WHO, 2020). School-age children (6–12 years) represent a critical stage for cognitive and psychosocial development. During this period, nutritional adequacy directly affects their ability to concentrate, remember, and process information effectively (Best, 2017; Nyaradi et al., 2016).

Learning concentration is a key component of academic performance. Concentration enables students to focus attention, absorb information, and apply acquired knowledge in problem-solving tasks (Maehler & Schuchardt, 2022). Students who maintain concentration during learning are more likely to achieve higher grades and retain information for longer periods. Conversely, poor concentration is often associated with fatigue, low glucose availability, and inadequate nutrition, which disrupt cognitive functioning (Adolphus et al., 2019; Benton & Nabb, 2021).

Nutrition provides the essential substrates for brain metabolism and neurotransmitter synthesis. Micronutrients such as iron, iodine, and zinc play important roles in cognitive processes, while macronutrients such as carbohydrates and proteins supply the energy needed for brain activity (Bryan et al., 2021). Glucose, in particular, is a critical energy source for the brain; insufficient intake can impair attention, memory, and decision-making (Dye et al., 2020). Balanced nutrition not only supports physical health but also strengthens students' ability to maintain focus and perform mental tasks efficiently (Wesnes et al., 2017).

Empirical studies have demonstrated that students with balanced nutritional intake, especially those who regularly consume breakfast, show significantly better learning concentration and academic outcomes compared to those who skip meals (Cahyanto et al., 2021; Masrikhiyah & Octora, 2020; Mahoney et al., 2019). However, other studies found no significant correlation between nutritional status and academic achievement (Utami et al., 2019; Astuti & Fathonah, 2019). These inconsistencies suggest that the impact of nutrition on learning may be mediated by other factors such as socioeconomic status, physical fitness, or educational environment (Astuti & Erianti, 2022; Taras, 2005).

Most existing studies have focused on specific aspects such as breakfast habits or energy adequacy without examining the combined effects of nutrition education, dietary diversity, and nutrient balance on students' cognitive and academic performance (Nurcahyani et al., 2020; Dharod et al., 2019). Therefore, a comprehensive synthesis of available evidence is required to better understand how nutritional intake contributes to learning concentration and achievement.

Child cognitive development is strongly shaped by the interaction of nutritional intake and neurobiological maturation. According to executive function theory, attention, working memory, and inhibitory control rely heavily on glucose availability in the prefrontal cortex, the brain region most sensitive to fluctuations in energy supply (Diamond, 2013). During school hours, children experience high cognitive load, making consistent nutrient intake essential for maintaining optimal neural efficiency.

Micronutrients also play a significant role. Iron is required for oxygen transport and dopamine synthesis, both crucial for attention regulation. Zinc supports neuroplasticity, while iodine contributes to thyroid hormone production, which regulates brain development. Deficiencies in these micronutrients have been associated with impaired task focus, slower processing speed, and reduced academic performance (Bryan et al., 2021; Nyaradi et al., 2016).

On a global scale, UNICEF (2022) reports that nearly 40% of school-aged children in low- and middle-income countries skip breakfast regularly, contributing to learning difficulties and increased in-class fatigue. In Indonesia, the National Basic Health Survey (Riskesdas, 2021) found that 1 in 3 students goes to school without breakfast, directly correlating with reduced concentration during morning lessons. These findings highlight the urgent need to address nutritional practices as part of the educational agenda.

This narrative review aims to analyze the relationship between students nutritional intake, concentration, and academic performance by integrating evidence from recent empirical studies (2015–2024). The findings are expected to contribute to the development of school-based nutrition policies and educational interventions that support students' cognitive and academic potential.

METHODS

This study employed a narrative literature review design to synthesize empirical evidence regarding the relationship between nutritional intake and students' learning concentration and academic achievement. The review followed the methodological framework for narrative synthesis outlined in recent literature (Campbell et al., 2020; Hong et

al., 2018), ensuring transparency, reproducibility, and systematic identification of relevant studies.

A comprehensive search was conducted using *Google Scholar*, *PubMed*, and the *Scimago Journal Database*. The keywords used in both English and Indonesian included: "nutritional intake," "learning concentration," "academic achievement," "student performance," and "nutrition education." Boolean operators (AND/OR) were applied to combine search terms and refine the results. The search was limited to articles published between 2016 and 2024 to ensure the inclusion of up-to-date evidence.

Inclusion criteria: Articles published from 2015–2024; Empirical research using quantitative, quasi-experimental, or correlational designs; Studies examining nutrition-related variables (e.g., energy intake, protein adequacy, breakfast habits, or nutrition education) in relation to learning concentration or academic performance; Participants aged 6–18 years; and Published in English or Indonesian with full-text availability. Exclusion criteria: Review papers, conference abstracts without full text, or non-peer-reviewed sources; Studies involving clinical or special-needs populations; and Articles without measurable indicators related to nutritional intake or concentration.

Selection process: The database search initially identified 56 studies. After removing duplicates and screening titles and abstracts, 23 studies met the inclusion criteria for full-text assessment. Finally, 9 studies were retained for qualitative synthesis as they provided comprehensive and relevant data addressing the research objectives. The overall process followed a transparent screening and eligibility procedure consistent with recent narrative review standards (Hong et al., 2018).

Data analysis: The selected studies were analyzed using a thematic narrative synthesis approach (Campbell et al., 2020). Data were extracted for author, year, study design, sample characteristics, nutritional variables, and key outcomes. Thematic grouping was conducted to identify convergent and divergent findings, resulting in three main analytical themes: (1) the relationship between nutritional status and academic achievement; (2) the effect of energy and protein adequacy on learning concentration; and (3) the role of nutrition education in supporting students' cognitive performance.

This narrative synthesis enabled integration of diverse study designs and outcomes, providing a comprehensive understanding of how nutritional intake influences students' learning quality and achievement.

RESULTS

The results of the literature search on nutritional intake and its effect on students' learning concentration are shown in Table 1.

Table 1. Summary of Literature Review Search Results

Authors and Year	Publisher	Method	Results
Cahyanto et al. (2021)	PLACENTUM: Scientific Journal of Health and Its Applications	Cross-sectional analytical	Positive correlation between nutritional status and learning achievement; better nutritional status aligns with higher academic performance.
Nurcahyani et al. (2020)	Ghidza: Journal of Nutrition and Health	Quasi-experimental	Nutrition education significantly increased energy and protein intake ($p = 0.005$). Improvement in nutritional status from *poor* to *good*.
Masrikhiyah & Octora (2020)	Jurnal Ilmiah Gizi dan Kesehatan (JIGK)	Cross-sectional research design	Breakfast habits and good nutritional status were significantly related to academic achievement ($p < 0.005$).
Astuti & Fathonah (2019)	TEKNOBUGA: Journal of Fashion and Culinary Technology	Quantitative	No significant effect of physical activity or nutritional status on academic performance.
Utami et al. (2019)	National Seminar of Poltekkes Kemenkes Palu	Cross-sectional research design	No significant relationship between nutritional status and concentration; energy adequacy had a

Authors and Year	Publisher	Method	Results
			significant positive effect on concentration (36.2% contribution).
Sutisna et al. (2020)	Jurnal Ilmiah Pendidikan	Correlational research	Breakfast positively influenced learning concentration.
Tura et al. (2016)	Journal of Nutrition and Health Sciences	Cross-sectional research design	Significant positive association between nutritional status and academic performance.
Astuti & Erianti (2022)	Quantum Journal of Engineering, Science and Technology	Quantitative method	Nutritional status directly affected learning outcomes; physical fitness and confidence also contributed directly/indirectly.
Oktaviani & Subekti (2018)	Journal of Biology Education	Quantitative method	Positive correlation (44.2%) between nutritional status and learning patterns with learning outcomes.

Most reviewed studies consistently indicate that nutritional intake particularly energy and protein adequacy has a positive relationship with learning concentration and academic achievement. Studies by Cahyanto et al. (2021), Nurcahyani et al. (2020), Masrikhiyah & Octora (2020), and Oktaviani & Subekti (2018) demonstrated that adequate nutritional status or improved nutrition education leads to enhanced concentration, memory support, and better learning outcomes.

However, several studies offer contrasting results. For instance, Astuti & Fathonah (2019) found no significant effect of nutritional status on academic performance, suggesting that cognitive outcomes are not solely dependent on physiological factors. Similarly, Utami et al. (2019) reported no direct relationship between nutritional status and concentration but identified a strong role of energy adequacy, contributing 36.2% to concentration, emphasizing that nutrient intake quality may be more influential than general nutritional status.

Overall, the comparison across studies highlights a common pattern: nutritional intake, particularly energy-sufficient diets and breakfast habits, is more consistently associated with learning concentration than nutritional status alone, indicating the importance of daily intake behaviors in supporting cognitive performance.

DISCUSSION

The findings from the reviewed literature reveal consistent patterns showing that nutritional intake particularly energy and protein adequacy, as well as regular breakfast consumption, plays a central role in supporting students' learning concentration. Rather than functioning as a static indicator, daily nutritional behaviors emerge as more influential on cognitive performance than long-term nutritional status alone.

Across multiple studies, energy adequacy is repeatedly associated with improved concentration. Utami et al. (2019) demonstrated that energy sufficiency contributed significantly (36.2%) to students' concentration levels, suggesting that immediate availability of glucose, the brain's primary fuel, facilitates sustained attention and short-term memory. Similar patterns are supported by Nurcahyani et al. (2020), who showed that nutrition education improved students' intake of energy and protein, yielding better cognitive readiness. This aligns with physiological evidence indicating that adequate glucose supports neurotransmission, synaptic activity, and attentional mechanisms essential for learning.

A broader synthesis of the literature shows that nutritional intake has a more consistent association with concentration than anthropometric nutritional status. While several studies (e.g., Cahyanto et al., 2021; Masrikhiyah & Octora, 2020) reported positive correlations between nutritional status and academic achievement, others (Astuti & Fathonah, 2019; Utami et al., 2019) found no significant relationship. This inconsistency indicates that nutritional status alone cannot fully explain cognitive outcomes, as it does not capture daily metabolic fluctuations that directly affect cognitive function. Students who share similar nutritional status may exhibit

different concentration levels depending on meal timing, energy availability, and dietary quality.

Breakfast consumption emerges as a particularly strong predictor of concentration. Studies such as Sutisna et al. (2020) and Masrikhiyah & Octora (2020) found significant associations between regular breakfast habits and academic performance. Additional external studies strengthen this pattern: Burrows et al. (2017) reported small to moderate significant associations between dietary patterns especially breakfast and academic achievement, while Wote et al. (2022) found a direct correlation between breakfast intake and learning concentration among elementary students. These findings suggest that the timing of nutrient intake, particularly at the start of the day, influences cognitive functioning by stabilizing blood glucose levels and supporting attention span.

Interestingly, studies reporting no significant effect of nutritional status (e.g., Astuti & Fathonah, 2019) often involve populations where nutritional variability is limited or where confounding variables such as sleep quality, stress, and physical activity may overshadow nutritional factors. This highlights that concentration is influenced by a complex interplay of physiological, psychological, and environmental elements. As supported by Sholikhah and Rahma (2024), energy and macronutrient intake influence nutritional status, but the cognitive effects may depend more on short-term nutrient availability than on long-term indices such as BMI.

From a cognitive physiology perspective, the mechanisms linking nutrition to concentration involve the brain's dependence on glucose for optimal functioning. Inadequate nutrient intake, especially skipping breakfast or insufficient energy intake, may cause hypoglycemia, resulting in fatigue, reduced arousal, impaired memory encoding, and decreased ability to maintain attention. Handini (2023) further emphasized that breakfast nutrients directly support students' study concentration, reinforcing the importance of immediate nutritional supply for cognitive processes.

Broader Physiological Mechanisms

Nutritional intake influences concentration through multiple physiological pathways. Carbohydrate consumption regulates blood glucose, which affects neural firing rates in regions related to sustained attention. Protein intake supports neurotransmitter synthesis, including serotonin (mood regulation), dopamine (motivation and focus), and acetylcholine (learning and memory). When children skip meals, these neurochemical systems are disrupted, resulting in reduced alertness, slower information processing, and decreased memory encoding.

Furthermore, evidence from sports performance research demonstrates that adequate energy availability plays a central role in supporting neuromuscular function, explosive power, and movement efficiency. Ahmad et al. (2024), in a literature review on plyometric training for Pencak Silat athletes, noted that optimal physical performance requires sufficient metabolic resources to support muscle contraction, coordination, and reaction speed. Although their study focused on athletic performance, the underlying physiological principles align with the role of nutrition in cognitive function: both require stable energy supply to optimize neural processing, motor output, and task execution.

Comparing Local and Global Findings

Findings from Indonesia mirror global trends demonstrating the importance of breakfast and adequate nutrient intake. Adolphus et al. (2016) highlighted that breakfast consistently enhances attention and memory across diverse populations. Hoyland et al. (2009) further emphasized that breakfast improves cognitive test performance, especially in tasks involving sustained attention and problem-solving. These studies reinforce the findings from Utami et al. (2019) and Masrikhiyah & Octora (2020), suggesting that breakfast quality and timing are key predictors of learning concentration.

Reasons Behind Inconsistent Results

Studies reporting non-significant effects of nutritional status (Astuti & Fathonah, 2019) may suffer from methodological limitations. Cross-sectional designs cannot capture daily fluctuations in nutrient intake. Self-reported dietary recall introduces bias, and many studies do not control for confounding variables such as sleep, stress, hunger, or socioeconomic background. Thus, the lack of association may reflect methodological gaps rather than the absence of a true effect.

Overall, the synthesized literature highlights that nutrition influences concentration through its direct metabolic impact on the brain, rather than through nutritional status alone. Energy adequacy, regular meal patterns, balanced nutrient intake, and breakfast habits consistently appear as determinants of students' ability to focus, process information, and maintain cognitive stamina during learning activities. Thus, interventions such as nutrition education and school-based meal programs have the potential to improve students' learning concentration and academic performance by addressing the real-time nutritional needs that support cognitive functioning.

CONCLUSION

This narrative review demonstrates that students learning concentration is more strongly influenced by daily nutritional intake particularly energy and protein adequacy and regular breakfast consumption than by nutritional status alone. While several studies reported positive associations between nutritional status and academic achievement, the evidence shows that concentration is primarily dependent on immediate nutrient availability that supports brain function, especially glucose-based energy needed for attention and short-term memory. Nutritional status serves as an important indicator of overall health, but does not directly determine concentration or learning outcomes without adequate daily intake.

The reviewed evidence underscores the importance of improving students meal patterns, enhancing nutrition education, and ensuring sufficient energy intake to maintain cognitive readiness during learning activities. Schools should therefore implement comprehensive nutrition education programs, promote consistent breakfast habits, and support access to balanced meals as part of routine school health initiatives. Such efforts can significantly strengthen students' concentration, cognitive stamina, and academic performance.

Future research should examine the interaction between nutrition and other factors such as sleep quality, physical activity, socioeconomic conditions, and classroom environment to better understand the multifactorial influences on concentration. Longitudinal and experimental studies are also needed to evaluate the long-term impact of school-based nutrition interventions and to identify which specific components of dietary intake most effectively enhance students' cognitive and academic potential.

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