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Animal-Sourced Foods for Improved Cognitive Development

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Introduction

Animal-sourced foods are the best source of nutrient-rich foods for children aged 6 to 23 according to the World Health Organization. Studies on the role of animal-sourced foods on cognitive functions are limited, but consistently show compelling benefits [1]. Animal-sourced food consumption can positively contribute to school performance in children, lifelong achievement, economic productivity, and social and community outcomes. More large-scale randomized controlled longitudinal studies are required to fully understand the link between consumption of animal-sourced foods and cognitive development. Improving production of animal-sourced foods does not guarantee increased consumption by children. Complex health, gender, cultural, financial, and religious barriers limit the consumption of animal-sourced food by children, particularly in low- and middle-income countries. To increase consumption of animal-source food by vulnerable children, affordability, acceptance, and access must be increased.

Malnutrition continues to be an important problem, despite global increases in food production over the last century. Over 200 million children worldwide fail to meet their developmental potential because of malnutrition and other socio-environmental constraints [2]. In 2018, more than one in five children was stunted and 7.3% suffered from wasting (UNICEF 2019). Although wasting (low weight-for-age) is a measure of acute malnutrition and is associated with mortality, stunting (low height-for-age) is a widely used measure of chronic malnutrition. Children who are stunted in early childhood, particularly in the first 1,000 d, experience reduced growth and physical development and suffer compromised cognitive development leading to lower Intelligence Quotients, worse school performance, greater susceptibility to chronic diseases, increased behavioural problems, and reduced earning potential as adults. In a recent World Bank report, countries where the workforce was stunted in childhood had reduced gross domestic products by about 7% on average globally and 10% to 17% in Africa and South East Asia.

Stunting is caused by several interacting factors including poor hygiene and various health-related factors, but the most important cause is an inadequate diet (total calories and essential nutrients) especially during the first 1,000 d. These essential nutrients include iron, zinc, copper, chromium, selenium, iodine, manganese, and molybdenum, and 13 vitamins (vitamin A, vitamin B1, B2, B6 and B12, niacin, folate, pantothenic acid, vitamin C, vitamin D, biotin, vitamin E, and vitamin K). The prevalence of stunting among disadvantaged children in low- and middle-income countries is high and often exceeds 30% in many sub-Saharan and South East Asian countries [3]. This is in part because of the high prevalence of starch-based diets that lack these essential nutrients. Even among the populations that supplement these diets with fruits and vegetables, stunting remains a problem partly because plant foods lack readily bioavailable forms of various micronutrients because they are bound to other compounds like phytate or fibre, markedly reducing their bioavailability. Plant foods also completely lack other nutrients, such as vitamin B12, which predisposes people to megaloblastic anemia, developmental delays, failure to thrive, and poor growth in infants and insulin resistance. Due to widespread consumption of plant-based diets, vitamin B12 deficiency is relatively common, affecting ~40% of children and adults in Latin America, ~70% of children in Kenya, and ~80% of children in India. Vitamin B12 concentrations were deficient in the breast milk of 89% of 286 nursing Kenyan women indicating that even though breast milk is the ideal food for infants, its quality and in this case, B12 sufficiency, depends on the adequacy of animal-sourced foods in their diets.

The concentration of essential micronutrients in plant-based foods is also limited. For example, 2,400 g of spinach contains no more iron than 625 g of beef or 300 g of liver. This difference, combined with the greater bioavailability of iron in animal-sourced foods, implies that spinach would be the least favoured source of supplying iron to young infants who need dense bioavailable nutrient sources because of the small size of their stomachs. Hence, plant-based foods have limited capacity to fully meet the nutritional needs of infants [4].

The most deficient micronutrients in human diets globally, iodine, vitamin A, iron, and zinc, are all present in animal-sourced foods.

In addition, animal-sourced foods contain greater quantities of high-quality protein, due to their balanced or complete amino acid profile, compared with plant foods. Consequently, animal-sourced foods are ideal for stimulating muscle development and linear growth as well as enhancing cognitive development. These factors outline the vital importance of using animal-sourced foods to prevent or alleviate nutrient deficiencies.

The Role of Animal-Sourced Foods in Brain Development

There is limited understanding of the specific mechanisms by which animal-sourced foods contribute to improved cognitive development [5,6]. Studies indicate that bioavailable nutrients in animal-sourced foods such as iron, zinc, iodine, and B vitamins (B12, B6, folate, and riboflavin) enhance cognitive development through their impact on structural brain development via enhancement of myelination, dendritic arborization, and synaptic connectivity. Studies that model brain development using neonatal pigs indicated that early life iron deficiency impairs brain development.

Vitamin B12 increases iron and zinc absorption from fibre- and phytate-rich plant staples, contributing to their role in promoting cognitive development. Choline and lecithin, found in eggs, are substrates for the synthesis of the neurotransmitter acetylcholine, a chemical known to improve memory. Animal-sourced foods also contain polyunsaturated fatty acids, such as arachidonic acid and docosahexanoic acid, which together account for about one-fifth of the brain's dry weight. These fatty acids, along with eicosapentanoic acid, are essential for brain development and function. The accumulation of these fatty acids in the brain is most intense during the third trimester of pregnancy. During the first 2 years after birth, polyunsaturated fatty acid-dependent processes are involved in expansion of glial cells, neurons, axons, and dendrites and myelination of nerve fibres. Furthermore, the high-quality proteins found in animal-sourced foods facilitate specific mechanisms, such as speed of information processing, that are involved in learning tasks such as problem-solving capacity. Nevertheless, more research is needed to better understand the biochemical pathways by which consumption of animal-sourced foods positively contributes to cognitive development.

Animal-sourced foods are the best food-based strategy to prevent stunting and promote cognitive development. Alternatives to animal-sourced food-based provision of the missing nutrients include fortification, bio fortification, or supplementation. Fortification and bio fortification approaches are important and useful but tend to supply only one of several missing nutrients. Supplementation with missing nutrients is simply not feasible where needed most, such as in the rural areas of low- and middle-income countries due to their unavailability. Supplements would also be prohibitively expensive for the poor. Supplements and fortificants provided as part of research or development interventions do not offer sustainable solutions to these problems in low and middle-income countries, as these are usually discontinued when donor or government funding ends.

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