Chapter 12. Infant and Young Child Growth

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Abstract

Undernutrition is a global health problem especially in children and is responsible for a third of all deaths in children under the age of five years. The period of infancy and early childhood is an important period for child growth and development so targeting this period and reducing the prevalence of undernutrition should be a priority. This chapter discusses the burden, consequences and interventions for tackling childhood undernutrition and concludes that the agenda for combatting malnutrition requires a multifaceted approach involving both interventions directed at the immediate causes of suboptimum growth and development, as well as the large-scale programs that broadly address the underlying determinants of malnutrition.

Introduction

Each year, undernutrition—including fetal growth restriction, stunting, wasting and micronutrient deficiencies—and suboptimum breastfeeding (BF) underlie nearly 3.1 million deaths of children under age five years each year worldwide, accounting for 45 percent of all deaths in this age group (Liu and others 2012). Fetal growth restriction and suboptimum BF together are responsible for more than 1.3 million deaths, or 19.4% percent of all deaths among children younger than age 5 years.

Although the prevalence of stunted children has decreased from 40 percent in 1990 to 26 percent in 2011, an estimated 165 million children younger than age five years globally are stunted, based on the World Health Organization’s (WHO) Child Growth Standards (map __). Sub Saharan Africa and south Asia have the highest estimated prevalence, with 68 and 55.8 million stunted children living in South Asia and sub-Saharan Africa respectively (UNICEF, WHO, and World Bank 2012). Stunting prevalence among children younger than age 5 years is substantially higher in the poorest quintiles and rural areas compared to richest quintiles and urban areas, respectively (Black and others 2013). The complex interplay of social, economic, and political determinants of undernutrition results in substantial inequalities among population subgroups (Black and others 2013).
Optimum nutrition during the crucial periods of pregnancy and the first two years of life is essential to health and growth, and its benefits can extend throughout life. A major component of infant and young child feeding (IYCF) in the early years of life is the provision of breast milk and appropriate complementary foods (PAHO and WHO 2003). In 2003, the WHO and United Nations International Children's Fund (UNICEF) published a jointly developed Global Strategy for IYCF to refocus attention on the impact that feeding practices have on infant nutrition and health (WHO 2003; WHO and UNICEF 2003). In 2008, the WHO published a set of population-level IYCF indicators developed in response to the need for simple, practical indicators of appropriate feeding practices in children ages six months to 23 months (WHO 2002, 2008). A core set of eight indicators (three for BF and five for complementary feeding) includes measures of dietary diversity, feeding frequency, and consumption of iron-rich or iron-fortified foods, as well as indicators of appropriate BF practices (Jones and others 2014).

This chapter discusses key concepts in nutrition and growth during this early phase of life; intrauterine growth and maternal interventions (balanced energy and micronutrient supplementation); nutrition interventions to improve infant and child feeding (BF, complementary feeding, and micronutrient supplementation); other nutrition-related interventions; and challenges in infant and child feeding.

**Table __.1  World Health Organization’s Infant and Young Child Feeding Core Indicators**

<table>
<thead>
<tr>
<th>Breastfeeding indicators</th>
<th>Description</th>
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<tbody>
<tr>
<td>Early initiation of breastfeeding</td>
<td>Proportion of children born in the past 24 months who were breastfed within one hour of birth</td>
</tr>
<tr>
<td>Exclusive breastfeeding under age six months</td>
<td>Proportion of infants from birth to age five months who were exclusively breastfed during the previous day</td>
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</table>
Continued breastfeeding at age one year | Proportion of children ages 12–15 months who were fed any breast milk during the previous day

### Complementary feeding indicators

- **Introduction of solid, semi-solid, or soft foods**
  - Proportion of infants ages ix months to eight months who received solid, semi-solid, or soft foods during the previous day

- **Minimum dietary diversity**
  - Proportion of children ages six months to 23 months who received foods from four or more food groups during the previous day

- **Minimum meal frequency**
  - Proportion of breastfed and non-breastfed children ages six months to 23 months who received solid, semi-solid, or soft foods (including milk feeds for non-breastfed children) the minimum number of times or more during the previous day

- **Minimum acceptable diet: Proportion of children ages six months to six months to 23 months who had at least the minimum dietary diversity and minimum meal frequency (apart from breast milk) during the previous day**
  - Minimum acceptable diet: Proportion of children six months to 23 months of age who had at least the minimum dietary diversity and minimum meal frequency (apart from breast milk) during the previous day

- **Consumption of iron-rich or iron-fortified foods**
  - Proportion of children ages six months to 23 months who received iron-rich food or iron-fortified food specially designed for infants and young children, or fortified in the home, during the previous day

*Source: Jones and others 2014.*

### Consequences of Undernutrition

Good nutrition early in life is essential for children to be able to attain their full developmental potential. Malnutrition leads to early physical growth failure; delayed motor, cognitive, and behavioral development; diminished immunity; and increased morbidity and mortality (Black and others 2013). Deficiencies of essential vitamins and minerals are widespread and have substantial adverse effects on child survival and development. Deficiencies of vitamin A and zinc adversely affect child health and survival; deficiencies of iodine and iron, together with stunting, can limit the ability of children to realize their developmental potential.

### Mortality and Morbidity

A recent analysis demonstrates that all degrees of stunting, wasting, and underweight are associated with increased hazards of death from diarrhea, pneumonia, measles, and other infectious diseases, with the exception of malaria (Black and others 2013); this analysis confirms the complex interplay between undernutrition and infection. In addition to anthropometric measures, the association between micronutrient deficiencies, such as vitamin A deficiency and the increased risk of childhood infections and mortality, is well-established (Black and others 2013). Vitamin A deficiency increases the risk of severe diarrhea and diarrhea mortality, but it is not an important risk factor for the incidence of diarrhea or pneumonia, or for pneumonia-related mortality. Other micronutrient deficiencies, such as zinc and
iron deficiencies, are widespread in low-and-middle-income countries (LMICs) and are associated with increased risk of morbidity (Black and others 2003) and mortality (Guilbert 2003).

**Growth and Development**

Undernutrition has important consequences on physical and cognitive growth and development. Malnutrition leads to early physical growth failure; delayed motor, cognitive, and behavioral development; diminished immunity; and increased morbidity and mortality. Those who survive the initial and direct consequences of malnutrition in early childhood grow up as adults, but with disadvantages when compared to those who have been nutritionally adequate and enjoyed healthy environment in the initial crucial years of life. Undernutrition is strongly associated with shorter adult height, less schooling, reduced economic productivity; in women, it is associated with offspring with lower birthweights. Lower birthweight and undernutrition in childhood are risk factors for high glucose concentrations, blood pressure, and harmful lipid profiles (Greer, Sicherer, and Burks 2008). The later consequences of childhood malnutrition also include diminished intellectual performance, low work capacity, and increased risk of delivery complications (Waddington and others 2009).

**Maternal Nutrition and Fetal Growth**

The determination of the child nutrition status starts before birth, as maternal nutritional status and fetal growth restriction have been found to be closely associated with child health. Maternal stunting and underweight leads to small for gestational age (SGA) and prematurity. Fetal growth restriction, in turn, is an important contributor to stunting and wasting in children; approximately 20 percent of childhood stunting could have its origins in the fetal period (Black and others 2013). The conceptual framework in **figure 1** highlights the risk factors and interventions for childhood stunting and wasting.

**Figure 1 Malnutrition Risk Factors and Interventions**
**Definitions**

*Intrauterine growth restriction* (IUGR) describes the pathological inhibition of fetal growth. Although there is no standard definition of IUGR, two terms have been used to describe it: SGA and *low birth weight* (LBW).

- **SGA**, the most commonly used term for IUGR, is defined as babies born with weight less than the 10th percentile of recommended gender specific weight for gestational age for that population (WHO 1995; Yakoob and Bhutta 2011).
- **LBW** is defined as birth weight less than 2,500 grams, irrespective of gestational age.

As birth size depends on both gestational age and growth velocity, SGA is preferred to LBW. A baby born with low birth weight but appropriate for gestational age is expected to have better outcomes, compared to a baby born SGA. However, LBW has been the most commonly used indicator to describe fetal growth, as it can be difficult to determine true gestational age in LMICs (WHO 1995). In this chapter, SGA is used as a proxy indicator for IUGR.

**Causes of Intrauterine Growth Restriction**

IUGR can have multiple causes. Some of the known risk factors include maternal malnutrition; congenital malformations; congenital infections; maternal smoking; and maternal medical comorbidities, such as primary hypertension and diabetes mellitus (Romo, Carceller, and Tobajas 2009). In LMICs, maternal malnutrition is an important risk factor for SGA babies; however, in high-income countries (HICs), cigarette smoking is the most important single factor implicated in IUGR, followed by poor gestational nutrition (Salam 2014; Bhutta and others 2013). Maternal nutrition influences the availability of nutrients for transfer to the fetus; during starvation, it is likely that a low food intake results in a reduced nutrient stream from the mother to fetus, giving rise to fetal growth restriction. Maternal undernutrition (Body mass index [BMI] < 18.5 kg/m²) has decreased overall since 1980 but still remains over 10 percent in both South Asia and Sub-Saharan Africa (Black and others 2013).

**Consequences of Intrauterine Growth Restriction**

IUGR is associated with a higher risk of preterm delivery and higher rates of fetal and neonatal morbidity and mortality (Arcangeli and others 2012; Baschat 2011). This higher rates of neonatal mortality in IUGR infants is due to conditions that include birth asphyxia and infections (like sepsis, pneumonia, and diarrhea), which lead to mortality and which together account for about 60 percent of all neonatal deaths (Salam, Das, and Bhutta 2014).

The short-term consequences of IUGR involve metabolic and hematological disturbances, as well as disrupted thermoregulation, which lead to morbidities like respiratory distress syndrome, necrotizing enterocolitis, and retinopathy of prematurity (Salam, Das, and Bhutta 2014). The adverse consequences of IUGR are not limited to infancy and childhood; they extend over the lifespan. IUGR leads to stunting and wasting, and an estimated 20 percent of stunted children in LMICs were born SGA (Black and others 2013). Evidence exists that changes in the fetal nutritional environment are associated with increased risk of developing metabolic syndrome and cardiovascular disease, systolic hypertension, obesity, insulin resistance, diabetes type II, and neuropsychological and cognitive deficiencies, as well as with impairments in renal and lung development in adulthood (Bjarnegard and others 2013; Salam, Das, and Bhutta 2014).
**Prevention of Intrauterine Growth Restriction**

No effective therapies exist to reverse IUGR. Accordingly, initiatives focus on prevention through optimizing nutritional status of women at the time of conception to establish the foundation for healthy fetal growth and development. Pregnancy is a state of higher metabolic requirements, and both macronutrient and micronutrients play important roles. Multiple nutrition interventions have been studied to address maternal nutritional requirements. These include nutritional counseling; isocaloric (maternal nutrition supplement given during pregnancy in which protein provides 25% of total energy content), high (protein provides greater than 25% of total energy content), and balanced protein energy (BEP) (protein provides less than 25% of total energy content) supplementation; micronutrient supplementation; and low-energy supplementation for obese women.

Of these interventions, only BEP has been shown to affect the incidence of SGA (Bhutta and others 2013). A meta-analysis of 16 studies showed that BEP supplementation increased birth weight [mean difference (MD): 73g; 95% confidence interval (CI): 30, 117] and decreased the incidence of SGA [relative risk (RR): 0.66; 95% CI: 0.49, 0.89]. BEP supplementation also decreased the risk of stillbirth; however, the numbers of patients included in meta-analysis was small (Imdad and Bhutta 2012).

Micronutrient supplementation during pregnancy has been studied in terms of individual and multiple micronutrients and their beneficial effects for mothers and the developing fetus. Calcium supplementation has been shown to reduce the incidence of preeclampsia in populations with low calcium intake. Folic acid supplementation during the perinatal period has reduced the incidence of neural tube defects (Bhutta and others 2013). Among micronutrient interventions, multiple micronutrient supplementation has reduced the incidence of SGA babies by 13 percent (Haider and Bhutta 2012). The effects of supplementation in reducing the incidence of IUGR are clear; moreover, these benefits may extend into early childhood and impact growth and development. The effects of supplementation are not only apparent in terms of reduced IUGR but also its possible translation into early childhood development (Vaidya and others 2008).

**Breastfeeding**

**Timing**

The exact scientific basis for the absolute early time window of feeding within the first hour after birth is weak (Edmond and others 2006; Mullany and others 2008). A systematic review suggests that BF initiation within 24 hours of birth is associated with a 44 percent to 45 percent reduction in all-cause and infection-related neonatal mortality and is thought to primarily operate through the effects of EBF (Debes and others 2013).

Interventions to promoted BF are a key component of expanding its use. A review of the effects of promotion interventions on occurrence of BF concluded that counseling or educational interventions increased EBF by 43 percent at day one, by 30 percent until age one month, and by 90 percent from age one month to five months. Significant reductions in the occurrence of mothers not BF were also noted; 32 percent reduction at day one, 30 percent until one month, and 18 percent for one month to five months (Haroon and others 2013). Combined individual and group counseling seemed to be better than individual or group counseling alone.
Prevalence of Breastfeeding

BF provides numerous immunologic, psychological, social, economic, and environmental benefits. It results in improved infant and maternal health outcomes in both LMICs and HICs (Eidelman and others 2012) [26]. The WHO recommends exclusive breastfeeding (EBF) infants until age six months to achieve optimum growth (WHO 2001). In LMICs, one out of every three children is exclusively breastfed for the first six months of life, although considerable variations exist across regions (UNICEF 2006a). Recent data show that the prevalence of EBF in LMICs has increased from 33 percent in 1995 to 39 percent in 2010 (Cai, Wardlaw, and Brown 2012). The prevalence of EBF increased in almost all regions in LMICs, with a major improvement seen in central and west Africa, where the prevalence more than doubled from 12 percent to 28 percent. More modest improvements were observed in South Asia, where the prevalence increased from 40 percent in 1995 to 45 percent in 2010. The median coverage of EBF has increased from 26 percent in 2000-05 to 40 percent in 2006-11 in the 48 Countdown countries (WHO and UNICEF 2012).

EBF reduces the risk of hospitalization for lower respiratory tract infections in the first year by 72 percent (Chung and others 2007; Ip and others 2009). Any BF compared with exclusive commercial infant formula feeding can reduce the incidence of otitis media by 23 percent, while EBF for more than three months reduces the risk of otitis media by 50 percent (Chung and others 2007). Any BF is associated with a 64 percent reduction in the incidence of nonspecific gastrointestinal tract infections; this effect lasts for two months after cessation of BF (Chung and others 2007; Duijts and others 2010; Ip and others 2009; Quigley, Kelly, and Sacker 2007). BF is also beneficial for preterm infants; it is associated with 58 percent reduction in the incidence of necrotizing enterocolitis (Chung and others 2007). EBF offers a protective effect for three to four months on the incidence of clinical asthma, atopic dermatitis, and eczema by 27 percent in a low-risk population and up to 42 percent in infants with positive family history (Chung and others 2007; Greer, Sicherer, and Burks 2008).

Supportive Strategies

Although these results show the potential for scaling up, none of these trials addresses the issues of barriers around work environments and supportive strategies, such as provisions for maternity leave. A Cochrane review of interventions in the workplace to support BF for women found no trials (Abdulwadud and Snow 2012), so much more needs to be done to assess innovations and strategies to promote BF in working women, especially in low-income communities.

Complementary Feeding

Complementary feeding (CF) for infants refers to the timely introduction of safe and nutritional foods in addition to BF, specifically, clean and nutritionally rich additional foods introduced at age six months and typically provided until age 24 months (Imdad, Yakoob, and Bhutta 2011a; WHO 2002). It has been suggested that in addition to disease prevention strategies, CF interventions targeting this critical window are most efficient in reducing malnutrition and promoting adequate growth and development (Martorell, Khan, and Schroeder 1994).

According to the WHO, CF should be timely, adequate, appropriate, and given in sufficient quantity (WHO 2002). Several strategies have been employed to improve CF practices (Dewey and Adu-Afarwuah 2008). These include providing nutritional counseling for mothers to promote healthy feeding practices; providing complementary foods offering extra energy, with or without micronutrient fortification; and
increasing the energy density of complementary foods through simple technology (Dewey and Adu-Afarwuah 2008).

Inadequacy and insufficiency of complementary foods, poor feeding practices, and high rates of infections have unfavorable impacts on health and growth among children. Sufficient quantities of adequate, safe, and appropriate CF after the age six months are essential to meet nutritional requirements when breastmilk alone is no longer sufficient. However, estimates indicate that in LMICs, only 39 percent of children under age six months was exclusively breastfed in 2010 (Cai, Wardlaw, and Brown 2012), only 58 percent of babies ages six months to nine months were breastfed and given complementary foods, and only 50 percent of babies ages 10 months to 23 month were provided with complementary food and continued BF [UNICEF 2008].

Several strategies have been employed to improve CF practices. However, the diversity in CF interventions, in terms of types of food, duration, and interventions employed, makes it difficult to conclude that one particular type of CF intervention is the most effective (Dewey and Adu-Afarwuah 2008). A review (Lassi and others 2013) of two CF strategies—nutritional education and CF with or without nutritional education—showed significant impact of CF education on HAZ [MD: 0.23; 95% CI: 0.09, 0.36], WAZ (MD: 0.16, 95% CI: 0.05, 0.27), and rates of stunting (RR: 0.71; 95% CI: 0.56, 0.91). Impacts were even more dramatic when education on CF was provided in combination with actual complementary food in food-insecure populations (HAZ scores: RR: 0.39; 95% CI: 0.05, 0.73).

Education for improved feeding practices is essential to improve maternal knowledge and to prepare culturally acceptable enriched complementary foods that can lead to increased dietary intake and growth of infants. Maternal counseling in health system and community settings is critical to safeguarding optimal CF practices. Educational messages should be clear and include the promotion of nutrient-rich animal products. However, in food-insecure populations, these messages need to be combined with food provision or use of protein-rich plant food sources. Financial constraints may limit the possibility of including adequate amount of animal products in children’s diets, particularly among food-insecure populations (Lassi and others 2013). Measures should be taken at the community level to support activities involving community health workers, lay counselors, and mothers to build community or mother support groups. Communication and advocacy activities on CF are the roadmaps to improved growth and health.

**Micronutrient Supplementation**

**Micronutrient Deficiencies**

According to the WHO global estimates, 190 million preschool children and 19.1 million pregnant women have vitamin A deficiencies, defined as serum retinol < 0.70 μmol/l] (Bjarnegard and others 2013). Globally, an estimated 0.9 percent, or 5.17 million preschool-age children, has night blindness, and 33.3 percent or 90 million have subclinical vitamin A deficiencies (WHO 2009). Approximately 100 million women of reproductive age have iodine deficiencies, and an estimated 82 percent of pregnant women worldwide have inadequate zinc intakes to meet the normal needs of pregnancy (WHO and UNICEF 2003). Iron deficiencies are widespread; about 1.62 billion people have anemia (Benoist and others 2008); 18.1 percent and 1.5 percent of children have anemia and severe anemia, respectively (Salam and others 2013). The prevalence is highest in South Asia and Sub-Saharan Africa for all iron deficiency anemia (IDA), and in Sub-Saharan Africa for severe IDA (Black and others 2013). Suboptimal
vitamin B6 and B12 statuses have also been observed in many LMICs (McLean, De Benoist, and Allen 2008).

**Zinc**

Zinc deficiency has been associated with growth failure and increased risk of morbidity and mortality due to diarrheal and respiratory illness (Black and others 2013). Multiple randomized trials have studied the role of preventive zinc supplementation to promote linear growth; the findings varied across the study populations (Brown and others 2009; Ramakrishnan, Nguyen, and Martorell 2009). Meta-analyses have shown an overall beneficial effect of zinc supplementation to promote linear growth (Brown and others 2009; Imdad and Bhutta 2011b). This effect is more pronounced when zinc is supplemented alone, compared to when it is administered in combination with iron (Imdad and Bhutta 2011b). The effect is also more pronounced for children with baseline stunting (Umeta and others 2000). No standard dose and duration of zinc supplementation has been recommended to promote linear growth; however, combined data from multiple trials in one of the meta-analyses showed that a dose of 10 mg per day for 24 weeks led to net gains of 0.37 cm (SD ± 0.25) in the intervention group, compared to the control (Imdad and Bhutta 2011b).

**Vitamin A**

Vitamin A deficiency, a risk factor for increased incidence of infections, is the most common nutritional cause of blindness in the world. It is well-established that vitamin A supplementation during childhood decreases all-cause mortality and mortality due to diarrhea and measles (Imdad and others 2010). Studies have also evaluated its role in promotion of linear growth; results have shown that vitamin A supplementation does not have any significant role in this respect. A meta-analysis by Ramakrishnan and others analyzed data from 17 studies and found no statistically significant effect of vitamin A on growth (Ramakrishnan, Nguyen, and Martorell 2009). A recent large randomized trial conducted in India also did not show any positive effect of vitamin A supplementation on height gain (Awasthi and others 2013).

**Iron**

The proportion of all childhood anemia corrected by iron supplementation ranges from 63 percent in Europe to 34 percent in Sub-Saharan Africa, where there are other major causes of anemia; the proportion of severe anemia corrected by iron supplementation in Sub-Saharan Africa is 57 percent. A review of 33 studies showed that intermittent iron supplementation in children younger than age two years reduced the risk of anemia by 49 percent and iron deficiency by 76 percent (De-Regil and others 2011). The findings also suggested that intermittent iron supplementation could be a viable public health intervention in settings in which daily supplementation had not been implemented or was not feasible.

A review of the effect of iron supplementation in children on mental and motor development showed only small gains in the mental development and intelligence scores in supplemented school-age children who were initially anemic or iron deficient (Sachdev, Gera, and Nestel 2005). There was no convincing evidence that iron treatment had an effect on the mental development of children younger than age 27 months. Since the demonstration of the increased risk of admission to hospital and serious illnesses with iron supplementation in malaria endemic areas (Sazawal and others 2006), WHO recommends administration of routine prophylactic iron supplements in malaria-endemic areas on the stipulation that malaria prevention and treatment are made available (WHO 2011; WHO 2014).
Multiple Micronutrient Supplementation

In many LMICs, more than one micronutrient deficiency coexists, suggesting the need for simple approaches that evaluate and address multiple micronutrient supplementation. These include education, dietary modification, food provision, agricultural interventions, supplementation, and fortification, either alone or in combination. Food fortification can be a potentially cost-effective public health intervention and target a larger population through a single strategy. A meta-analysis of multiple micronutrient supplementation fortification in children showed an increase in hemoglobin levels by 0.87 g/dl (95% CI: 0.57, 1.16) and reduced risk of anemia by 57% (RR: 0.43; 95% CI: 0.26, 0.71). Fortification also increased vitamin A serum levels (retinol increase by 3.7 mg/dl, 95% CI: 1.3–6.1) (Eichler and others 2012).

In the past decade, point-of-use or home fortification of child diets has emerged to address the widespread micronutrient deficiencies. Multiple micronutrient powders (MNPs) or sprinkles are powdered encapsulated vitamins and minerals that can be added to prepared foods with little change to the food’s taste or texture. MNPs are designed to provide the recommended daily nutrient intake of two or more vitamins and minerals to their target populations. A review has established that MNPs appear effective for reducing anemia and iron deficiency in children under age two years (DeRegil and others 2013). Another review suggested benefit in improving anemia and hemoglobin among children; however, it showed no impact on growth and evidence of increased diarrhea, suggesting further consideration before large-scale implementation (Salam and others 2013).

Parallel Interventions

Complementing the direct nutritional interventions are parallel programs to aid the implementation of these primary interventions. These programs include the following:

- Water, sanitation, and hygiene (WASH) strategies
- Financial incentives at multiple levels
- Community-based nutrition education and mobilization programs.

These strategies can be delivered through the health systems, agriculture, market-based approaches, or other community-based platforms.

WASH Strategies

Consensus exists on the importance of improved water supply and excreta disposal for prevention of diseases, especially diarrheal diseases. Provision of safe and clean water, enhanced facilities for excreta disposal and promotion of hygiene not only aim to improve the quality of life but also help reduce the incidence of infectious diseases particularly in children. In 2011, 89 percent of the world population used an improved drinking-water source, and 55 percent had a piped supply on the premises. In the same year, one billion people still defecated in the open (WHO 2013). Although geographic disparities exist, rural and urban disparities within countries are also striking; 83 percent of the rural population has no access to safe water and 71 percent lives without sanitation (WHO 2013). There is an urgent need to ensure safe water, sanitation, and hygiene practices at household and community levels.

A review (Dangour and others 2013) on the effect of WASH interventions on nutritional status of children under 18 years of age found no impact on WAZ scores (MD 0.05; 95% CI: -0.01, 0.12) and WHZ
scores (MD: 0.02; 95% CI: -0.07, 0.11), but small impact on HAZ scores (MD 0.08; 95% CI 0.00 to 0.16).

Another review (Cairncross and others 2010) highlighted promising impacts of handwashing on reducing diarrhea morbidity by 47 percent (RR: 0.53; 95% CI: 0.37, 0.67). Water quality improvement also showed significant impacts on reducing the incidence of diarrhea by 42 percent (RR 0.58; 95% CI: 0.46-0.72). Another review (Waddington and others 2009) on the effectiveness of these interventions concluded that those for water quality (protection or treatment of water at source or point of use) were more effective than those to improve water supply (improved source of water or improved distribution, or both). Interventions for water quality were associated with a 42 percent relative reduction in diarrhea morbidity in children, whereas those for water supply had no significant effects.

Overall, sanitation interventions led to an estimated 37 percent reduction in childhood diarrhea morbidity and hygiene interventions to a 31 percent reduction. Subgroup analysis suggests that provision of soap with education was more effective than education only. The results suggest that interventions to improve the microbial quality of water, adequate excreta disposal and behavior change intervention for promotion of hand washing and hygiene play their part very efficiently in reducing the occurrence of infectious diseases and hence improving nutrition. Disease prevention and management interventions also have a role in improving nutrition especially interventions targeting diarrhea and pneumonia (Bhatta and others 2013).

**Financial Incentives**

Financial incentives are increasingly used as policy strategies to counter poverty, reduce financial barriers, and improve population health. A review of the effect of financial incentives on the coverage of health and nutrition interventions and behaviors targeting children younger than age five years (Bassani and others 2013) concluded that financial incentives have the potential to promote increased coverage of several important child health interventions. More pronounced effects seemed to be achieved by programs that directly removed user fees for access to health services. Some indication of effect was noted for programs that conditioned financial incentives on participation in health education and attendance to health care visits.

**Community-Based Programs**

A full spectrum of promotive, preventive, and curative interventions to improve child nutrition can be delivered via community platforms. A review (GHWA 2010) of community-based packages of care suggested that these interventions can double of the rate of initiation of BF within one hour of birth (RR: 2.25, 95% CI: 1.70, 2.97). Lewin and colleagues (2010) reviewed 82 studies with lay health workers and showed moderate quality evidence of the effect on the initiation of BF (RR: 1.36, 95% CI: 1.14, 1.61), any BF (1.24, 1.10-1.39), and EBF (2.78, 1.74–4.44), compared with usual care.

Although much of the evidence from large-scale programs using community health workers is of poor quality, process indicators and assessments do suggest that community health workers are able to implement many of these projects at scale, and they have substantial potential to improve the uptake of child health and nutrition outcomes in difficult-to-reach populations (GHWA 2010). It is important to underscore the crucial importance of community engagement and buy-in to ensure effective community outreach programs, behavior change, and access.
Challenges and the Way Forward

Existing Evidence

The nutrition series in *The Lancet* highlights the existing promising interventions to reduce fetal growth restriction and SGA births and improving child nutrition in LMICs (table 2) (Bhutta and others 2013). These include the following:

- Periconceptional folic acid supplementation or fortification
- Maternal BEP
- Multiple micronutrient supplementation and calcium supplementation
- BF promotion
- Appropriate CF
- Preventive zinc and vitamin A supplementation
- Management of acute malnutrition in children.

Scaling up these identified interventions to 90 percent coverage could reduce nearly 15 percent of deaths among children under age five years and could reduce stunting and severe wasting by 20 percent and 61 percent, respectively (figure 2) (Bhutta and others 2013).

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<th>Table 2.2 Interventions to Improve Maternal and Child Undernutrition</th>
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<th>Maternal Interventions</th>
<th>Estimates</th>
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<tbody>
<tr>
<td>Intervention</td>
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<tr>
<td>Iron/Iron-folate supplementation</td>
<td>•  LBW (RR: 0·80, 95% CI: 0·68-0·97)</td>
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<td></td>
<td>•  Birth weight (MD: 30.81g, 95% CI: 5·94-55·68)</td>
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<td>•  Serum hemoglobin concentration at term (MD: 8·88 g/l, 95% CI: 6·96-</td>
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<td>10·80)</td>
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<td></td>
<td>•  Anemia at term (RR: 0·31, 95% CI: 0·19-0·46)</td>
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<td>•  Iron deficiency (RR: 0·43, 95% CI: 0·27-0·66)</td>
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<td>•  Iron deficiency anemia (RR: 0·34, 95% CI: 0·16-0·69)</td>
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<td>•  Side effects (RR: 2·36, 95% CI: 0·96-5·82)</td>
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<td></td>
<td>•  Non-significant impacts on premature delivery, neonatal death,</td>
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<td>congenital anomalies</td>
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<td>Maternal multiple micronutrient supplementation</td>
<td>•  LBW (RR: 0·89; 95% CI: 0·83-0·94)</td>
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<td>•  SGA (RR: 0·87, 95% CI: 0·81-0·95)</td>
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<td>•  Non-significant impacts on preterm birth, miscarriage, maternal</td>
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<td>mortality, perinatal mortality, stillbirths and neonatal mortality</td>
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<tr>
<td>Maternal balanced energy protein supplementation</td>
<td>•  Risk of SGA reduced 34 percent (RR: 0·66, 95% CI: 0·49-0·89)</td>
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<td>•  Stillbirths reduced 38 percent (RR: 0·62, 95% CI: 0·40-0·98)</td>
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<td>•  Birth weight increased (MD: 73g, 95% CI: 30-117).</td>
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<td>Child Interventions</td>
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<td>Breast feeding</td>
<td>•  Exclusive breastfeeding rates increased by 43 percent at four to six</td>
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<td>weeks, with 89 percent and 20 percent significant increases in LMICs</td>
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<td>and HICs, developed countries, respectively.</td>
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<td>•  Exclusive breastfeeding improved at age six months by 137 percent,</td>
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<td>with a six-fold increase in LMICs.</td>
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<td>Complementary and supplementary feeding</td>
<td>•  Statistically significant difference of effect for length during the</td>
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<td>intervention in children</td>
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| Iron supplementation | • Anemia (RR: 0·51, 95% CI: 0·37-0·72),  
• Iron deficiency (RR: 0·24, 95% CI: 0·06-0·91), hemoglobin (MD: 5·20 g/l, 95% CI: 2·51-7·88), ferritin (MD: 14·17 mcg/l, 95% CI: 3·53-24·81) |
| Vitamin A supplementation | • All-cause mortality reduced by 24 percent (RR:0·76, 95% CI: 0·69-0·83)  
• Diarrhea-related mortality by 28 percent (RR: 0·72, 95% CI: 0·57-0·91)  
• Incidence of diarrhea reduced by 15 percent (RR: 0·85, 95% CI: 0·82-0·87)  
• Incidence of measles reduced by 50 percent (RR = 0·50 (95% CI 0·37 to 0·67))  
• Non-significant impacts on measles and ARI-related mortality |
| Zinc supplementation | • Height improved by 0·37 (SD 0·25) in children supplemented for 24 weeks  
• Diarrhea reduced by 13 percent  
• Pneumonia reduced by 19 percent  
• Non-significant impacts on mortality |
| Disease Prevention and Management |  |
| WASH interventions | • Diarrhea reduced by 48 percent (RR: 0·52, 95% CI: 0·34-0·65) with handwashing with soap, 17 percent with improved water quality, and 36 percent with excreta disposal |
| Deworming | • Prophylactic single and multiple dose deworming had a non-significant effect on hemoglobin and weight gain.  
• Treating children with proven infection showed that single dose of deworming drugs increases weight (0·58 kg, 95% CI 0·40 to 0·76) and hemoglobin (0·37 g/dL, 95% CI 0·1 to 0·64) |
| Malaria prevention and treatment | • Antimalarials to prevent malaria in pregnant women reduced antenatal parasitemia (RR: 0·53, 95% CI: 0·33-0·86),  
• Birth weight increased (MD: 126·7 g, 95% CI: 88·64-164·75),  
• LBW and severe antenatal anemia reduced by 43 percent and 38 percent, respectively.  
• ITNs in pregnancy reduced LBW by 23% (RR: 0·77, 95% CI: 0·61-0·98) and fetal loss reduced (first to fourth pregnancies) by 33 percent (RR: 0·67, 95% CI: 0·47-0·97)  
• Non-significant impacts on anemia and clinical malaria |

Note: ITNs = *Insecticide treated bed nets*; LBW = low birth weight; LMICs = low-and-middle-income countries; SGA = small for gestational age.
**Geographic Disparities**

Despite the existence of proven interventions and relative improvements in nutrition indicators overall, nutrition data indicate considerable disparities among geographic regions, with South Asia bearing the highest burden (Stevens and others 2012). Almost 75 percent of all the world’s LBW infants are born in South Asia. In the 75 Countdown countries globally, stunting rates are well above the 3 percent threshold; more than one child in three is stunted, while the median prevalence of wasting is 7.1 percent. Within countries, wide disparities exist between the richest and poorest wealth quintiles; in 20 percent of the Countdown countries, more than 50 percent of the children in the poorest 20 percent of all families is stunted. With these existing disparities, another challenge is the high rates of HIV that threaten to reverse all the nutrition gains achieved through large-scale programs.

**Way forward**

Optimal infant and young child feeding means that mothers are empowered to initiate BF within one hour of birth, BF exclusively for the first six months, and continue BF for two years or more, complemented by nutritionally adequate, safe and age-appropriate feeding of solid, semi-solid, and soft foods starting in the sixth month (UNICEF 2014). Despite the existing guidelines, early cessation of BF and untimely introduction and poor quality CF prevail. Strategies to protect, promote, and support EBF are needed at the national, health-center, and community levels.
• **At the national level**, it is vital to create appropriate structures that ensure the adoption and implementation of the proper policies and legislation (UNICEF 2014). This approach includes the development and implementation of national IYCF policies and strategy frameworks, as well as the development and enforcement of legislation that relates to the International Code of Marketing of Breast-milk Substitutes and maternity protection.

• **At the health systems level**, this includes implementation of the Baby-Friendly Hospital Initiative (BFHI) as well as capacity-building of health workers in areas such as BF counseling (UNICEF 2014).

• **At the community level**, maternal support activities involving community health workers, lay counselors and mother-to-mother support groups are crucial. Implementation of an evidence-based communication strategy using multiple channels, connecting and coordinating the efforts at the three levels, is also vital for the successful protection, promotion, and support of BF.

Appropriate CF is a proven intervention that can significantly reduce stunting during the first two years of life. An important issue is that the quality of the food received is often inadequate, failing to provide sufficient protein, fat, or micronutrients for optimal growth and development. Meeting the needs for the minimum required dietary quality is a challenge in many countries and has often not enough emphasis. Children may not receive complementary foods at the right age, are not fed frequently enough during the day, or the quality of the food may be poor. A comprehensive approach includes both counseling for caregivers on the best use of locally available foods and feeding and care practices, and the provision of micronutrient and food supplements when needed.

The ability to measure and monitor BF and CF practices might help raise awareness of its importance and facilitate progress in achieving improvements in BF practices worldwide (UNICEF 2006b). Understanding the extent to which indicators of dietary quality predict anthropometric outcomes is important for interpreting the meaning of the measurements arising from these indicators (Jones and others 2014). Relatively simple indicators for assessing BF practices have been in widespread use since the early 1990s (WHO 1991). However, defining simple CF indicators has proven challenging because of its multiple dimensions, the variation in these practices across contexts, and the changes in recommended practices that occur from ages six months to 23 months (Arimond, Daelmans, and Dewey 2008; WHO 2008). The WHO IYCF indicators are designed for use not only for describing trends in IYCF practices over time but also for identifying populations at risk and evaluating the impacts of interventions. A literature review examining the eight core WHO IYCF indicators and their relationships with child anthropometry using country-level data suggests that these indicators are especially well suited for monitoring trends in diet quality in large-scale data sets wherein detailed dietary data cannot be collected; however, they may not be highly sensitive or specific measures of dietary quality in the analysis of the causal pathways to child growth (Jones and others 2014).

**Conclusions**

Infant and young child nutrition is dependent on the direct determinants of nutrition and growth, including diet, behavior and health. It is also greatly affected by indirect determinants, such as food security, education, environment, economic and social conditions, resources, and governance. Hence, the agenda for combatting malnutrition requires a multifaceted approach that involving both the interventions directed at the more immediate causes of suboptimum growth and development, as well as the large-scale programs that broadly address the underlying determinants of malnutrition.
References


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http://www.unicef.org/nutrition/index_statistics.html

http://www.unicef.org/nutrition/index_breastfeeding.html


