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*Annual Review of Nutrition*

# All Children Thrive: Integration of Nutrition and Early Childhood Development

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## Keywords

early child development, equity, nurturing care, nutrition, thrive, infant, toddler

## Abstract

Building on the successes of child survival, we review the evidence needed to ensure both that children who survive also thrive and that recommendations promote equity, with no child left behind. To illustrate the critical roles played by nutrition and child development, we revise the Conceptual Framework for the Causes of Malnutrition and Death and the Nurturing Care Framework to create the Conceptual Framework of All Children Surviving and Thriving. The revised framework highlights the goals of child growth and development, supported by health, nutrition, learning, responsive caregiving, and security and safety. We review the challenges posed by undernutrition, stunting, micronutrient deficiencies, overweight, and children not reaching their developmental potential. Although integrated nutrition–childhood development interventions have shown promising effects, most have not been implemented at scale. Implementation science that investigates how and why integrated interventions work in real life, along with the acceptability, feasibility, cost, coverage, and sustainability of the interventions, is needed to ensure equity for all children thriving.

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## 1. ADVANCES IN CHILD SURVIVAL

The dramatic 56% reduction in child mortality over the past 3 decades represents the successes in child survival. During this period, global mortality among children under age 15 years declined from 14.2 million in 1990 to 6.2 million in 2018, with 85% of childhood deaths occurring in the first 5 years (145). Although child survival continues to be a major global initiative, there is an increasing global effort to ensure that children who survive also thrive. The Global Strategy for

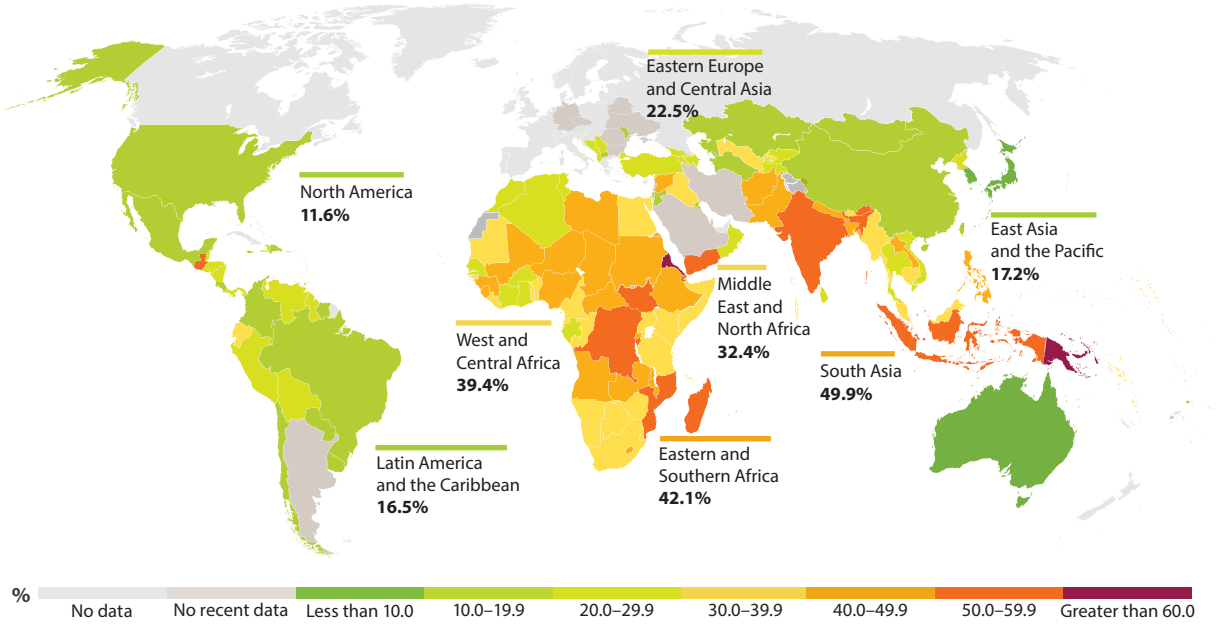



**Figure 1**

Prevalence of children under age 5 years who were not growing well (stunted, wasted, or overweight) as of 2018. Figure adapted from Reference 145.

Women's, Children's, and Adolescents' Health provides a road map for interventions to ensure that children thrive (162).

Growth and development are essential components of thriving. Despite major advances in both areas, the most recent World Health Organization (WHO), UNICEF, and World Bank Group joint child malnutrition estimates show that in 2018, 149 million children (21.9%) were stunted (height for age $<-2$ standard deviations of the WHO Growth Standard), 49 million children (7.3%) were wasted (weight for height $<-2$ standard deviations of the WHO Growth Standard), and 40 million (5.9%) were overweight (weight for height $>2$ standard deviations of the WHO Growth Standard) (146). Of the children who were wasted, 16.6 million were severely wasted (weight for age $<-3$ standard deviations of the WHO Growth Standard), which puts them at imminent risk of death unless appropriately fed and treated for underlying infectious diseases (139). In addition, 249 million children (43%) were not reaching their developmental potential (96). The greatest proportion of children at risk for poor growth and development live in low- and middle-income countries (LMICs), primarily in Asia and sub-Saharan Africa (**Figure 1**). The cost of inaction will negatively affect millions of children and families, as well as the countries where they reside (130).

This article addresses the thriving initiative by focusing on the global burden associated with nutritional and developmental inequities and reviewing strategies to promote thriving and equity. We take a developmental perspective by focusing on children under age 5 years, particularly in their first 1,000 days (conception to age 24 months) because that is a period of rapid brain development when children build foundational skills that define their health and well-being throughout life. These first years of life are characterized by a complex series of genetic and environmental experiences timed to coincide with critical and sensitive periods of heightened sensitivity to environmental stimuli (57, 153). Nutrition plays a central role in children's development and is

**WHO:** World Health Organization

**LMICs:** low- and middle-income countries



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aligned with similar critical and sensitive time periods (57, 153). Although the rapid development early in life affords plasticity, it is also a period of vulnerability in response to adverse conditions, ranging from environmental poverty to exposure to toxins to violence. However, interventions through the enabling environments that support caregivers and nurturing care in the home have been effective in enabling young children to thrive (25, 48, 49).

**NCF:** Nurturing Care Framework

**WHA:** World Health Assembly

We begin with the conceptual framework that guides our review. We then discuss the integration between nutrition and child development through the developmental life stages, ranging from preconception and the prenatal period to infancy and early childhood; nutritional challenges for infants and young children; environmental challenges and their impact on child development and nutrition; and policies for improving child nutrition and early childhood development. We conclude with implementation strategies to promote thriving.

## 2. CONCEPTUAL FRAMEWORK OF CHILDREN THRIVING: INTEGRATING NUTRITION AND EARLY CHILDHOOD DEVELOPMENT

In 1990, as part of its nutrition strategy, UNICEF developed a Conceptual Framework for the Causes of Malnutrition and Death that highlights the dual roles of inadequate dietary intake and disease resulting in malnutrition (66). The framework illustrated that causes of malnutrition are multisectoral, including food, health, and caring practices. Over the past 25 years, the framework and associated programs and research have advanced both nutritional policies and practices. To thrive, in addition to the nutrition and health included in the UNICEF Conceptual Framework, children require responsive caregiving, opportunities for learning, and security and safety, components of Nurturing Care (20, 25, 130). This review is framed around the Conceptual Framework of All Children Surviving and Thriving (**Figure 2**), an updated version of the UNICEF Conceptual Framework that incorporates Nurturing Care, focuses on thriving, and was created by us.

Nurturing Care is a dynamic systems model including five components that are central to children's well-being: nutrition, health, learning, responsive caregiving, and security and safety. As with any systems model, all components are necessary; no single component is sufficient; and if any component is out of alignment, the entire system is at risk. Nurturing Care is activated by enabling environments that range from proximal to distal sources, extending from families to communities, services (e.g., health and education), and policies, with influences from political, ideological, and economic forces as well as climate change.

In addition to direct mechanisms, many aspects of children's well-being are responsive to compensatory mechanisms, whereby enabling environments can alter children's developmental pathways and promote equity and thriving. Synergy among interventions occurs when the interactive effects of two interventions (i.e., nutrition and responsive caregiving) create a multiplicative effect greater than the sum of their separate effects and can be tested by including an interaction term. For example, a trial in Jamaica found that the impact of zinc supplementation on childhood development was greater among the group who received both zinc and psychosocial stimulation versus groups who received either intervention alone (59). Most combined or integrated interventions have reported individual or additive effects, and not formally evaluated synergistic effects.

With the current focus on children thriving, WHO and partners incorporated the Nurturing Care components and enabling environments into the Nurturing Care Framework (NCF) (165). The NCF, endorsed by the World Health Assembly (WHA) in 2018, is designed to promote equity and enhance thriving by informing the development and implementation of multisectoral programs and policies globally. Equity (**Figure 3**) is a central component of the NCF, based on the principle of no child left behind. Equity is ensured by incorporating all components of the NCF, with additional support as needed.



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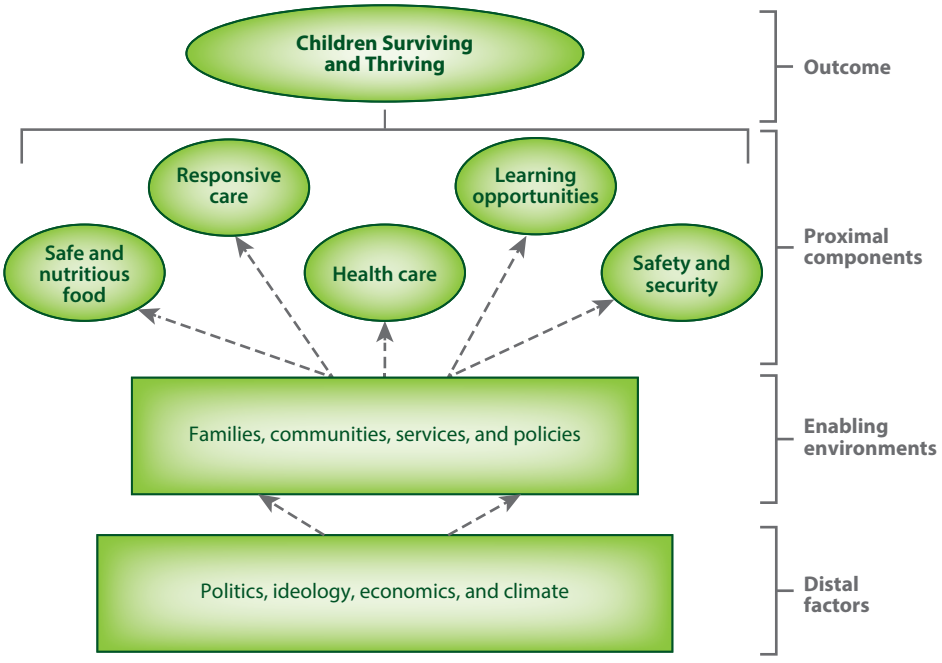



**Figure 2**

Conceptual Framework of All Children Surviving and Thriving, a revision of the 1990 UNICEF Conceptual Framework for the Causes of Malnutrition and Death (66), updated to integrate Nurturing Care (19).

## 3. MATERNAL NUTRITION PRECONCEPTION AND DURING PREGNANCY

Maternal nutrition prior to conception and during pregnancy affects not only the health of the newborn but also maternal health. Poor maternal nutrition is the cause of more than 200,000 neonatal deaths and 20% of cases of stunting in young children (22). Women who are

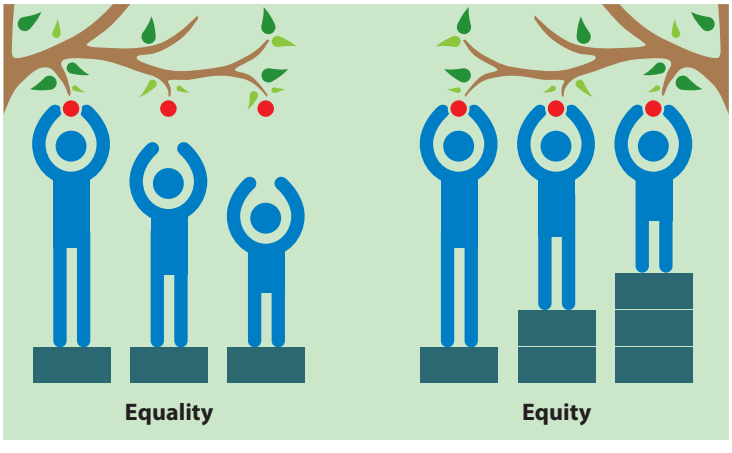



**Figure 3**

Equality versus equity.



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undernourished or overweight during pregnancy are at particular risk for poor pregnancy outcomes. Women who are short are at increased risk of obstructed labor and are more likely to need a lifesaving caesarian section, which in many low-income and rural settings is not readily available. Pregnancy complications for overweight women include high blood pressure, gestational diabetes, preeclampsia, increased risk of delivery by caesarean section, and increased risk of postnatal infection (33). Newborns of obese mothers are at increased risk of health problems that require specialized care, low blood sugar, and problems breathing immediately after birth. Pregnant adolescent girls are at particularly high risk of poor pregnancy outcomes (22).

### 3.1. Iodine Deficiency

Iodine deficiency during pregnancy is a major preventable cause of developmental delay among children and causes other adverse pregnancy outcomes, including mortality. Iodine is an essential nutrient and necessary for biosynthesis of thyroid hormones, which in turn regulate growth, development, and metabolism (73). Salt iodization is one of the mainstays to prevent iodine deficiency. In countries where salt iodization is inadequate or in settings where salt is not commonly consumed, the WHO recommends iodine supplements of 250 μg/day for pregnant and breastfeeding women (169).

### 3.2. Choline Deficiency and Essential Fatty Acids

Compared with other essential nutrients, choline has received very limited attention. It is an important precursor of phospholipids, which are needed for cell division, growth, and membrane signaling (30, 173, 174). Inadequate intake during pregnancy has been associated with neural tube defects (140), changes in brain structure and function in the offspring (175), and adverse pregnancy outcomes (152). Adequate intake of essential fatty acids, especially docosahexaenoic acid, during pregnancy is critical for fetal brain development (99).

### 3.3. Folate Deficiency

During the first few weeks of pregnancy, maternal folate deficiency can increase the risk of neural tube defects among women with specific mutations of the *MTHFR* gene. Because this type of birth defect occurs before most women realize they are pregnant, women need adequate folate status prior to conception. In many countries, staple foods such as breads, pastas, and cereals are fortified with folic acid, and staple food fortification programs have resulted in large estimated reductions in neural tube defects and anemia (86). The US Centers for Disease Control and Prevention recommend that women, especially those considering pregnancy, consume 400 μg daily folic acid supplements (32). Continued folic acid supplementation beyond the first trimester may also improve children's cognitive development (103, 110).

### 3.4. Iron Deficiency

Iron deficiency, highly prevalent during pregnancy even in high-income settings, also poses serious risks to women. It increases their risk of hemorrhaging at birth (blood loss ≥500 mL), which is a major cause of maternal mortality (71). Some risk factors for hemorrhaging at birth include multiparity, previous caesarian section, macrosomia, and hypertension (101). Iron deficiency anemia during pregnancy has been associated with anemia after delivery and postpartum and, if combined with blood losses at birth, places women at greater risk for reduced cognitive and physical performance, infections, and postpartum depression (107). Maternal iron deficiency also results in lower stores of iron for the newborn, increasing the risk of iron deficiency in infancy (98). Iron



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deficiency in infancy and early childhood increases the risk of poor developmental outcomes (94, 95). To maximize iron stores in the newborn, delayed cord clamping at birth, which allows placental blood to flow to the newborn, is recommended (161). A 2-min delay in clamping provides 1 to 3 months of additional iron reserves to the infant (35).

Iron supplementation is recommended for all pregnant women (164) and is highly effective when consumed. WHO recommends that pregnant women consume 30 to 60 mg of elemental iron and 400 μg of folic acid daily (160). However, weak health delivery systems in many LMICs do not reliably distribute iron supplements or provide counseling on appropriate use and strategies for addressing common side effects (14). As a result, women in low-income settings are far more likely to suffer from iron deficiency than women in high-income settings.

### 3.5. Health and Lifestyle Behaviors

WHO nutrition recommendations for pregnant women include counseling about healthy eating and keeping physically active to stay healthy and prevent excessive weight gain (164). In undernourished populations, WHO recommends balanced energy protein dietary supplementation to reduce the risk of stillbirth and small-for-gestational-age neonates. In populations with low dietary calcium, calcium supplements are recommended, and in populations where vitamin A deficiency is a severe public health problem, vitamin A supplementation is recommended.

## 4. INFANCY AND EARLY CHILDHOOD

### 4.1. Breastfeeding

Breastfeeding improves the survival, health, and development of all children, regardless of the country of birth or wealth of their parents. The WHO recommends skin-to-skin contact for at least an hour as well as breastfeeding initiation at birth. It also recommends that babies be exclusively breastfed (i.e., fed only breast milk) for 6 months and that breastfeeding continue for 2 years or more along with adequate, safe, and properly fed complementary foods (157).

Breastfeeding has been associated with beneficial effects for infants against infections and malocclusion, increases in intelligence, and probable reductions in risk for overweight and diabetes, particularly infants in LMICs (150). Among mothers, breastfeeding protects against breast cancer, improves birth spacing, and protects against ovarian cancer and type 2 diabetes mellitus. Both breast milk and the act of breastfeeding may benefit children's cognitive development. Breast milk contains essential fatty acids, which nourish the developing brain, along with antibodies, growth factors, cytokines, and antimicrobial compounds that support the infant's immune system. The physical closeness of breastfeeding contributes to the mother–infant nurturing relationship, potentially enhancing cognitive development. Skin-to-skin contact associated with kangaroo mother care benefits self-regulation (i.e., ability to organize sleep–wake cycles and modulate arousal to external stimuli) among infants born prematurely or with low birth weight (4).

The effects of breastfeeding on cognitive development are difficult to study because breastfeeding cannot be randomized, and mothers who breastfeed may differ from mothers who are unable or choose not to breastfeed. A meta-analysis of 17 studies found that breastfed children had a mean IQ 3.44 points higher than that of nonbreastfed children; the effect was attenuated among studies that controlled for maternal IQ, with a mean IQ difference of 2.62 points (76).

Breastfeeding is one of the few health and nutrition indictors for which low-income countries are closer to WHO recommendations than high-income countries. In LMICs, breastfeeding is more common among women in low socioeconomic groups; in high-income countries, women in higher-income groups have better breastfeeding indicators.

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Rates of breastfeeding initiation have increased in the United States over the past 4 decades and are approaching the Healthy People 2020 national goal of 81.9%. However, duration lags below the goal of 60.6% at 6 months. Breastfeeding rates are lower among African American and socioeconomically disadvantaged mothers than among white and Hispanic mothers. Mothers with higher levels of education or income are more likely to initiate breastfeeding and breastfeed longer than mothers with lower levels of education or income.

Multiple factors have contributed to the increase in rates of breastfeeding initiation in the United States, including an increased awareness of the merits of breastfeeding, baby-friendly hospitals, and breastfeeding promotion through the Special Supplemental Nutrition Program for Women, Infants, and Children and other programs. As rates of initiation have increased, breastfeeding has become normative in some populations with opportunities for peer support. Environmental constraints limit breastfeeding duration. Flexible work hours, paid maternity leave, on-site child care, and a supportive work environment (e.g., lactation breaks and facilities for expressing breast milk) facilitate breastfeeding duration.

## 4.2. Complementary Feeding

Complementary feeding is defined as "the process starting when breast milk alone is no longer sufficient to meet the nutritional requirements of infants, and therefore other foods and liquids are needed, along with breast milk" (167). The timing of complementary feeding is based on the developmental maturity of the gut and neuromuscular system, growth rate, and activity level (88), which occurs at around 6 months. Infants need foods to complement breast milk to meet their evolving nutritional needs, particularly iron and zinc.

The WHO and UNICEF indicators for infant and young child feeding practices assess intake of eight key food groups over 24 h to ensure that children consume a variety of nutrients: breast milk; grains, roots, and tubers; legumes and nuts; dairy products; flesh foods (meat, fish, poultry, and organ meats); eggs; vitamin A–rich fruits and vegetables; and other fruits and vegetables (145, 159). Globally, only 29% of children aged between 6 and 23 months consume at least five of the eight food groups (minimum dietary diversity); the lowest prevalence occurs in South Asia and in Eastern and Southern Africa, as well as in low-income and rural regions (145). A diet lacking in diversity increases the risk of micronutrient deficiencies. Consuming a diverse set of foods that meet nutrient requirements promotes cognitive and physical development, as well as general health. Animal-source foods (ASF) including dairy, meat, fish, and eggs provide essential nutrients in highly bioavailable forms (79). However, consumption of ASF is low in low-income, rural areas, where these foods are often unaffordable. Consumption of poor-quality foods limits nutrients during the period of rapid brain development and may contribute to infants' preference for low-nutrient, highly palatable foods. Food contamination and safety are major concerns, particularly in areas without adequate refrigeration or access to safe storage.

Complementary feeding coincides with infants' developmental readiness to consume food and with a period of rapid growth and multiple developmental changes, along with nutritional and health risks. This period is often marked by illness and weight faltering (151), the risk of micronutrient (especially iron) deficiencies, and challenging hygienic practices, with infants crawling on the floor and putting objects into their mouths. Young children are guided by a desire to explore their surroundings: not only what they see and hear but also what they touch, feel, and taste. The slowdown in intake that typically occurs during the latter part of meals is influenced by both the abatement of hunger and a desire for exploration. Parents who misinterpret the slowdown as early food refusal may resort to controlling or pressuring strategies that disrupt the exploration and result in stress for both parents and children.



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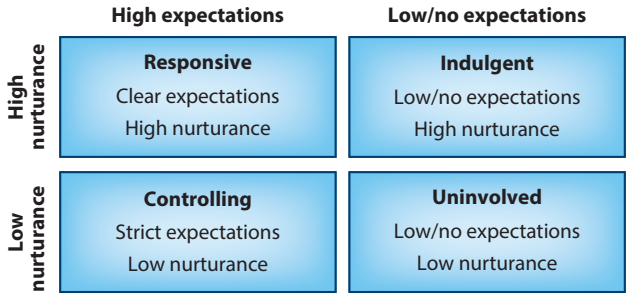



**Figure 4**

Responsive parenting applied to feeding.

## 4.3. Responsive Parenting

Responsive parenting refers to the back-and-forth pattern of parents and children responding to one another on the basis of previous behaviors or perceptions (135). Early in life, this process is reflected in the emotional bonding and attachment between infants and parents that form the basis for healthy socioemotional functioning (3). Parenting behavior is influenced by parents' perceptions of their child. For example, parents who perceive their child as difficult may engage in more harsh or restrictive parenting than parents who perceive their child as agreeable (12). Research from high-income countries has shown that disruptions in parent–child relationships, characterized by inconsistent and nonresponsive interactions, can undermine children's subsequent social and emotional development (90). Responsive parenting behaviors are developmentally appropriate; emotionally supportive of the child; related to the child's behavior; and not passive, intrusive, or controlling (18). Responsive parenting often occurs in the context of a supportive routine or structure whereby the child learns to expect responses that are predictable and supportive (102).

Responsive parenting has been applied to the feeding context and is often characterized by feeding styles and feeding practices. Feeding styles refer to the emotional climate of the interaction, characterized by expectations and nurturance (**Figure 4**). High expectations and high nurturance characterize responsive feeding. Parents communicate clear expectations while responding to the child's signals by providing nurturance and support. In contrast, the high-expectations and low-nurturance style, classified as controlling, is typically operationalized by strict rules, little warmth, and limited attention to the child's signals or consideration of the child's preferences. The controlling style includes strategies in which the parent takes control and pressures the child to eat, restricts eating, or uses food to control negative emotions. The low-expectations and high-nurturance style represents indulgence. In this style, parents have few rules and are very responsive, often with few limits, permitting children to eat what, where, and when they wish. Low expectations and low nurturance represent the uninvolved style. Parents make few demands, and meals may be disorganized. Controlling, indulgent, and uninvolved feeding styles represent nonresponsive feeding. Feeding practices refer to the behaviors that parents use to organize and structure meals, including location, distractions, positioning of the child, modeling, food presentation, and communication of expectations. These practices can influence children's eating behavior (17).

## 4.4. Responsive Feeding

As a derivative of responsive parenting, responsive feeding acknowledges that children's eating is influenced by internal regulatory cues of hunger and satiety as well as cognitive, fine motor, and socioemotional development that facilitate interest in food, self-regulation, and self-feeding



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**Figure 5**

Mother feeding child. Figure reproduced from ProPAN Complementary Feeding Contest, Pan American Health Organization, 2013.

(17). Responsive feeding helps children learn to eat in response to internal regulatory cues. For parents, child feeding practices are influenced by cultural and family variations in foods, flavors, textures, and eating patterns; food access and availability; and perceptions of children's growth, health, appetite, and temperament (42). A study in Australia found that mothers pressured their child to eat when they were concerned about their child's food fussiness (74). Recommendations for feeding infants and young children generally address what and when to feed, often with less attention to how to feed or strategies to handle variability in infants' signals regarding hunger and satiety or likes and dislikes (138).

Infants and young children signal hunger and satiety through actions such as hand sucking, leaning forward for food, opening and closing of the mouth, head turning, and crying/fussing. Parents' perceptions of feeding signals vary by external events, such as time of day, along with their perceptions of their infant's size, health, and overall behavior. Feeding signals also vary across infants (e.g., flexed hand position may signal hunger in some infants), contributing to interpretation confusion. Parents are often more responsive to hunger signals than to satiety signals (70). Children also express their food likes and dislikes through facial expressions and signals that may be easily confused with hunger/satiety signals. As children mature and parents and children develop consistent interaction patterns, signals are easier to interpret, but they are likely to change as infants transition to complementary feeding and experience new flavors and textures (**Figure 5**).

**4.4.1. Autonomy and feeding problems.** Along with the transition to complementary feeding, as children mature they become more autonomous, with both the capacity and the desire for self-control. Parents can support toddlers' emerging autonomy by enabling them to touch food and begin to self-feed (148). However, parent-reported feeding problems occur among up to 50% of typically developing toddlers throughout the world, and frequently include food refusal, food selectivity (pickiness), or disruptive mealtime behavior (88, 137). A study of toddlers in Bangladesh found relatively high rates of food refusal (mean of six to seven times per meal), with fewer than 20% of mouthfuls self-fed (1). In many cases, feeding problems represent typical toddler development of neophobia (hesitancy to try new foods) or autonomy (desire for independence). Food refusal can be confusing to parents because it may be unclear whether children are signaling satiety, exerting their will by requesting an alternative, or exhibiting a behavioral problem. Early feeding

problems are often transient and resolve over time, particularly when parents are sensitive to their child's signals of satiety and emerging autonomy and adhere to regularly scheduled mealtime routines and responsive behavior. However, when feeding problems are associated with family stress (135) or handled with nonresponsive feeding behaviors, they can result in weight-related problems (either underweight or overweight), nutrition-related health conditions, and long-term behavioral problems. Feeding problems can increase in severity when parents misinterpret their toddler's signals or mismanage the situation.

To avoid feeding problems, effective education teaches parents to recognize children's cues and address the entire feeding context (e.g., routines, distractions, opportunities for modeling), includes parent social support, and provides opportunities to simulate the recommended practices (104). An intervention in Australia that included an eight-session, group-based behavioral intervention was effective in reducing feeding problems among typically developing children, as measured by both parent reports and direct observations of eating (2).

Research on responsive feeding in LMICs has shown that some parents report the need to use pressure and forceful feeding strategies rather than responsive strategies to ensure that their child eats enough food. This is usually attributed to parents' concerns about their child's ability to determine satiety and the health consequences that could result in sickness or death without adequate food (2). This finding emphasizes the central role that maternal beliefs, social conditions, and local customs play in parent feeding practices. An intervention in rural India that trained village women to coach mothers on infant and young child feeding and responsive feeding demonstrated benefits to infants' dietary intake and growth (reduction in stunting) (149).

**4.4.2. Global guidelines.** The *Guiding Principles for Complementary Feeding of the Breastfed Child* (116) and *Guiding Principles for Feeding Non-Breastfed Children 6–24 Months of Age* (158) were published by the Pan American Health Organization/WHO and WHO, respectively (see the sidebar titled Guiding Principles for Complementary Feeding of the Breastfed Child). Both include responsive feeding as a principle (168), highlighting the importance of caregivers reading children's signals of hunger and satiety, promoting self-feeding, not forcing or pressuring children, and making meals occasions for pleasant social interactions. Principles of responsive feeding have been incorporated into Care for Child Development (170), a WHO/UNICEF intervention package implemented through community health workers that uses principles of responsive parenting, operationalized through play and communication.

Children with physical or developmental disabilities are at increased risk of feeding problems, nutritional deficiencies, and obesity (10), often associated with oral–motor and other physical limitations. Specialized services, including nonoral feeding, are available (1) and provide an example of equity by ensuring that children with special needs receive necessary nutrients and are included in daily activities as much as possible.

## 5. NUTRITIONAL CHALLENGES FOR INFANTS AND YOUNG CHILDREN, IMPACT ON COGNITION, AND EFFECTIVE INTERVENTIONS

Although most of the world's malnourished children younger than 5 years experience undernutrition, overweight and obesity are rising globally. Many LMICs are now facing the challenge of addressing undernutrition as the prevalence of overweight and obesity rises. The immediate consequences of undernutrition and overweight during these formative years include significant morbidity and mortality, delayed cognitive and motor development, and later risk of noncommunicable diseases (145). In the long term, child undernutrition and overweight lead to reduced



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work capacity and earnings and, among girls, reduced reproductive capacity. Overweight children are at an increased risk of developing noncommunicable diseases, including early onset of type 2 diabetes mellitus, hypertension, respiratory problems, sleep disorders, and social problems such as stigmatization and depression (163).

## GUIDING PRINCIPLES FOR COMPLEMENTARY FEEDING OF THE BREASTFED CHILD

**1. Duration of exclusive breastfeeding and age of introduction of complementary foods**. Practice exclusive breastfeeding from birth to 6 months of age and introduce complementary foods at 6 months of age (180 days) while continuing to breastfeed.

**2. Maintenance of breastfeeding**. Continue frequent on-demand breastfeeding until 2 years of age or beyond.

**3. Responsive feeding**. Practice responsive feeding, applying the principles of psychosocial care. Specifically, (*a*) feed infants directly and assist older children when they feed themselves, being sensitive to their hunger and satiety cues; (*b*) feed slowly and patiently, and encourage children to eat, but do not force them; (*c*) if children refuse many foods, experiment with different food combinations, tastes, textures, and methods of encouragement; (*d*) minimize distractions during meals if the child loses interest easily; and (*e*) remember that feeding times are periods of learning and love—talk to children during feeding, with eye contact.

**4. Safe preparation and storage of complementary foods**. Practice good hygiene and proper food handling by (*a*) washing caregivers' and children's hands before food preparation and eating, (*b*) storing foods safely and serving foods immediately after preparation, (*c*) using clean utensils to prepare and serve food, (*d*) using clean cups and bowls when feeding children, and (*e*) avoiding the use of feeding bottles, which are difficult to keep clean.

**5. Amount of complementary food needed**. Start at 6 months of age with small amounts of food and increase the quantity as the child gets older, while maintaining frequent breastfeeding. The energy needs from complementary foods for infants with average breast-milk intake in developing countries are approximately 200 kcal per day at 6–8 months, 300 kcal per day at 9–11 months, and 550 kcal per day at 12–23 months. In industrialized countries, these estimates differ somewhat (130, 310, and 550 kcal per day at 6–8, 9–11, and 12–23 months, respectively) because of differences in average breast-milk intake.

**6. Food consistency**. Gradually increase food consistency and variety as the infant gets older, adapting to the infant's requirements and abilities. Infants can eat pureed, mashed, and semisolid foods beginning at 6 months. By 8 months, most infants can eat finger foods (snacks that can be eaten by children alone). By 12 months, most children can eat the same types of foods as consumed by the rest of the family (keeping in mind the need for nutrient-dense foods, as explained in point 8, below). Avoid foods that can cause choking (i.e., items that have a shape and/or consistency that may cause them to become lodged in the trachea, such as nuts, grapes, or raw carrots).

**7. Meal frequency and energy density**. Increase the number of times that the child is fed complementary foods as he/she gets older. The appropriate number of feedings depends on the energy density of the local food and the usual amounts consumed at each feeding. For the average healthy breastfed infant, meals of complementary foods should be provided two to three times per day at 6–8 months of age and three to four times per day at 9–11 months of age and 12–23 months of age, with additional nutritious snacks (such as a piece of fruit or chapatti with nut paste) offered once or twice per day, as desired. Snacks are defined as foods eaten between meals—usually self-fed, convenient, and easy to prepare. If energy density or amount of food per meal is low, or the child is no longer breastfed, more frequent meals may be required.

**8. Nutrient content of complementary foods**. Feed a variety of foods to ensure that nutrient needs are met. Meat, poultry, fish, or eggs should be eaten daily, or as often as possible. Vegetarian diets cannot meet nutrient needs at this age unless nutrient supplements or fortified products are used. Vitamin A–rich foods and vegetables should be eaten daily. Provide diets with adequate fat content. Avoid giving drinks with low nutrient value, such as tea, coffee, and sugary drinks such as soda. Limit the amount of juice offered so as to avoid displacing more nutrient-rich foods.



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**9. Use of vitamin/mineral supplements or fortified products for infant and mother**. Use fortified complementary foods or vitamin/mineral supplements for the infant, as needed. In some populations, breastfeeding mothers may also need vitamin/mineral supplements or fortified products, both for their own health and to ensure normal concentrations of certain nutrients (particularly vitamins) in their breast milk. (Such products may also be beneficial for prepregnant and pregnant women.)

**10. Feeding during and after illness**. Increase fluid intake during illness, including more frequent breastfeeding, and encourage the child to eat soft, varied, appetizing, favorite foods. After illness, give food more often than usual and encourage the child to eat more.

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## 5.1. Undernutrition

Undernutrition, which includes fetal growth restriction, suboptimal breastfeeding, stunting, wasting, and micronutrient deficiencies, increases the risk of illness and mortality and causes 45% of mortality among children younger than 5 years (22). Stunting and linear growth retardation are also associated with adverse child development outcomes (143). Evidence has shown that this association is not causal, as both are associated with a shared group of determinants that include suboptimal nutrition, inadequate care, and repeated infections (91).

A systematic review and meta-analysis of 75 early intervention studies involving more than 72,000 children age 5 years or younger found that outcomes of height and development were not related, illustrating that improved growth does not lead to improved neurodevelopment. Studies that provided nutritional supplements had small, but positive effects on both height and development. Studies that provided learning or responsive caregiving had four- to fivefold-higher effects on neurodevelopment in comparison to nutritional supplementation studies, with no effects on height (125). The analysis did not include studies that provided both nutrition and responsive caregiving interventions. Although nutrition and child development are intricately related, especially during the earliest years, when brain development is rapid, evidence for integrated nutrition-responsive caregiving interventions is limited (67). These findings suggest that to promote thriving, which includes both growth and development, interventions need to target both early childhood nutrition and neurodevelopment.

## 5.2. Micronutrient Deficiencies

Infants and young children are also at high risk of micronutrient deficiencies, a condition often called hidden hunger because it is associated with a low-nutrient diet. Iron, zinc, and vitamin A have received the most attention, especially iron, because deficiency negatively affects immune function and neurodevelopment in children (63). However, other essential vitamins and minerals have also been shown to be lacking in young children's diets (64). Depending on the setting and mix of foods provided, children may be at risk of deficiencies in riboflavin, niacin, thiamin, folate, calcium, and vitamins C and $B_6$ (156). UNICEF estimates that approximately half of all children younger than age 5 experience micronutrient deficiencies (145). Hidden hunger may affect children regardless of their growth, including children whose growth is normal.

Compared with micronutrients, fats in the diets of infants and young children have received little attention (24). They not only provide essential fatty acids but also facilitate the absorption of fat-soluble vitamins and increase the energy density and palatability of foods. Fats also support brain, ocular, and nervous system development. The quality of dietary fat matters; long-chain

polyunsaturated fatty acids, particularly *n*-3 and *n*-6, are related to child development (106). Recent evidence has associated choline with improved cognition (31, 80). In contrast, *trans*-fatty acids can interfere with the metabolism of essential fatty acids, with potential long-term negative consequences (81). Saturated fats are a concern in children's diets in the United States (9) and are also likely to be of concern in other parts of the world.

**CMAM:** community management of acute malnutrition

**WASH:** water, sanitation, and hygiene

The evidence for effective treatment of undernutrition is strongest for severe acute malnutrition with well-established treatment protocols (126). Community management of acute malnutrition (CMAM) uses ready-to-use therapeutic foods for home treatment of severely undernourished children without medical complications. The CMAM approach has improved survival rates compared with expensive inpatient hospital care, and it is highly cost-effective.

In contrast, because of the multifaceted causes of micronutrient deficiencies and stunting, their reduction is both a programmatic and policy enigma. Interventions to prevent stunting have been categorized as either nutrition specific or nutrition sensitive (22). Stunting is associated with early-life environmental conditions, often occurring prenatally (7). Nutrition-specific interventions to prevent stunting postnatally are often delivered through the health system and include promotion of breastfeeding, dietary diversity, and complementary feeding; supplementation with vitamin A, iron, or multiple micronutrients; preventive zinc supplementation; and disease prevention and management (15). Although stunting is associated with poor child development, it is not causal (91), and comprehensive interventions that incorporate responsive caregiving may help alleviate stunting and promote child development.

Supplementation with iron and multimicronutrient powders, while efficacious in research trials to prevent iron deficiency and other micronutrient deficiencies, has proven less successful when implemented through weak health systems. The effectiveness of the promotion of dietary diversity and complementary feeding is strongly predicated on a family having the resources to obtain the high-quality nutrient-dense foods needed for optimal child nutrition as well as on the quality of the counseling provided. Complementary feeding interventions, even those that provide supplementary foods, have shown relatively small positive effect sizes (15, 58, 117).

### 5.3. Nutrition-Sensitive Interventions

Nutrition-sensitive interventions occur outside the health system, including interventions related to agriculture (133). Evidence of the nutritional effect of agricultural programs, with the exception of biofortification for vitamin A adequacy, has not been established, likely because of poor-quality evaluations. Because of the negative effect of diarrhea on the growth of young children, improvements in water, sanitation, and hygiene (WASH) are another nutrition-sensitive intervention that has been widely researched and implemented. A relatively neglected nutrition-sensitive intervention is family planning. Undernutrition is associated with age of first birth (increased risk for young and particularly adolescent mothers), short birth spacing, and the number of children in a household (134).

A recent analysis that pooled data from 50 demographic and health surveys conducted since 2000 in 14 countries showed the challenges in addressing the factors associated with stunting and the need for a combination of nutrition-sensitive and -specific interventions (7). The analysis followed a hierarchy similar to the conceptual model presented in this review, looking at distal, intermediate, and proximal factors. Among the 14 countries, the annual rate of stunting reduction was very low, averaging only 1.04%. Among the distal factors assessed, a decrease in the Gini coefficient (a measure of income inequality), an improvement in women's decision making, and an increase in urbanization were significantly associated with a lower probability of stunting within a country. Significant intermediate drivers were improvements in households' access to improved



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sanitation facilities and drinking water sources and children's access to basic vaccinations. Significant proximal factors were improvements in early initiation of breastfeeding and a decrease in the prevalence of low birth weight. Many lessons can be learned from two countries, Peru and Brazil, which have been successful in reducing stunting through a multisectoral approach (77, 108). However, as stunting declines with the increase in urbanization, globalization, and economic growth, overweight and obesity emerge.

## 5.4. Overweight and Obesity

Obesity is a chronic and inflammatory state caused by an imbalance between energy ingested and energy expended that results in an excessive accumulation of body fat. Globally, undernutrition is associated with poverty and overweight with affluence (120). Obesity rates are growing fastest among children in low-income and rural households, including those identifying as indigenous. In contrast, in high-income countries, the prevalence of child overweight and obesity is highest among children in low-income families. Among children, obesity is associated with increased risk for subsequent cardiovascular disease, diabetes (114), and reduced self-esteem and psychosocial well-being (68).

Limited research has examined the association between obesity and child development. Studies in LMICs have shown that children with obesity have poorer socioemotional behavior (47), cognition and language, and academic scores (127) as well as lower fine and gross motor skills (118, 141) compared with children whose growth is within normal limits. However, differences are usually small and inconsistent across ages and sex (85). Obesity may influence cognition through altered brain structure and inflammation, as well as through the motor skeletal system, in association with lower motor performance (154).

Overweight and obese children are at increased risk of becoming obese adults, particularly if their parents are overweight or obese (92). The Feeding Infants and Toddlers Study, an investigation of the dietary patterns of 3,000 infants and toddlers across the United States, showed that in many cases children's mean energy intakes exceeded their mean energy requirements, meaning that many children were overfed with more calories than they expended. In middle- and high-income countries, issues such as feeding in the absence of hunger and nonresponsive feeding practices are becoming increasingly problematic. Thus, provision of integrated early childhood nutrition and development through promotion of common caregiving competencies may be a promising venue for programs and services to optimize child health.

Randomized controlled trials in high-income countries promoting caregiving competencies and reinforcing caregiver–child interactions have shown long-term reduced obesity prevalence in childhood and adulthood. For instance, two long-term follow-up trials in high-income settings demonstrated that children at risk for behavioral problems who received a parenting intervention at age 4 had a lower body mass index as they approached adolescence (age 8–10 years) (26). Another multicenter study with low-income families in the United States, the Family Check-Up trial, reported that a home-visiting intervention to prevent the development of behavioral problems from age 2 to 5 years by improving family management practices predicted parents serving more healthful meals to children, which in turn slowed weight gain from age 5 to 9 years (142). Lastly, the Carolina Abecedarian Project, a long-term follow-up, preschool-based randomized controlled trial, tested whether quality early childhood environments could prevent developmental delays among disadvantaged children born between 1972 and 1977 (28). Following a curriculum that emphasized child development, emotional regulation, cognitive skills, and two meals and a snack per day, intervention-group children had better academic performance than control-group children. After 3 decades, at age 35 years, intervention-group males had higher levels of

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high-density lipoprotein cholesterol, and were less likely to have metabolic syndrome, compared with control-group males randomized to receive care as usual (27). These findings suggest that lifestyle interventions can promote thriving by benefiting both growth and development.

## 6. ENVIRONMENTAL CHALLENGES: IMPACT ON CHILD DEVELOPMENT AND NUTRITION

### 6.1. Poverty

More than half of the world's poor are children (53), and many are exposed to early trauma, poor health, and poor nutrition, inhibiting their ability to learn (119) and earn adequate income in adulthood (29). These conditions lead to inequity across the life span and into future generations (93).

Adequate nutrition paired with an environment that promotes learning and social interaction with responsive caregivers is critical for cognitive, social, and physical development (21). Disparities in children's development are driven by risks associated with poverty that emerge early in life and include inadequate nutrition, low maternal education, lack of opportunities for early learning and responsive caregiving, and low levels of maternal well-being (5). A meta-analysis of more than 20,000 LMIC children showed that low maternal and paternal education, short maternal stature, low birth weight, preterm birth, and anemia in infancy were associated with low child development (137). A longitudinal analysis of a cohort of Chilean children of low and middle socioeconomic status found psychosocial stress in infancy to be a stronger predictor of neurocognitive functioning in adolescence than psychosocial stress in adolescence or iron supplementation early in life (45).

Household-level factors also play an important role in children's development and nutrition. For instance, children living in crowded households (defined as more than three persons per room, according to the United Nations) have delayed psychosocial and cognitive development, have lower school achievement, and spend less time engaged in play with objects (54). Residential crowding can also disrupt parent–child interactions, as parents may talk less with their children. Parents also engage in less monitoring and rules in crowded households, which in turn negatively influences socially supportive relationships and increases withdrawal behaviors. An empirical study using longitudinal data from two birth cohorts in the United States and the United Kingdom has shown that higher residential crowding and poorer cognitive development were largely explained by diminished maternal responsiveness (50). Thus, interventions that promote maternal responsiveness may attenuate the negative effect of residential crowding on children's cognitive development.

### 6.2. Food Insecurity

Household food insecurity is associated with poverty and poses risks for child development and nutrition. Both the Food and Agriculture Organization (FAO) (51) and the US Department of Agriculture (USDA) (147) define food insecurity as the lack of secure access to sufficient amounts of safe and nutritious food for normal growth and development and an active and healthy life. The three categories used by the FAO to form the Food Insecurity Experience Scale (FIES) are similar to the four categories used by USDA: high food security, marginal food security, low food security, and very low food security. Both sets of categories are based on responses to questionnaires regarding access to food. Food insecurity is a household condition, in contrast to hunger, which is an individual-level physiological condition. Children who experience hunger are likely to be food insecure, but children in food-insecure households are not necessarily hungry. A recent



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report from the FAO estimated that more than two billion people do not have regular access to safe, nutritious, and sufficient food, a number that includes 8% of the population in North America and Europe (52).

Maternal deprivation of nutritious and safe foods during pregnancy may impede fetal development and increase the risk of low birth weight, a risk factor for child stunting and poor child development (37). In a US study among children under 3 years of age, the period of rapid physical and brain growth, food insecurity was associated with an increased risk of adverse health conditions (including hospitalizations), poor development, and behavioral problems (38). A study from the United Kingdom suggested that food insecurity was associated with emotional problems in children, but not with lower cognitive development or behavioral problems, after accounting for differences in caregiving practices and quality of the home environment (11). A recent study among more than 20,000 infants and toddlers in low-income US households found that food insecurity was not related to either obesity or underweight but was related to adverse health conditions and developmental risk (46). These findings suggest that food insecurity cannot be detected by size among very young children but that it is associated with economic hardships and associated stressors.

Food insecurity may affect children's health and development through both nutrition and/or nonnutrition (i.e., anxiety/stress) pathways (39). The nutrition pathway suggests that in the absence of adequate and healthy food supplies (e.g., in type, quality, and amount), families may rely on inexpensive, high-carbohydrate, ultraprocessed foods that are low in nutrients, and they may binge when food is available (87). These coping strategies increase the risk of nutritional deficiencies, including iron deficiency, and they may lead to a positive energy balance, resulting in weight gain and increasing the risk for overweight and obesity among school-age children and adolescents. The nonnutritive pathway addresses parental anxiety, stress, and depression associated with food insecurity, as shown in a study using the global FIES Survey Module for Individuals data from 149 countries (83, 84). Thus, food insecurity poses risks to young children beyond the challenges of poverty. In addition to providing access to food, interventions to alleviate food insecurity may need to address associated adverse physical and mental health among parents and children (104).

### 6.3. Hygiene

Children growing up in poverty are exposed to environmental risks such as lack of safe drinking water and limited access to sanitation. UNICEF estimates that approximately 1.1 billion people have no access to sanitation facilities and practice open defecation, and approximately 783 million people lack access to improved drinking water sources. Programs and interventions including WASH have the potential to enhance thriving by reducing exposure to environmental risk factors and altering children's developmental and growth trajectories. Three large cluster randomized trials of WASH [WASH-Benefits Bangladesh, WASH-Benefits Kenya, and Sanitation Hygiene Infant Nutrition Efficacy (SHINE)] (78, 97, 111), implemented during pregnancy, found no effects on child linear growth and mixed effects on diarrhea. One interpretation is that the environments were so contaminated with fecal and other pathogens that longer time interventions are needed to measure benefit.

Two of these trials also included measures of children's neurodevelopment. The WASH-Benefits Bangladesh trial demonstrated that the WASH intervention (i.e., chlorinated drinking water, improved sanitation, handwashing with soap) either alone or in combination with nutrition strategies (i.e., counseling and provision of lipid-based nutrient supplements) positively influenced developmental outcomes at age 2 years, with smaller effects in the WASH-only group compared with the group receiving both WASH and nutrition strategies (144). The SHINE trial found that



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neither the WASH intervention nor a nutrition intervention focused on infant and young child feeding affected the children's neurodevelopment at age 2 years (65).

A recent consensus statement concluded that although the biological plausibility of WASH interventions on child growth is supported, "basic WASH services alone are unlikely to have a large impact on childhood stunting" (40). The statement recommended a comprehensive package of interventions, tailored to the local context. Thus, to effect thriving (growth and development), interventions should address the local exposure landscape and include health, nutrition, and opportunities for children to learn and experience responsive caregiving.

A recent review found that, in addition to physical health consequences (e.g., asthma and allergies) among children, exposure to environmental toxicants (e.g., pesticides, bisphenol A, polycyclic aromatic hydrocarbons, tobacco smoke, polychlorinated biphenyls, flame retardants, phthalates, and gas pollution) is linked to cognitive and learning deficiencies, mental health difficulties, and sociobehavioral problems (43). However, the research is limited, and findings of toxicant exposure may vary by child characteristics (e.g., gender), contextual factors (e.g., stress), and exposure to other toxicants.

## 7. POLICIES FOR IMPROVING CHILD NUTRITION AND EARLY CHILDHOOD DEVELOPMENT

This section addresses four policies that specifically address thriving among children under age 5 years: breastfeeding, parental leave, childcare, and social safety nets.

### 7.1. Breastfeeding

Breastfeeding initiation and duration are influenced by structural factors (sociocultural and commercial context), settings (health system and services, family and community, and workplace and employment), and individual perceptions and values (maternal and infant attributes and the mother–infant relationship) (132). Effective breastfeeding interventions include social mobilization and mass media, legislation, policy, health systems reform, counseling, support, and lactation management, supported by political will and financing (132).

Breastfeeding support includes policies and programs within the health system, as the health system plays a critical role in a mother's ability to carry out her breastfeeding goals. Comprehensive breastfeeding policies and programs, implemented at the national level, are associated with positive national trends in exclusive breastfeeding (100).

**7.1.1. The International Code of Marketing of Breast-milk Substitutes.** Breastfeeding protection usually refers to legal measures and includes the International Code of Marketing of Breast-milk Substitutes (the Code) and maternity legislation. The Code was passed by the WHA in 1981 following accounts of inappropriate and unethical marketing of breast-milk substitutes, resulting in infants becoming undernourished or dying (155). The Code outlines the responsibilities of governments, health care systems and workers, and those marketing or manufacturing breast-milk substitutes, defined as any food that serves as a partial or total replacement for breast milk. In addition to infant formula, a breast-milk substitute includes other milk products, cereals, vegetable mixes, juices, follow-up milks, feeding bottles, and teats. The WHA has reaffirmed the importance of the Code every 2 years since 1981.

Implementation of the Code depends on national legislation, monitoring, and enforcement. A major challenge is the large and growing market for breast-milk substitutes (124). Milk formula sales increased from US$2 billion in 1987 to approximately US$40 billion in 2013. A recent report



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from WHO, UNICEF, and the International Baby Food Action Network shows that as of 2018, few countries had robust measures in place to eliminate inappropriate promotion of breast-milk substitutes and complementary foods for infants and young children (171). In four out of the six WHO regions, slightly more than half of countries had provisions that empowered government agencies to impose sanctions on violators of their law. Monitoring and enforcement have been weak.

**7.1.2. Baby-Friendly Hospital Initiative.** The WHO/UNICEF Baby-Friendly Hospital Initiative (BFHI), launched in 1991 and updated in 2018, aims to protect, promote, and support breastfeeding (166). The BFHI promotes hospital practices consistent with early initiation of breastfeeding, an environment conducive to breastfeeding, appropriate clinical management of breastfeeding, and compliance with key provisions of the Code, such as no donations of free or subsidized infant formula. These practices are summarized in 10 steps, which form the basis for certification as a baby-friendly facility. A meta-analysis examining the relationship between supportive health systems and breastfeeding showed that interventions that included the BFHI, counseling, and lactation management increased exclusive breastfeeding by nearly 50% and any breastfeeding by 66% (132).

## 7.2. Parental Leave

Paid parental leave provides working parents with the time and access to resources and services needed to provide nurturing care in the postnatal period. In 2000, International Labour Organization (ILO) Convention 183 recognized the importance of parental leave for children's development and called for at least 14 weeks of leave for mothers of newborns (83, 84). As of 2014, only 42 countries (23%) met or exceeded this recommendation, leaving an estimated 840 million women workers across the globe with inadequate protection (82). Although most high-income countries comply with and exceed the ILO recommendations, the United States is an exception. Most women in the United States rely on the Family and Medical Leave Act, which protects a woman's job for up to 12 weeks after childbirth but provides no payment. Eligibility is limited to women who have been working for their current employer for at least a year and requires that the employer have at least 50 employees.

Maternal employment is often cited as a reason for not breastfeeding or breastfeeding for a short duration (44, 113, 115). A maternity leave of 6 weeks or less is associated with a fourfold increase in the odds of not initiating breastfeeding or early cessation (69). A recent study using data from 38 LMICs between 1996 and 2014 reported that for every 1-month increase in the duration of maternity leave there was a 5.9% increase in the prevalence of exclusive breastfeeding and a 2.2-month increase in the total duration of breastfeeding (34). Lengthier paid parental leave is also associated with a reduction in risk of neonatal and infant mortality (109) and higher childhood immunization rates (72).

In addition to improving nutritional and health outcomes, paid parental leave can contribute to prevention of family violence and can support child security and safety and responsive caregiving. Studies in high-income settings have found that parental leave was associated with lower chances of partner violence in the first year after birth (60), as well as a lower prevalence of child maltreatment and physical abuse (89).

Multiple studies have supported the economic effects of paid leave through increasing women's economic empowerment and their ability to contribute to family income, thus reducing children's risk of exposure to poverty-related conditions that can impair their physical, cognitive, and emotional development. A 19-country study found that longer parental leave was associated with a



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smaller income gap between mothers and nonmothers (123), and a 22-country study found that an 8-month to 1-year leave reduced gender pay gaps (23).

Despite the benefits of parental leave, many caregivers do not have access to this legal right because the policy applies only to the formal work sector. An estimated 55% of women in countries with legal rights to parental leave do not have access to maternity leave because they work in the informal sector or have part-time or intermittent jobs. In some countries, paid family leave programs partially replace wages and do not guarantee job protection for some, negatively affecting the decision to apply for this benefit.

Global data from the UCLA WORLD Policy Analysis Center (see **https://www.worldpolicycenter.org/about/about-world**) reported that maternal leave rose from 89% to 96% and paid leave for fathers from 21% to 52% from 1995 to 2015. Although progress is still needed, 54% of all countries meet the ILO standard of at least 14 weeks of paid maternity leave, and 27% (mostly high-income countries) provide 6 months or more of paid leave. Women in the informal sector, which includes most women in LMICs, cannot take advantage of parental leave, thereby potentially increasing their children's risk of not thriving.

## 7.3. Childcare Services

As maternal employment increases worldwide, there is a growing need for childcare services. An analysis conducted by the Overseas Development Institute in 2016 found that in 53 LMICs, an average of 20% of children under age 5 years were without adult care for at least an hour in a given week—either left alone or in the care of a sibling under the age of 10 (136). Factors that affect the decision of leaving children alone at home include parental unavailability and poor working conditions, limited support social networks, the inability to afford childcare, neighborhood safety, and children's age. In urban Nepal, unavailability of childcare (from family and non–family member adults) was associated with an increased risk of underweight and stunting among children age 10–24 months of both nonworking and working mothers (104).

In addition to the safety and security issues of leaving children unattended at home, the lack of interaction and learning opportunities during this period can have long-lasting effects on children's development. Childcare has been shown to protect infants and children from the detrimental effects of poverty (112). Experimental studies of intensive and high-quality care for children in low-income settings in LMICs have shown positive effects on early learning, cognitive and language development, and school achievement that sometimes last until adulthood (41).

Options for safe and regulated care of young children are limited and costly. Data from the UNICEF global database shows that on average just under one-third of children aged 3 to 5 years participated in early childhood care and education (ECCE) in 67 LMICs. For children under age 3 years, the proportion in ECCE is likely to be much lower. In 34 OECD (Organisation for Economic Co-operation and Development) countries, the cost of childcare or preschool for a 2-year-old is approximately 27% of an average worker's wage. A study conducted in periurban cities in Africa reported that the majority of children aged 3 to 6 attended ECCE (ranging from 71% in Soweto to 93% in Ashaiman) and estimated an average cost of one-quarter to one-half of an average's worker wage (16).

Subsidized childcare services provided by governments or employers can substantially reduce the costs associated with access to ECCE. Evaluation of a subsidized childcare program in Colombia with data from 10,173 beneficiaries ranging from 3 to 6 years of age found a modest improvement in children's cognitive and socioemotional development, but no effect on nutritional status, after at least 15 months attending the program (13). A recent community-based



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randomized controlled trial tested the effect of enhancing the childcare program supported by the government of Malawi with an integrated agriculture intervention to enhance food diversity in communities and feeding and caregiving practices (62). The integrated intervention improved dietary diversity among preschool-aged children in the intervention group and decreased stunting prevalence among younger siblings, with no effects reported on children's development (61).

In the United States, more than 60% of children age 5 and younger are enrolled in a non-parental care arrangement, where they may consume up to two-thirds of daily calories and spend up to 33 h per week. Healthy eating policies such as the Child and Adult Care Food Program (CACFP) ensure exposure to healthier food options through national reimbursement of three meals (combination of snacks and meals) served to low-income children attending eligible child-care centers. All regulated family childcare providers and centers are eligible, as are centers where 25% of enrolled children participate in the Child Care Subsidy Program. Despite the varying levels of compliance with nutrition- and physical activity–related policies and practices across centers (6), programs under the CACFP support an environment for children to thrive, as they serve more fruits and vegetables and fewer sugar-sweetened beverages than non-CACFP centers (131).

Universal access to quality childcare throughout early childhood has the potential to promote thriving and equity. Investing in early childhood education for at-risk children is a potential payoff to governments, as it forecasts later school and labor market success (75).

## 7.4. Social Safety Nets

Social safety net programs augment income among vulnerable groups by increasing access to basic needs, such as housing, clothing, food, health care, and education, often through cash transfers. Some programs include additional interventions or conditions to link populations to health, nutrition, and education services, and empower women by directing the transfers to them. Cash transfer programs can enhance a country's human capital by targeting the underlying determinants of poor health, nutrition, and child development and by enabling parents to provide a better environment for their children through greater financial resources. There are two main pathways that could explain the effect of such programs on health, nutritional, and developmental outcomes among children living in extreme poverty (36). The first pathway is the increase in purchasing power, which allows households to purchase more and healthier food and increase food security, thereby improving nutritional outcomes. The additional income could also be used to purchase household materials and equipment, such as flooring, refrigerators, and cleaning products, that could reduce infections and improve health, or to purchase books, newspapers, and toys to increase learning opportunities in the home and influence child development. The second pathway is the improvement in the psychosocial well-being of the family members, which could increase responsive caregiving and influence child development outcomes.

Studies evaluating the effect of conditional cash transfer (CCT) programs have found a decrease in child illness and morbidity. In Colombia, there was a significant decrease in diarrhea for rural but not urban children (8). In Brazil, the CCT program significantly improved children's health status (129) and reduced the under-5 mortality rate, particularly deaths attributable to malnutrition and diarrhea (128).

Effects of CCT on nutritional outcomes have been mixed. A meta-analysis of 19 programs found an average positive but small effect of 0.04 in the height-for-age *z* score (133). The positive effects of CCT on child growth are found mainly among the most vulnerable and youngest children, or among those exposed to the program for long durations (8, 133). In Peru, there were



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no significant effects of the CCT programs on children's height, although the lack of significance may have been due in part to the study's small sample size (121).

Few countries have evaluated the effect of CCT programs on children's cognitive outcomes, and the majority report small but positive effects. An evaluation of Mexico's *Oportunidades* CCT program (now called *Prospera*) shows that children randomized to the program earlier had better behavior outcomes than those receiving the program later (56). Children in households receiving a greater amount of cash had higher scores on tests of cognition, language, and motor skills (55).

Although many cash transfer programs reach a small portion of the vulnerable population, some countries have extensive coverage, according to the World Bank's 2018 report on social safety net programs (172). These countries include Uruguay (*Asignaciones Familiares*, covering 75% of the poorest quintile), Mexico (*Prospera*, reaching 63% of the poorest), and the Philippines (4Ps, or *Pantawid Pamilyang Pilipino* Program, covering 60% of the poor).

## 8. IMPLEMENTATION STRATEGIES TO PROMOTE ALL CHILDREN THRIVING

Nutrition and child development are intricately linked during the early years. Not only do they share many common determinants, but also understanding infant and young child feeding requires attention to both what children are eating and how they are being fed. There are also important differences between interventions to promote nutrition and those to promote child development (125). Multiple interventions that combine both nutrition and early childhood development have promising additive effects, but most have not examined synergetic effects or been implemented and evaluated at scale (67).

Implementation of integrated nutrition and child development programs requires multisectoral collaboration, because nutrition and child development are typically located in different sectors and ministries. The nutrition sector responds to indicators aligned with nutrition and health, and the early child development sector responds to indicators aligned with early child development and education. Integrating programs across the two sectors requires attention to policies, finance, governance and multisectoral collaboration, workforce development, and stakeholder involvement (20). At times, the programs are completely integrated such that the two components cannot be separated and evaluated independently. However, when the programs are not completely integrated, analyses could examine the synergistic as well as the additive effects of the programs by including an interaction term.

Researchers, program personnel, and policy makers are often unaware of the steps needed to implement programs at scale. Implementation science addresses the gap between research and practice by examining the methods that promote the uptake of research findings into practice (105). Implementation science emphasizes real-world situations, rather than the experimental situations generally used in research contexts. For example, in implementation science, programs are designed to be implemented in community sites and to engage staff who are employed in target areas and facilities and who often have responsibilities beyond program implementation. Countries need systematic information on indicators and evaluations of services, such as reach; coverage; cost; and requirements for training, coaching, and supervision. This information can be generated by a system of accountability that includes valid indicators, quality data, and timely feedback, thereby facilitating continuous quality improvement. Measurement and accountability are components of implementation science, with the goals of both evaluating the implementation of the intervention, including the barriers and enabling environments, and operationalizing a system to improve the implementation of the intervention. Through a process of continuous quality improvement, metrics are shared and used to alter the system.



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Through the involvement of transdisciplinary teams, including implementing partners, stakeholders, and participants, implementation science investigates study participants' view of the fidelity and impact of the intervention, including an investigation of how and why the intervention works in real-life situations. Investigators address the acceptability, feasibility, cost, coverage, and sustainability of the intervention, and also identify the barriers to its adoption and sustainability (122). Thus, the next step, that of scaling integrated nutrition–child development intervention, will require additional expertise to ensure that implemented programs reach the goals of thriving and ensuring equity.

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## 9. CONCLUSION

We have reviewed how nutrition and early child development can promote thriving among children under age 5 throughout the world. Although integrated nutrition–childhood development interventions have shown promising additive effects, most have not been evaluated for synergistic effects or implemented at scale. Challenges posed by undernutrition, stunting, micronutrient deficiencies, overweight, and children not reaching their developmental potential remain widespread. Solving inequities in the distribution of all types of malnutrition and poor development between and within countries is a major challenge. Research is needed to establish the evidence base regarding the acceptability, feasibility, cost, coverage, and sustainability of the interventions to ensure equity for all children thriving. Ultimately, political will is required to implement the multisectoral policies and programs all children deserve.

### SUMMARY POINTS

1. The revisions to the UNICEF Conceptual Framework of All Children Surviving and Thriving provide a road map to promote equity and thriving, based on enabling environments that support children's nutrition, health, learning, responsive caregiving, and safety and security.
2. Elevated rates of stunting, underweight, micronutrient deficiencies, and not reaching developmental potential among children under age 5 years threaten the long-term well-being of millions of children and families and of the countries where they reside. Solving inequities in the distribution of malnutrition and poor development between and within countries continues to be a challenge.
3. Childhood overweight and obesity are global problems that begin early in life and increase children's long-term risk for noncommunicable diseases, stigma, and other physical and social problems.
4. Poverty and food insecurity undermine families' ability to provide the nutrition and caregiving that children need to thrive; integrated services that include health care, nutrition, responsive caregiving, learning, and safety and security can promote equity and thriving.
5. Policies such as breastfeeding, parental leave, childcare, and social safety nets can promote equity and thriving, if they are fully implemented.
6. Evidence supports integrated nutrition and child development programming, but there are few comprehensive policies or examples of programs at scale.

## FUTURE ISSUES

1. Underweight and stunting often occur prenatally. Strategies are needed to ensure preconception and prenatal nutrition to ensure that infants are born at term with birth weight and length within normal limits.
2. There is a need to unpack the elements of the Conceptual Framework of All Children Surviving and Thriving to clarify how the components work together, with attention to policies, finance, governance and multisectoral collaboration, workforce development, and stakeholder involvement.
3. Although evidence suggests that policies related to breastfeeding, parental leave, childcare, and social safety net programs benefit children's growth and development, implementation is limited. Political will and strategies are needed to implement policies fully.
4. Research on parental feeding behaviors has been conducted primarily in high-income countries; research is needed in low- and middle-income countries (LMICs).
5. Limited attention has been directed to children with disabilities and special health care needs. Attention is needed to ensure that programs are equitable and inclusive.
6. Although the earliest years (conception to age 5 years) are foundational to children thriving, brain, physical, psychological, and mental development continue through childhood and adolescence. Attention to thriving and equity should be extended throughout childhood and adolescence.

## DISCLOSURE STATEMENT

The authors are not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

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