CHAPTER 6

NUTRITION DURING THE FIRST
THOUSAND DAYS OF LIFE

Part II: Infant Feeding and Development

Lisanne M. du Plessis, Celeste E. Naude, and Rina Swart

Outline

• Normal patterns of growth and development of infants and young children
• Assessment of the growth and development of infants and young children
• Problems of underweight, stunting, wasting, and overweight
• Other nutrition-related problems of young children: worm infestations, oral health
• Nutritional benefits of breast-feeding for the infant
• Complementary feeding
• Appropriate feeding practices for pre-school children
• Malnutrition in infants and young children
• Issues of breast-feeding for mothers who are HIV-positive
• Nutritional needs of infants and young children
• Nutrition interventions and programmes for infants and young children

Objectives

At the completion of this chapter you should be able to:

• Describe the normal pattern of growth and development of infants and young children
• Describe how to assess the growth and development of infants and young children
• Describe the problems of underweight, stunting, wasting, and overweight in terms of anthropometry
• Describe the nutritional advantages of breast-feeding for the infant
• Describe good complementary feeding practices
• Discuss the appropriate recommendations for breast-feeding if the mother is HIV-positive
• Discuss the nutritional requirements of infants and young children
• Discuss nutrition interventions and programmes for infants and young children
• Describe the appropriate feeding practices for pre-school children
• Discuss the consequences (morbidity and mortality) of malnutrition in infants and young children
• Discuss other factors that impact the nutritional status of young children:
  • Worm infestations
  • Oral health
1. MALNUTRITION AMONG INFANTS AND YOUNG CHILDREN

Every year, more than 10 million children die before they reach the age of 5. Almost 4 million of them die within the first 4 weeks of life. Most of these 4 million deaths occur in developing countries, predominantly in South Asia and sub-Saharan Africa (Black et al., 2003).

Five categories of immediate determinants of the child survival rate have been proposed (Mosley & Chen, 2003; Hill, 2003):

- Maternal factors (age, parity, birth interval)
- Environmental contamination (air, food/water/fingers, skin/soil, inanimate objects, insect vectors)
- Nutrient deficiencies (energy, protein, micronutrients)
- Injury (accidental/intentional)
- Personal illness control (personal prevention measures, medical treatment)

The World Health Report 2005 stated that more than half of the deaths in children younger than 5 years can be attributed to undernutrition (see Figure 6.1).

Many children are permanently disabled by the physical and mental effects of inadequate dietary intake in the earliest months of life. It was documented in 2008 that for children younger than 5 years, stunting, severe wasting, and intrauterine growth restriction (IUGR) together caused about 2.2 million deaths and were responsible for 21% of the total number of lost disability-adjusted life-years (DALYs). Vitamin A and zinc deficiencies were estimated to be responsible for 0.6 million and 0.4 million deaths, respectively, and a combined 9% of global childhood DALYs. Deficiencies of iron and iodine lead to fewer child deaths, and combined were liable for about 0.2% of global childhood DALYs.

As the above figures indicate, infant and young child feeding practices directly affect the nutritional status of children under 2 years of age and ultimately impact child survival. If children are undernourished
before they reach the age of 2 years, they could suffer irreversible physical and mental damage and this will undoubtedly influence their future health and wellness. Improving infant and young child feeding practices in children aged 0 to 23 months is therefore critical to improved nutrition, health, and development of children (WHO, 2008a).

The consequences of mild-to-moderate malnutrition, specifically chronic undernutrition, are not always visible, but have significant effects on mortality, morbidity, educability, and the future productivity of children (see Figure 6.2). Evidence of the many consequences of undernutrition in children has been provided by numerous meta-analyses (Jones et al., 2003; Nannan et al., 2007; Engle et al., 2007; Grantham-McGregor et al., 2007). Conversely, overnutrition and overweight in children can contribute to the risk of adult overweight and obesity. Adult obesity is associated with an increased risk of the development of hypertension, coronary heart disease, diabetes, stroke, and some forms of cancer (see Chapter 13).

<table>
<thead>
<tr>
<th>Short-term</th>
<th>Long-term</th>
</tr>
</thead>
<tbody>
<tr>
<td>Early nutrition in utero and childhood</td>
<td></td>
</tr>
<tr>
<td>Brain development</td>
<td>Cognitive and educational performance</td>
</tr>
<tr>
<td>Growth and muscle mass Body composition</td>
<td>Immunity Work capacity</td>
</tr>
<tr>
<td>Metabolic programming of glucose, lipids, protein hormone / receptor / gene</td>
<td>Diabetes Obesity Heart disease High blood pressure Cancer Stroke Ageing</td>
</tr>
</tbody>
</table>

Figure 6.2: The short-term and long-term effects of early nutrition. 

2. **GROWTH AND DEVELOPMENT OF INFANTS AND YOUNG CHILDREN**

Physical growth and development involve progressive changes in size (Rolfes et al., 1990), as well as accompanying changes in skill and behaviour (Rovee-Collier, 1996; Engle et al., 2007). Growth and development are not uniform. Each living organism and each body system has its own unique schedule of growth and development, varying in rate, patterns, and duration (Rolfes et al., 1990). In community nutrition an awareness of what is normal, as well of normal variation and the reasons for this variation is required in order to make informed decisions as to when action is necessary.

2.1 **Physical Growth**

Normal growth (i.e., the increase in the mass of body tissue as a child changes from an infant to an adult) is the result of a number of factors, such as growth hormones, genetics, nutrition, general health, intrauterine growth, emotional care/deprivation, and psychological factors, as well as the continuous and complex interactions between these factors throughout the whole period of growth (Eveleth & Tanner, 1990; Kumar & Clarke, 2000). In community nutrition settings, growth of the infant and young child is generally measured by assessing weight and length/height, and in certain circumstances head circumference.
Normal growth patterns from birth to adulthood vary between individuals owing to differences in bodily proportions and composition, as well as differences in timing of growth spurts. All infants demonstrate accelerations and decelerations in growth in response to changes in their environment or because of illness. The majority of environmental factors that affect growth hinge upon the level of nutrition that the infant or child receives (Eveleth & Tanner, 1990). During an illness, even a quite mild one, growth tends to slow down, but if the child is receiving adequate nutrition, this slow-down is followed by catch-up growth, which rapidly restores the child to the normal growth curve. However, if the cause of the delayed growth lasts for a long period of time, catch-up growth may never happen completely (Bax et al., 1990).

The most dramatic period of child growth velocity is between birth and 4 months of age. Many full-term infants lose some weight shortly after birth, which they regain by day 8 to day 10 (Chumlea & Guo, 2004). Thereafter, the average weight gain during the first year of life is 7 kilograms, of which about half is gained in the first 4 months at a rate of almost 200 grams per week. This is followed by an average weight increase of 2 to 4 kilograms in each of the next 2 years with average weight gain per week being about 40 grams. Average birth weight babies usually double their birth weight by 6 months and treble it by one year of age (Frankle & Owen, 1993; Chumlea & Guo, 2004). By 4 to 5 years of age the growth rate stabilizes at an increase of 2 to 4 kg/year. Sex differences in weight during pre-school years are slight, but after 2 years of age girls tend to have higher adipose tissue as evidenced in skinfold measurements (Chumlea & Guo, 2004). Children who start fat development earlier are at an increased risk of obesity and should be monitored regularly.

The average length at birth is 45 to 53 cm for girls and 46 to 55 cm for boys (WHO, 2006a). Infants usually increase in length by 50% by year one (approximately 25 cm), followed by another 12 cm increase between years one and two to double birth length by age 4, and triple it by age 13 (Chumlea & Guo, 2004). During years 3 to 5 there is a greater increase in height relative to weight (Frankle & Owen, 1993).

At birth, average head circumference is about 35 cm and increases by about 12 cm during the first year to about 47 cm. Measuring head circumference during this period is important because it reflects brain growth, and the brain doubles its birth weight by one year of age. From one to two years of age the head grows an average of about 5 cm in circumference, but by age 3 the mean annual increase slows to less than one cm per year (Chumlea & Guo, 2004).

Most growth faltering begins in utero or soon after birth. Although this may continue to about 40 months of age, it is most pronounced within a relative short period; from 6 months until about 18 months of age (ACC/SCN, 2000; Grantham-McGregor et al., 2007).

In the first week after birth preterm infants grow very little as they adjust to extra-uterine nutrition. The preterm infant’s weight curve is expected to cross the percentile lines during the first few months and by the end of the first year the length of the average preterm infant is usually around the 50th percentile. However, the smallest infants may not reach normal percentiles until after the second year (Bax et al., 1990).

IUGR infants show varying degrees of catch-up growth after birth, which is most marked during the first 6 months of life, resulting in attainment of percentile channels approximately between the 10th and 25th percentile for weight and length by the age of 2 years. By this age, adjustment for gestational age does not have to be done when plotting weight and height of IUGR and LBW infants. Infants who experience slow foetal growth rates before week 34 gestation are likely to remain smaller than those in whom growth restriction was confined to the last 6 weeks of pregnancy. Head circumference of IUGR infants also shows a period of catch-up growth after birth, which suggests that some degree of restriction of overall brain growth occurs in these infants during pregnancy (Bax et al., 1990).

### 2.2 Milestones of Behaviour and Development

Child development refers to the ordered emergence of interdependent skills of sensory-motor, cognitive-language, and social-emotional functioning (Engle et al., 2007). A rapid increase in brain weight takes place during the second half of pregnancy, which continues well into the second post-natal year (brain growth spurt). At birth the brain is already 25% of its adult weight and this reaches 50% by 4 years (Bax et al., 1990). IUGR and undernutrition in infancy have been found to be associated with physical brain deficits such as reduction of brain size, loss of cerebral cortical neurons, deficit in brain lipids, and reduction in the numbers of synapses per cortical neuron. However, there is no simple relationship between head circumference and
brain size. Findings that a higher proportion of human brain growth occurs post-natally than was formerly thought are a stimulus for providing an ideal nutritional environment for every infant, in both the developed and the developing world (Bax et al., 1990).

The behaviour that an infant displays is constrained by its niche in time (associated with age and abilities) and its current environment (Rovee-Collier, 1996). Initially (weeks 0 to 9), the infant maximizes energy intake and minimizes energy expenditure in order to convert energy to optimal growth. Behaviours are either related to ingestion of food (sucking and rooting), or require minimal energy expenditure (such as looking). When the infant is liberated from the initial energy-preserving niche, large amounts of energy can be expended to learn about the environment. During this phase (10 to 24 weeks), what infants will or will not learn is determined by the ergonomics of learning, not by capacity (Rovee-Collier, 1996). Limitations in nutrient supply, especially energy, to the infant and young child will therefore have an impact on whether the infant or child is able to reach his or her developmental milestones and consequent intellectual development potential.

A child’s development is also affected by psychosocial and biological factors and by genetic inheritance. Figure 6.3 shows a conceptual model of early childhood development and contributing factors. The first few years of life are particularly important because vital development occurs in all domains (Grantham-McGregor, 2007). Poverty and its accompanying problems are major risk factors for poor developmental outcomes. Development can also be modified by the quality of the environment. Variation in the quality of maternal care can produce lasting changes in stress reactivity, anxiety, and memory function in the offspring (Grantham-McGregor et al., 2007). Caregiver sensitivity is associated with more secure infant attachment, whilst higher levels of maternal responsiveness are associated with higher infant cognitive ability and fewer behavioural problems. The negative effects of exposure to violence are likely to be increased when family cohesion or the mental health of the primary caregivers is disrupted. Recovery from early insults is possible with interventions. Early cognitive and social-emotional development are strong determinants of school progress. Each standard deviation increase in early intelligence or development quotient is associated with substantially improved school outcomes (Grantham-McGregor et al., 2007), although school and family characteristics also play a part.

**Figure 6.3:** Conceptual model of early childhood development.

*Source: Adapted from Engle et al., 2007; Grantham-McGregor et al., 2007.*
Currently, there are no globally accepted indicators for child development. This is often measured through individual assessments of developmental changes in multiple domains, such as cognitive, language, social, and emotional (Grantham-McGregor et al., 2007). The availability of indicators would improve the ability of different countries to set targets, allocate resources, monitor progress, and ensure accountability.

3. ASSESSMENT OF MALNUTRITION IN INFANTS AND YOUNG CHILDREN

Malnutrition is the outcome of a complex combination of interrelated causes as depicted in the UNICEF conceptual framework (described in Chapter 1). At the "underlying causes level" major strides against key problems can be achieved through programmatic health and nutrition interventions, if implemented on a sufficient scale (Bhutta et al., 2008).

3.1 Growth Monitoring and Promotion

Growth monitoring is the process of using periodic anthropometric measurements to track the growth rate of a child in comparison to a standard. Such tracking allows growth faltering to be identified before the child has developed actual undernutrition; it can also serve as a warning of overnutrition (UNICEF, 2008).

A single measurement of a child's weight or length/height can indicate whether the child is within the normal range, but it does not indicate whether the child is growing well. Instead, a child must be weighed and measured regularly and the measurements plotted on a graph to produce a growth curve, which illustrates trends in the child's growth rate. Such a curve reveals whether a child is growing steadily or whether a problem may exist – as, for example, when a child stops gaining weight or is actively losing weight (see Figure 6.4). An individual child's growth curve can also be plotted against standard growth curves, or reference curves (see Figure 6.5). An individual child's growth curve may fall above or below a particular reference curve, but it should increase at the same rate – that is, it should remain parallel to the reference curve. A growth curve that parallels the reference curve indicates that the child is growing well. Flat growth lines indicate that a child's weight and height has not increased at all: the child has stopped growing. This is called growth faltering, and such children are at risk of growth failure. Growth failure is specifically signalled by a loss of weight. Children who are gaining weight after an episode of growth faltering are said to be in the process of catch-up growth.

Figure 6.4: Growth curve showing changes in a child's weight
Figure 6.5: A growth chart showing weight-for-age according to Z-scores (see section 4.1 of chapter 22). The chart is for boys, aged 6 months to 2 years. The child whose weight is plotted on the chart was below the mean but was growing well up to the age of 13 months. A period of growth faltering then set in, which lasted for 5 months, followed by catch-up growth. Source: WHO, 2008b, p. 43.

As defined by UNICEF (2008, p. 2), *growth monitoring and promotion* (GMP) is “a prevention activity that uses growth monitoring... to facilitate communication and interaction with [a] caregiver and to generate adequate action to promote child growth.” This action is the result of:

- Increased caregiver’s awareness about child growth
- Improved caring practices
- Increased demand for other services, as needed (UNICEF, 2008, p. 2)

The expected outcomes of GMP are:

- Heightened awareness of the importance of caregiver practices for adequate growth and the link between adequate growth and child health
- Increased knowledge and skills and subsequent improved child feeding and health-care practices by caregivers
- Increased coverage of particular health services, if they are offered along with GMP
- Improved care-seeking/utilization of services when these are promoted/supported through GMP counseling (UNICEF, 2008, p. 3)

Crucial to growth monitoring is the existence of reliable standards against which the growth of either an individual child or a specific population of children can be evaluated. Until fairly recently, assessments relied
on standard growth curves that had been jointly established by the National Centre for Health Statistics (NCHS) and WHO and were recommended for use internationally. In 1993, however, a WHO Expert Committee questioned the suitability of the NCHS/WHO standards, in part because these reference curves were based on data from children who had, for the most part, been bottle-fed rather than breast-fed (WHO, 1999). As a result, in 1994, WHO began planning for the development of new reference standards that would reflect how children should grow in all countries rather than merely describing how they grew in a particular setting at a specific time (de Onis, 2008).

The WHO Multicentre Growth Reference Study (MGRS) (1997–2003) collected primary growth data and related information from roughly 8500 healthy children whose growth appeared normal. The sample was deliberately drawn from a diverse array of countries – Brazil, Ghana, India, Norway, Oman, and the United States – and the children thus represented a wide variety of cultures and ethnicities. The aim was to develop a new set of growth curves that could serve as an international standard for evaluating the growth and nutritional status of children under 5 years of age (WHO, 1999; see also ACC/SCN, 2000). The new WHO growth standards (WHO, 2006a) use the breast-fed infant as the biological norm for growth and development.

The use of these growth charts for the assessment of nutritional status is discussed in detail in section 4.1 of Chapter 22. It is important to note, however, that the newer reference curves produce significantly different results:

Differences are particularly important in infancy. Stunting will be greater throughout childhood when assessed using the new WHO standards compared to the NCHS/WHO reference. The growth pattern of breast-fed infants will result in a substantial increase in rates of underweight during the first half of infancy and a decrease thereafter. For wasting, the main difference is during infancy when wasting rates will be substantially higher using the new WHO standards. With respect to overweight, use of the new WHO standards will result in a greater prevalence that will vary by age, sex and nutritional status of the index population. (WHO, 2006a, pp. xix–xx)

In interpreting the results of studies pertaining to child growth, one should always look for information about the reference standards that were employed, as different standards will produce different assessments.

### 3.2 Growth Measurements: Undernutrition and Overnutrition

#### 3.2.1 Underweight

In anthropometric terms, underweight is defined in relation to weight-for-age. A child is considered significantly underweight if he or she has a weight-for-age below –2 standard deviations (SD) of the median value for the reference population. Weight is usually one of the first parameters affected by dietary deficiency and/or disease in infants and young children. Underweight is therefore considered one of the primary indicators of recent nutritional stress.

Severe underweight is defined as a weight-for-age below –3SD of the median value for the reference population. A relatively high prevalence of severely underweight individuals in a population is evidence of an acute and extreme nutritional insult (possibly on top of prior undernutrition), such as food shortages experienced during natural disasters and wars, as well as outbreaks of infectious disease (ACC/SCN, 2000).

#### 3.2.2 Wasting

Whereas underweight is defined in terms of weight-for-age, wasting is defined by weight-for-height. Wasting reflects acute undernutrition or severe disease, independent of possible chronic undernutrition. A moderately wasted child has a weight-for-height that is below –2SD of the median value for the reference population; a weight-for-height below –3SD is evidence of severe wasting. Wasting reflects acute undernutrition or severe disease, independent of possible chronic undernutrition that might have compromised the height of the child. Internationally, wasting is not as common as underweight or stunting. These rates can, however, change rapidly, especially in situations of emergency food shortages and population displacements (ACC/SCN, 2000).
3.2.3 Stunting

One of the indicators of chronic malnutrition is stunting – that is, a retardation in linear growth. Stunting is the product of a number of long-term factors, including chronic insufficient protein and energy intake, recurrent infections, feeding practices that are inappropriate and/or ineffective, and micronutrient deficiencies, notably of vitamin A, iron, and zinc. The condition is classified as moderate if a child’s height-for-age is below–2SD of the median value for the reference population and severe if it is below–3SD. According to a study published in The Lancet in 2008, an estimated 178 million children under the age of 5 suffered from stunting. Roughly 90% of these children were in a mere 36 countries, mostly in sub-Saharan Africa or South and Southeast Asia (Bhutta et al., 2008, p. 417).

Childhood stunting is a serious medical issue. In infants and small children, it is associated with an increased mortality risk, as well as with poor cognitive and motor development and other impairments in function. These, in turn, have been linked with reduced performance in school. In adults, stunting is associated with lower earning capacity and a greater likelihood of obesity and chronic disease (Allen & Gillespie, 2001; UNICEF, 2013).

Once a child reaches the age of 3, the effects of stunting are extremely difficult to reverse. For this reason, interventions directed at pregnant women and very young children, ideally under the age of 24 months, are critically important. For mothers, these include advice about the importance of breast-feeding, as well as supplements of micronutrients, especially iron and folate. For children, particularly important supplements include vitamin A and zinc supplementation, as well as iron in areas where malaria is not endemic, and the promotion of iodised salt (Bhutta et al., 2008).

3.2.4 Overweight

Overweight (that is, an excessive accumulation of body fat) is most commonly measured in terms of body-mass index (BMI), a calculation based on weight-for-height. Although age-adjusted BMIs are available for children and young adults between the ages of 2 and 20, they are less often used for the assessment of children under the age of 6 years. In young children, overweight is defined as a weight-for-height greater than +2SD of the mean value for the reference population. Childhood obesity, which often persists into adulthood, is associated with several risk factors for later chronic diseases, such as hypertension, heart disease, stroke, type 2 diabetes, and certain types of cancer. These risk factors may operate through the association between childhood and adult obesity, but they may also act independently (Cole et al., 2000).

From a public health perspective, no guidelines exist for assessing the severity of the problem of childhood obesity. It is clear, however, that among both children and adults, the prevalence of overweight and obesity has been steadily increasing throughout the world – a phenomenon sometimes called “globesity.” The increase is chiefly the result of a shift in diet in the direction of foods high in sugar and fat but low in nutrient value, in combination with a decline in physical activity. These factors are all closely associated with urbanization and with economic development. Obesity was once primarily confined to relatively affluent, industrialized countries but has now spread to developing countries. Although development-driven obesity is increasing at all social levels, those in the lowest socio-economic categories in developing countries are affected the most dramatically, as the accompanying diseases of lifestyle are superimposed onto health systems that are already struggling to cope with communicable diseases, the incidence of which remains high.

3.2.5 Growth monitoring as a tool for public health

The proportion of children in a given population whose height or weight is abnormal for their age can be important information from a public health perspective. Table 6.1 defines levels of severity in relation to four basic indicators.

There is a long-standing debate regarding the actual impact of large-scale growth monitoring and promotion programmes and whether investments in such programmes are justified. Although growth monitoring can help to signal the presence of malnutrition and other health issues, in order to be effective in reducing child malnutrition and mortality, it must be accompanied by community-based health and nutrition interventions.
Table 6.1: Guidelines for assessing the public health significance of malnutrition and overnutrition in children

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Low (%)</th>
<th>Medium (%)</th>
<th>High (%)</th>
<th>Very high (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stunting</td>
<td>20%*</td>
<td>20–29</td>
<td>30–39</td>
<td>≥40</td>
</tr>
<tr>
<td>Underweight</td>
<td>10%</td>
<td>10–19</td>
<td>20–29</td>
<td>≥30</td>
</tr>
<tr>
<td>Wasting</td>
<td>5%</td>
<td>5–9</td>
<td>10–14</td>
<td>≥15</td>
</tr>
<tr>
<td>Overweight</td>
<td>5%</td>
<td>5–9</td>
<td>10–14</td>
<td>≥15</td>
</tr>
</tbody>
</table>

*Percentages refer to the prevalence among children.
Source: For the first three indicators, WHO, 1995.

As a recent study concluded, growth monitoring and promotion programmes should focus their attention on infants and children under 18 months of age and place an emphasis on nutrition counselling, with a view to maximizing contact between community health workers and caregivers. In addition, training, supervision, and support for health workers must be improved so that they will be equipped with the knowledge and the communication skills they need in order to be effective counsellors in growth promotion programmes. The impact of these programmes will depend in large measure on their coverage, on the intensity of contact between caregivers and health workers, and on the performance of health workers in the field (Ashworth et al., 2008).

3.3 Micronutrient Malnutrition

Micronutrient malnutrition is often referred to as “hidden hunger” because the consequences are not always visible. Deficiencies of several micronutrients in pregnancy and early childhood can have serious long-term consequences. Micronutrients of special concern include vitamins A and D, iodine, iron, and zinc. These nutrients are looked at in more detail in other chapters: see Chapters 5 and 9 for iodine, iron, and vitamin A; Chapter 9 for zinc; and Chapter 13 for vitamin D.

3.4 Other Factors That Impact the Nutritional Status of Young Children

3.4.1 Worm infestations

In poor communities with inadequate sanitation and hygiene, it is common to find 90% of children infected with at least one parasite, such as hookworm or roundworm. The health impact of helminths (worms) includes anaemia and poor absorption of nutrients, which can lead to stunting and impaired cognitive development. Simple and inexpensive treatments are readily available and can easily be administered to prevent helminthic infestations and to help children reach their full potential for growth. The prevalence and intensity of worm infestations peak in children between the ages of 6 to 15 years (WHO, 2006b). This group is therefore the priority for treatment, and they can also be easily reached through school systems. Regular deworming has been shown to improve school attendance and learning (Fincham & Dhansay, 2006). The WHO’s global target was to treat at least 75% of schoolchildren at risk of morbidity from schistosomiasis and soil-transmitted helminths by the year 2010 (WHO, 2006b). Pre-school children, in their exploration of their environment, are at risk of worm infestation and will also benefit from treatment (see WHO, 2007). The WHO recommends that deworming for pre-school children be delivered in an integrated programme that includes vitamin A supplementation and vaccination. The recommended deworming treatment for pre-school children includes albendazole or mebendazole (see Table 6.2 for doses); treatment should always be supervised on site. Children younger than one year should not be treated with deworming medication (WHO, 2006b).
3.4.2 Oral health

Oral health and nutrition have a synergistic relationship (Naidoo & Myburgh, 2007). Tooth decay is the most common chronic disease of childhood in developed countries. Children with early childhood caries (ECC) are at a higher risk of dental decay in primary and permanent dentition. In many cases ECC is the result of poor dental hygiene in combination with one or more of the following factors:

- Inappropriate use of a bottle or feeding cup whilst sleeping. Because of the decreased saliva flow during sleep, clearance of sugar from the mouth is decreased leading to an increased cariogenic effect of the sugar.
- Constantly snacking or constant drinking sugar-containing substances (from a bottle or feeding cup specifically, but also frequent drinking per se). A high frequency of eating and drinking (more than 3 meals and 2 to 3 snacks per day) encourages the growth of Streptococcus mutans which leads to an increase in the acidity of the mouth. This then promotes demineralization of the tooth surface (König, 2000).
- Drinks that contain high levels of acid also increase the acidity of the mouth.
- Early malnutrition (as early as 6 weeks gestation when tooth development begins) is linked to increased dental caries. Vitamin A deficiency during tooth formation is also linked to poor tooth calcification and results in hypoplasia of the enamel (Kleinman ed. 2004).
- During childhood, vitamin D deficiency has been reported to interfere with dentin formation.

Basic primary dental preventive care is, however, the most effective way to maintain oral health.

4. THE IMPORTANCE OF BREAST-FEEDING

In Chapter 5, we discussed breast-feeding in relation to the health and nutrition of the mother. We now look at breast-feeding in relation to the health and nutrition of the infant.

4.1 The Decision to Breast-Feed

WHO recommends exclusive breast-feeding (EBF) for the first 6 months of an infant’s life. At that point, complementary foods can be introduced, in combination with frequent or on-demand breast-feeding that should continue at least until the child reaches the age of 2 (WHO, 2008a, 2013).

Breast-feeding is widely practiced throughout the developing world, with initiation rates exceeding 90% in most countries. In fact, the rate is actually increasing, in spite of demographic trends such as urbanization that tend to have a negative impact (ACC/SCN, 2000). Exclusive breast-feeding is, however, uncommon, and yet it is the behaviour that is most associated with infant health and survival (WHO, 2008a, 2013). The highest prevalence of the practice is found in Asia (82% of infants younger than 4 months) and in North Africa (63% in Morocco) (ACC/SCN, 2000). EBF requires not only a decision to breast-feed on the part of the mother but also the willingness to engage in a process of learning, to persevere when difficulties arise, and, sometimes, to defy cultural norms (Hill et al., 2003).

Care is defined as the commitment of caregivers – mothers, fathers, siblings, and child-care providers – to provide the food, health care, stimulation, and emotional support necessary for children’s healthy growth and development (ACC/SCN, 2000). The provision of food to young children, from the time they are born until they are able to obtain all their nutrient requirements from an adequate share of the household diet, is
especially challenging for caregivers, regardless of the level of household food security (Pelto et al., 2003). Particular attention is paid in this section to breast-feeding and complementary feeding.

Many factors interact in infant feeding behaviour (see Figure 6.5). The most proximate of factors are the woman’s choice and her ability to act upon her choice. Underlying these two conditions is the availability of information on infant feeding, as well as the physical and social support available to the woman over the period starting from before birth. These factors are in turn influenced by familial, medical, and cultural attitudes and norms, demographic and economic conditions and resources, commercial pressures, and national and international policies and norms (ACC/SCN, 2000). According to the International Food Policy Research Institute (IFPRI), care-giving practices, whether good or bad, seem to reinforce one another, and “it may be that a minimum number of good practices is necessary for any health benefits to be obtained” (Armidon & Ruel, 2001, p. iii). Health programming must therefore be directed towards ensuring that healthy care-giving practices prevail.

Figure 6.6: Determinants of infant feeding behaviours.

### 4.2 The Nutritional Benefits of Breast-Feeding

Breast-feeding provides the ideal natural first food for babies (Brown, 2002). Breast milk supplies all of the nutrients required by an infant during the first 6 months of life, half of the requirements during the second 6 months, and one-third of requirements in the second year (ACC/SCN, 2000).

Breast milk also promotes sensory and cognitive development (Horta et al., 2007) and protects the infant against both infectious and chronic diseases through its nutritional and immunological qualities (Brown, 2002; Kramer et al., 2001). This effect is greatest during the first months of life (Hill et al., 2003). In particular, EBF reduces infant mortality due to common childhood illnesses, such as diarrhoea and pneumonia (Brown, 2002; Kramer et al., 2001). With EBF, there is no risk of illness due to contamination of food or utensils.

In addition, evidence indicates that breast-feeding helps infants to recover more rapidly during illness. During illness, breast-feeding serves as a sustained source of nutrition, as breast milk intake is not reduced, whereas intake of complementary foods declines considerably when a child is ill (Brown, 2002; Kramer et al., 2001).

The benefits of breast-feeding extend beyond reducing risks of morbidity and mortality due to infectious disease. EBF seems to have a preventive effect on the early development of allergic diseases, including asthma, atopic dermatitis, and suspected allergic rhinitis (Gdalevich et al., 2001; Kull et al., 2002; Oddy et al., 2004). This protective effect has also been shown to be evident in multiple allergic diseases (Kull et al., 2002).
Although there is clear evidence that breast-feeding presents short-term benefits for child health, its long-term benefits have been the subject of controversy, with some studies reporting a variety of positive effects and others failing to confirm these findings. A WHO report (Horta et al., 2007) therefore set out to conduct a systematic review and analysis of the available evidence regarding the long-term effects of breastfeeding. The report concludes that breast-feeding may indeed have long-term benefits. Adults who had been breastfed tended to have lower blood pressure and total cholesterol, as well as a lower prevalence of obesity and type 2 diabetes. They also scored better on intelligence tests. All these outcomes were statistically significant, although for some the effect was relatively modest.

4.3 Replacement Feeding of Infants

Despite the compelling reasons why breast-feeding is best, many women, for one reason or another, choose to feed their infants using infant formula. Health-care workers should always ensure that these mothers are making an informed decision. Mothers should be made aware of the benefits of breast-feeding and the financial implications and other risks of formula feeding. The requirements for safe formula feeding include:

- Access to safe water and electricity (or another energy source) to allow for safe, hygienic preparation of infant formula and cleaning of utensils
- Sufficient money to buy formula and cups/bottles for the first year of the baby’s life. Infant formula is expensive and a baby requires 3 to 4 kg of formula per month for the first 6 months, and thereafter roughly 2 kg per month.

The WHO has emphasized that health-care personnel, community health workers, and parents and other caregivers must be provided with enough information and training on the preparation, use, and handling of powdered infant formula in order to minimize health hazards. They also need to be informed that powdered infant formula may contain pathogenic micro-organisms and therefore carries a risk of infection (WHO, 2013).

Mothers who opt to practice replacement-feeding should be encouraged to follow these instructions for preparing and feeding infant formula:

- Wash hands with soap and water before the formula is prepared
- Boil the water used for formula preparation
- Keep all food and formula preparation areas clean
- Serve the formula in a cup or bowl rather than a bottle, where possible
- Wash the bottle/cup/bowl with soap and water, or by boiling

It is important that the instructions are followed exactly and that the formula is not made more concentrated by adding extra scoops of powder. Nor should it be made too diluted since this can lead to malnutrition.

Household nutrition and hygiene practices are key determinants of the health risks for mothers and their offspring. Infections and diarrhoeal diseases can be exacerbated by inadequate nutrition and poor basic hygiene practices, such as failing to wash one’s hands with soap or ashes after urinating or defaecating and before the preparation and eating of meals (UNICEF, 2009).

An especially useful source is the WHO’s Guiding Principles for Feeding Non-breastfed Children 6-24 Months of Age (WHO, 2005a), which is available in English, French, and Spanish at http://www.who.int/maternal_child_adolescent/documents/9241593431/en/.

4.4 Complementary Feeding Practices

The early introduction of solids and or additional fluids (other than water) into the diets of infants is common in many countries in the world. WHO recommends 10 guiding principles for complementary feeding of the breast-fed child (see Box 6.1).
Box 6.1: Guiding Principles for Complementary Feeding of the Breast-Fed Child

1. **Duration of Exclusive Breast-Feeding and Age of Introduction of Complementary Foods**
   Practice exclusive breast-feeding from birth to 6 months of age and then introduce complementary foods while continuing to breast-feed.

2. **Maintenance of Breast-Feeding**
   Continue frequent, on-demand breast-feeding 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; (e) remember that feeding times are periods of learning and love-talk to children during feeding, with eye-to-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 breast-feeding. The energy needs from complementary foods for infants with “average” breast milk intake in developing countries are approximately 200 kcal per day at 6 to 8 months of age, 300 kcal per day at 9 to 11 months, and 550 kcal per day at 12 to 23 months. In industrialized countries these estimates differ somewhat (130, 310, and 580 kcal/d at 6 to 8, 9 to 11, and 12 to 23 months, respectively) because of differences in average intake of breast milk.

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 semi-solid foods beginning at 6 months. By 8 months most infants can also 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 item #8 below). Avoid foods that may 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, and 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 foods and the usual amounts consumed at each feeding. For the average healthy breast-fed infant, meals of complementary foods should be provided 2 or 3 times per day at 6 to 8 months of age and 3 or 4 times per day at 9 to 24 months of age, with additional nutritious snacks (such as a piece of fruit or bread or chapatti with nut paste) offered once or twice a 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 breast-fed, 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 (see item #9 below). Vitamin A-rich fruits and vegetables should be eaten daily. Provide diets with adequate fat content. Avoid giving drinks with low nutrient value, such as drinks with added sugar.
as tea, coffee, and sugary drinks such as soda. Limit the amount of juice offered so as to avoid displacing more nutrient-rich foods.

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, breast-feeding 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 pre-pregnant and pregnant women.)

10. Feeding During and After Illness
Increase fluid intake during illness, including more frequent breast-feeding, and encourage the child to eat soft, varied, appetizing, favourite foods. After illness, give food more often than usual and encourage the child to eat more.


5. NUTRITIONAL REQUIREMENTS OF INFANTS AND YOUNG CHILDREN
Adequate nutrition is essential for achieving growth and development potential. The rapid growth experienced by infants and children places great demands on their nutrient intake. Breast milk provides all the energy and nutrients that an infant needs for the first 6 months of life. Nutrient requirements for infants younger than 6 months are therefore based on the quantity of nutrients provided by human milk. Thereafter, the recommended nutrient requirements are based on the consumption of breast milk or breast-milk substitutes, as well as increasing amounts of solid foods.

In North America, tables of recommended nutrient intake are known as the Recommended Dietary Allowances (RDAs). These are part of the Dietary Reference Intakes (DRIs) and are described in Chapter 14. The RDA tables have been used extensively. The World Health Organization publishes the Recommended Nutrient Intakes (RNIs), which can be considered an alternative to the RDAs. The two sets of dietary recommendations are more or less identical for boys and girls up to the age of 9 years.

To ensure optimal nutrient intake, it is essential that the dietary intake of infants and young children be assessed as part of the nutrition counselling component of growth monitoring and promotion activities. See Box 6.2 for questions that can be asked in a community setting in order to gain insight into the dietary intake of infants and young children. Further evaluation, such as a detailed dietary analysis, should be performed if inadequacies are suspected or other conditions exist that adversely affect the infant's health. Instructions for performing a dietary analysis are provided in Chapter 22.

Box 6.2: Questions to Ask About an Infant's Diet

<table>
<thead>
<tr>
<th>Type of feeding</th>
<th>Is the infant breast-fed, formula-fed, or both? If formula-fed, what kind of formula is used, and how is it prepared?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity and frequency of feeding</td>
<td>If breast-fed, how frequently does the infant nurse, and how long do feedings last? If on formula, how much does the infant drink each day?</td>
</tr>
<tr>
<td>Vitamin and mineral supplements</td>
<td>Is the infant given supplements? If so, which ones, and how much?</td>
</tr>
</tbody>
</table>
6. NUTRITION INTERVENTIONS AND PROGRAMMES FOR INFANTS AND YOUNG CHILDREN

Improving child health is a long-term investment in the health and development of any country. Goal 4 of the United Nations’ Millennium Development Goals is specifically dedicated to reducing child mortality (see Box 6.3).

**Box 6.3: Recommended Targets and Indicators for Millennium Development Goal 4**

<table>
<thead>
<tr>
<th>Goal</th>
<th>Reduce child mortality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Targets</td>
<td>Reduce by two-thirds the mortality rate among children under five</td>
</tr>
<tr>
<td>Indicators</td>
<td>Under-five mortality rate</td>
</tr>
<tr>
<td></td>
<td>Infant mortality rate</td>
</tr>
<tr>
<td></td>
<td>Proportion of one-year-old children immunized against measles</td>
</tr>
</tbody>
</table>

*Source: United Nations, 2007*

The period from the start of pregnancy up to the time an infant reaches the age of 24 months, often referred to as “the first thousand days,” presents a critical window of opportunity for nutrition interventions. In Chapter 5, we presented a summary of the evidence for various interventions (see Table 5.1). Effective interventions for infants and young children include promotion of breast-feeding, education on complementary feeding (with additional food supplements in food-insecure populations), supplementation with various micronutrients (including zinc, vitamin A, and iodine), treatment of severe malnutrition, and promoting hygiene practices (Bhutta et al., 2008).

A number of studies have found that the key intervention linked to an increase in EBF and the duration of breast-feeding is interpersonal counselling, more so from peers than from health professionals. Of particular
importance are the number of contacts with support persons and the timing of these contacts. Counselling should therefore take place as close as possible to the time of the event or situation to which it pertains. Reaching women soon after delivery and within the first month post-partum is critical to increasing the duration of EBF (ACC/SCN, 2000).

Engle et al. (2007) argue that the most effective interventions have the features described in Box 6.4.

**Box 6.4: Characteristics of Successful Early Child Development Interventions**

The integration of health, nutrition, education, and social and economic development, and collaboration between governmental agencies and civil society.

A focus on relatively disadvantaged children, who have the potential to benefit more than other children. Younger children (2 to 3 years) tend to benefit more than older children (5 to 6 years).

Interventions that are of sufficient intensity and duration and that include direct contact with children beginning early in life. Low-intensity programmes that do not direct services at children may have limited effects. Longer exposure results in larger and more consistent effects on child development.

Parents and families as partners with teachers or professional caregivers in supporting children’s development. Services and attention offered directly to children are more effective than simply providing information to parents. A clear correlation exists between the frequency of home visits and improvements in child development.

The provision of opportunities for children to initiate their own learning and explore their surroundings by means of age-appropriate activities.

A blend of traditional child-rearing practices with newer evidence-based approaches.

The involvement of early child development staff who are given in-service training and supportive and continuous supervision and who use observational methods to monitor children’s development.

*Source: Adapted from Engle et al., 2007.*

The promotion of healthy patterns of feeding for infants and young children requires not only counselling individual mothers but also changing the context in which infant- and child-feeding choices are made (ACC/SCN, 2000). With regard to the latter, three international initiatives have proved especially influential: (1) the International Code of Marketing of Breastmilk Substitutes, adopted by the World Health Assembly in 1981; (2) the Innocenti Declaration of 1989, which operationalized the “Ten Steps to Successful Breastfeeding”; and (3) the WHO/UNICEF Baby-Friendly Hospital Initiative, which was endorsed by the Forty-fifth World Health Assembly in 1992. The gradual implementation of these initiatives by various governments has gone a long way towards achieving optimal infant-feeding practices throughout the world.

Interventions designed to improve a child’s intake of complementary foods can greatly enhance infant and child growth. One study, which reviewed efficacy trials and programmes undertaken in 14 different countries and aimed at increasing infant dietary intake, found that the majority of these programmes improved growth rates by 0.10 to 0.50 SD. As the authors noted, “In absolute terms, this range of improvement in growth would reduce prevalences of malnutrition (<–2 SD) at 12 months of age by 1% to 19% and could reduce deaths due to malnutrition by 2% to 13%, depending on the underlying prevalence of malnutrition in the community” (Caulfield et al., 1999, p. 183).

Although, understandably, children at risk of malnutrition are the greatest concern, it is worth remembering that childhood obesity is on the increase throughout the developing world, as well as in highly developed countries. Long-term outcome data regarding possibly successful approaches to the treatment of overweight in children are limited. Growth monitoring can, however, contribute to the early recognition of excessive weight gain relative to linear growth, which can in turn trigger preventive measures. Nutrition counselling should be provided to parents of overweight, or potentially overweight, children in an effort to foster healthy
dietary practices and to encourage moderation in food consumption. In particular, it is important to discourage the consumption of snacks full of sugar and fat and the use of sweets as rewards, as well as to emphasize the importance of regular physical activity. The subject of overweight and obesity is discussed in more detail in Chapter 13. (For a useful overview, see Kleinman, 2009, chap. 33.)

7. FEEDING PRACTICES FOR PRE-SCHOOL CHILDREN

During the toddler years, fine and gross motor development enhances the ability of children to chew foods of different textures and also to learn to feed themselves. Mothers can continue to breast-feed children beyond the age of 2, but at that age children can be fed their own portions of family meals. Children should also be given two nutritious snacks a day (such as fresh fruit or bread with nut spread) and should be encouraged to eat foods rich in vitamins A and C and iron.

Parents play a crucial role in instilling healthy eating patterns in their children. While it is important to encourage children to eat foods that are nutritious, eating takes place in a specific context, which can be positive or negative. Box 6.5 presents some practical information and recommendations about child feeding.

Box 6.5: Key Guidelines for Feeding of Pre-school Children

- Parents should respond appropriately to children’s hunger and satiety cues.
- Parents should focus on the long-term goal of developing healthy self-control of eating in children.
- Parental influence should be positively focused on the child’s developing food preferences and should encourage the child to select a variety of foods consistent with a healthy diet.
- Children have an instinctive preference for foods that are sweet or slightly salty; they tend to dislike bitter, sour, and spicy foods.
- Children are often reluctant to accept new foods and unfamiliar flavours, and they may need to be repeatedly exposed to such foods before they are willing to accept them.
- Children need to be served appropriate child-sized servings of food. The general guideline is that a portion consists of one tablespoon of food for each year of age (e.g., 3 tablespoons of rice equals a portion of rice for a 3-year-old).
- Children should be fed in secure, happy, and positive environments, with adult supervision.
- Children should never be forced to eat anything.

Source: Adapted from Wooldridge, 2008.

Children of late pre-school age appear to be more responsive to external cues than to their instinctive ability to self-regulate intake. Parents and caregivers should therefore be keenly aware of the role they play in modelling healthy eating behaviours for young children (Birch & Fisher, 1995; Wooldridge, 2008).

DISCUSSION QUESTIONS AND EXERCISES

1. Visit a local community health centre to observe and, if possible, participate in growth monitoring and promotion. Write a report describing your experience. Be sure to include the following:
   - Profiles of the children who were monitored on that day (e.g., age, gender, anthropometric status, growth velocity, feeding practices, immunization status, vitamin A supplementation status).
   - An overview of promotional activities that accompanied the growth monitoring.
   - A critical assessment of the process, activities, and recommendations for improved practice.
2. Imagine you are the director of the national nutrition programme. Write a letter to the minister of health to argue for an increase in the budget for nutrition-related interventions, with specific emphasis on infants and young children. Explain why the present budget is inadequate and what more needs to be done.

3. Roberto, aged 9 months, has had frequent episodes of diarrhoea. He cries a lot and is restless. If his skin is pinched, the blood returns slowly, he drinks eagerly, and his tongue is dry. His mother says he seems to be growing slowly and has diarrhoea frequently, “almost every month.” He has been taking cow’s milk from a feeding bottle since he was one month old and began to eat regular food at the age of 8 months. His mother reports that, since the diarrhoea started, she has given him some formula but no solid food “because he was not hungry.” What is wrong with Roberto, and what should be done for him? Develop a comprehensive management plan.

REFERENCES


ADDITIONAL RESOURCES


ACKNOWLEDGEMENT

This chapter is based on a chapter in an earlier book:


We acknowledge the contribution of Ali Dhansay, who was an author of the previous version of this chapter.

doi:10.15215/aupress/9781927356111.01