Substantiating Impact on Nutritional Adequacy in Infancy and Toddlerhood: Opportunities and Challenges

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Nutritional Landscape and Dietary Patterns in Infants and Toddlers: Challenges and Opportunities

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To provide a snapshot of childhood health and growth within a pediatric population, nutritional landscape data typically includes key nutrition and nutrition-related indicators related to child malnutrition and anthropometrics of a geographical region. As some global regions undergo epidemiological and economic transitions, a shift in the predominance of undernutrition, to a higher prevalence of over nutrition is emerging. As a result, many countries are facing persistent childhood underweight and stunting, along with newer rising obesity rates.

Although moderate or severe undernutrition remains a significant public health concern across the globe, over the past 40 years the prevalence of childhood obesity has significantly increased in nearly all of 200 countries studied [1]. Among children < 5 years of age, in 2014, approximately 41 million children were affected by overweight and obesity [2]. Moreover, there is mounting evidence that childhood obesity begins during the first 1000 days, the period from conception to age 2 years.

During childhood, food preferences and dietary habits are being established, and often persist into later life [3]. Dietary intake surveys of infants and toddlers from nationally representative samples provide insight into not only the local nutritional landscape related to nutrient gaps and excess, yet also the frequency in which food groups are consumed, and the relative contribution that these food groups provide to total energy intake. Some of these food patterns, including high caloric, low nutrient density intakes, are established during the first year of life. For example, data from the Mexican National Health and Nutrition Survey [4-6] indicated that among 12 month old children, only 16% of children consumed a vegetable on the survey day; average daily intake of the vegetable group was 24g. The percent of energy from vegetables remained stable from 6 - 36 months (4-5% of total energy), indicating that the dietary pattern for vegetable intake was established during infancy, and on a per capita basis, remained similar throughout early childhood. In contrast, 82% of 12 month old Mexican children consumed a sweet or dessert on the survey day, with an average daily intake of 256g. At 12 months of age, 24% of total energy was derived from sweet or salty snacks, a value that persisted to 36 months (range 23-28% of total energy). These findings reinforce the importance of nutrition education for parents/caregivers beginning prior to the complementary feeding period during infancy.

In addition to dietary intake of infants and toddlers, multiple feeding related behaviors shape the nutritional landscape and influence healthy growth within young populations. Antecedents of early childhood growth, at both extremes of the World Health Organization (WHO) growth standards, are multifactorial, and associations of varying strength have been documented for genetic/epigenetic, biologic, dietary, environmental, social, and behavioral influences. Modifiable factors in pregnancy associated with early childhood growth include maternal overweight/obesity, maternal smoking, gestational weight gain and prenatal diet quality [7]. Modifiable feeding and related behaviors linked to healthy growth commencing at birth include infant and young child feeding (e.g., breastfeeding, timing of complementary foods, diet quality and quantity), caregiver responsive feeding practices (e.g., appropriate responsiveness to hunger and satiety cues and the feeding environment), as well as sleep duration, and physical activity [7-9]. As with dietary intake patterns, several of these early behaviors track through childhood.

WHO recommends that a multifaceted approach be taken to address the current obesogenic environment within low, mid, and high income countries, and that interventions in early life, when biology is most plastic and amenable to change, are likely to have the greatest positive sustained effects on obesity prevention [2]. For behavior change, or adoption of new behaviors, interventions based within nutrition education theories hold promise for effectiveness [10]. Educational programs addressing modifiable diet and feeding related behaviors in early life identify both opportunities and challenges in promoting healthy infant and toddler nutrition and eating patterns that influence the growth and nutritional landscape of children.

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Nutritional Deficiencies: Links with Cognitive and Social Development Among Infants and Toddlers

Nutritional deficiencies during the first 1000 days (conception to age 24 months) can impact cognitive and social development during infancy and toddlerhood, with consequences that extend through childhood and into adulthood (Figure 1). Nutrition plays a central role in children's growth and development.

Breastfeeding

Breastfeeding is an effective strategy to ensure that infants receive both the nutrients and nurturance needed early in life. The World Health Organization recommends exclusive breastfeeding for the first 6 months, followed by continued breastfeeding with appropriate complementary foods for up to two years or beyond.[1] Evidence linking breastfeeding with cognitive development has been controversial, primarily because many factors associated with decisions to breastfeed are also related to advanced child development, raising concerns about confounding. However, a 30-year follow-up in Brazil where breastfeeding initiation was nearly universal found beneficial effects on IQ, years of schooling, and wages.[2] In addition, recent meta-analyses and reviews have concluded that breastfeeding has a beneficial effect on cognitive development.[3]

Complementary feeding

Complementary feeding occurs from approximately 6 to 24 months with the transition from liquids to semi-solid and solid food. During this period, infants are gaining the oral motor and physiological skills to chew, swallow, and digest complex foods. Transitioning to the family diet may enhance children's exposure to multiple nutrients if families provide high nutrient-dense complementary foods. Infants need nutrient-rich food that provides a diversity of nutrients, including fruits, vegetables, and animal source foods.

Growth faltering and stunting

Growth faltering often occurs during the complementary feeding period, as infants become mobile (crawling and walking), increase their eye-hand coordination (put things into their mouth), and are introduced to foods and environments that vary in hygienic quality. Growth faltering that is chronic may lead to a slow down in weight gain (underweight) and then to a slow down in linear growth (stunting). Stunting prior to age 2 years has been associated with long term negative consequences in growth and development, including poor school performance and adult earning capacity. [4,5]

There is no consensus on the mechanisms linking stunting and children's development.[6] Possible mechanisms include neurological, hormonal, infection, stress, and functional isolation, as well as combinations or interactions among mechanisms. Efforts to prevent or reduce stunting have met with limited success, prompting consideration of additional causes of stunting beyond undernutrition.[7] In addition to poor maternal health/nutrition and suboptimal infant and young child feeding practices, important causes of stunting include infectious diseases and subclinical infections (both of which cause inflammation), as well as underlying causes such as poverty, food insecurity, and inadequate care practices. Additional efforts to prevent stunting may consider strategies to prevent or reduce inflammation. [8]

Using stunting and poverty as proxies, estimates from 141 low and middle-income countries indicate that 43% of the world's children under age 5 years (249 million children) are at risk for not reaching their developmental potential. [9,10]

Nutritional Deficiencies.

Iodine. Iodine deficiency is closely tied to children's cognitive functioning and is a primary cause of intellectual disabilities. Iodine facilitates thyroid hormone synthesis and is critical during early brain development.[11] Iodine deficiency can result in neurocognitive deficits and in extreme conditions, in cretinism. Iodized salt can effectively prevent iodine deficiency. The 2017 Annual Report of the Iodine Global Network reports recent advances in iodine adequacy "At the end of 2017, only 19 countries were classified as having insufficient iodine intake, down from 54 in 2003, and 113 in 1993."

Zinc. Zinc plays a critical role in multiple aspects of brain development and in immune functioning. However, reviews of zinc supplementation trials have not found consistent effects on children's cognitive development.[11]

Iron. Iron deficiency is the most common nutritional deficiency world-wide and the leading cause of anemia. Iron is necessary for multiple aspects of brain development, including myelination and the development of the dopamine, serotonin, and norepinephrine systems.[12] Although multiple observational studies have shown associations between iron deficiency in infancy and cognitive performance that last into adulthood,[12] results from reviews of iron supplementation and fortification trials have been mixed. Even when anemia has been corrected, children may experience long-term deficits in cognitive functioning.[13]

Food insecurity,

Food insecurity, lack of an adequate supply of safe, nutritious, and culturally appropriate food to ensure a healthy lifestyle, is a major global concern. Rates of food insecurity worldwide have

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been increasing from 2014 to 2017 with 10.2% of the population experiencing severe food insecurity. Severe food insecurity means that a person has no food for a day or more. In low-income countries, food insecurity rates vary by region and are highest in Africa (29.8%) and Central America (12.5%).

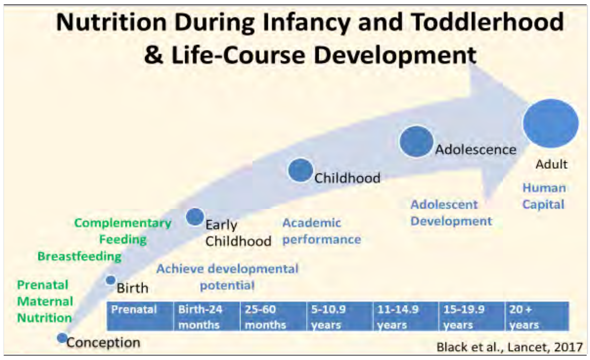
Food insecurity is also a significant public health problem in many high income countries. The United States Department of Agriculture (USDA) estimates 16.4% of households with children under 6 years-of-age experienced food insecurity in 2017, with higher rates among households headed by parents who were single, Black, or Hispanic. [14] Food insecurity among young children correlates with poor overall health, hospitalizations, and behavioral and developmental problems. [15,16] Associations between food insecurity and children's weight status have been inconsistent, with reports of underweight, overweight, and no impact on weight. [17]

Recommendations

Evidence for early interventions based on brain development research lead to three recommendations: 1) ensure nutritional adequacy and the avoidance of other forms of early adverse experiences, 2) ensure nurturance and responsive caregiving, and 3) initiate inter-ventions early in life to take advantage of the sensitive periods of brain development when neural plasticity is high. Early findings from nutrition specific and nutrition sensitive interventions suggest that such interventions are feasible and effective in promoting early development.[9]

Strategies to promote early development, known as nurturing care, primarily involve children's families and integrate five elements: health, nutrition, responsive caregiving, protection, and opportunities to explore and learn.[9] Both nutrition and cognitive/psychosocial interventions delivered separately early in life can benefit early childhood development.[18] However, it is inefficient and time-consuming to implement multiple interventions, leading to recommendations that interventions integrate nutrition, cognitive/psychosocial development, and other elements of nurturing care.[19] Investing in early intervention based on evidence from brain development and ensuring nutritional adequacy throughout the first 1000 days are effective means to ensure that children have the necessary health, cognition, creativity, and commitment to achieve the Sustainable Development Goals.

Figure 1



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Optimal vitamin D Nutrition and Health in Childhood

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Vitamin D, more accurately described as a hormone than as a vitamin, is critical for multiple function. It's principal physiological role is to increase the active absorption of calcium in the intestine and increase bone mineral formation and prevent loss of bone mineral. Osteoporosis is recognized as a pediatric condition in that suboptimal bone mineral accumulation in children increases the risk of this disease later in life. Peak rates of bone mineral accrual occur in childhood, especially in early puberty. Vitamin D status is generally assessed by the level of 25-hydroxyvitamin D in the blood, although this is more of a marker of exposure than a direct measure of physiological function. Identification of deficient and insufficient levels of 25-hydroxyvitamin D are controversial, but most groups consider levels below 50 nmol/L as being at risk for insufficiency, although much lower levels are generally associated with clinical vitamin D deficient disease. Clinically, in children, severe vitamin D deficiency is manifest by rickets, a condition that can be caused by severe calcium or vitamin D deficiency or a combination of both. Although uncommon, nutritional rickets exists throughout the world and vitamin D deficiency may be a severe problem in numerous low and middle income countries.

Vitamin D can be obtained from several sources. Although sunlight is the natural source of UV radiation needed to convert vitamin D precursors to vitamin D, this is not assured in all locations and among all populations and dietary sources of vitamin D are needed to assure adequate vitamin D status in many children. Naturally occurring dietary sources are highly variable and in some, but not all countries, vitamin D is added to commercial food products, notably dairy products, although other foods may also be fortified. Screening for vitamin D deficiency can most commonly be done by pediatricians asking dietary and exposure questions, it is not necessary to routinely screen low risk children with blood levels of 25-hydroxyvitamin D.

The role of vitamin D in non-bone related conditions remains uncertain. Although some evidence suggests a relationship with respiratory infections, this relationship is uncertain and most likely is primarily among those with severe deficiency of vitamin D. Vitamin D research in this regard is often confounded by the challenges of separating out and identifying those who have low sunlight exposure due to other health reasons that might be associated with disease states rather than a direct causal relationship between disease and vitamin D status.

Future research should be focused on conducting controlled trials evaluating vitamin D supplementation in non-bone health conditions and also to further evaluate the need for supplementation or fortification with vitamin D more broadly, especially in low and middle income countries where limited data regarding vitamin D status are available.

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