

CHAPTER 1

Nature and nurture

And one man in his time plays many parts,
His acts being seven ages. At first the infant,
Mewling and puking in the nurse's arms.
And then the whining schoolboy, with his satchel,
And shining morning face, creeping like a snail
Unwillingly to school.

William Shakespeare

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KEY COMPETENCES

YOU MUST...

Know and understand

- How babies develop and socially interact over time
- Factors that influence physical growth through the life course
- The advantages of, and how to encourage, breast-feeding
- How to promote optimal bottle feeding
- The components of healthy nutrition and healthy eating behaviours through childhood
- The importance and recommendations for physical activity
- The development of sleep patterns at different ages

Be able to

- Make up a formula feed
- Support a mother wishing to breast-feed
- Hold and undress a baby

Appreciate

- The importance of the early years for long term health and wellbeing
- The challenges of parenting and the influence that its quality has on a child's development
- The critical role that the internal, psychosocial and external physical environment has on child health
- The impact that social determinants have on health
- The importance of encouraging breast-feeding

This chapter describes children's neurological, psychological, emotional and physical development. It discusses the importance of the early years and parenting, children's nutritional, physical activity and sleep needs, and the impact that social determinants have on children's health.

The importance of the early years

The early years are a period of enormous growth and development. Much of the infant brain develops after birth, shaped by events in the first years of life. Babies have relatively few synapses at birth. Over the next few years synapses develop and are refined by stimulation and experience: nature interacting with nurture.

The formation of synapses follows a 'bottom-up' sequence, with lower level brain 'circuits' wired first. The skills and abilities that emerge in young babies reflect this sequence. From a focus on bodily functions such as hunger and the need for sleep, babies rapidly start to explore the world around them, develop emotional bonds and then manifest higher brain functions such as reasoning, language, self-control and language.

Neuronal circuits strengthen the more that experiences (positive or negative) are repeated. Over time they stabilize, making alteration harder at a later date. By the age of six years 'pruning' starts where infrequently used synapses are eliminated and well-used ones are retained (see Figure 1.1). Pruning ensures that the most important networks of synapses grow and become more complex.

The developmental process is not uniform and there are periods, or windows, of opportunity when specific parts of the brain are particularly developmentally sensitive. Vision and hearing develop first, peaking in the first few months, followed by language circuits later in the first year and higher cognitive function peaking during the second year of life (see Figure 1.2).

Influences on early development

Responsive caregiving and positive stimulation are essential for development:

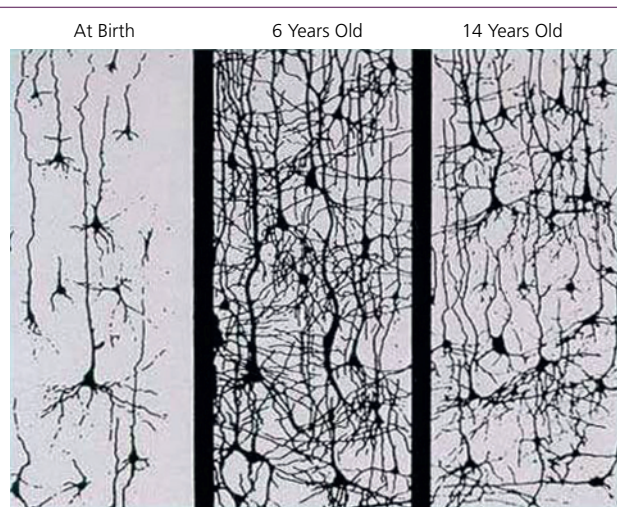


Figure 1.1 Synaptic density in children at birth, 6 years and 14 years old. *Source:* Reproduced with permission from Families and Work Institute (1997) New York.

Relationships

Attachments through one-to-one interaction with adults begin developing at birth. Babies who form secure attachments develop a secure sense of self and a lifelong ability to form healthy relationships, while those whose earliest attachments are negative or insecure may have continuing difficulty in developing positive relationships.

Nutrition

A balance of nutrients is needed for healthy brain growth and development. Undernourished children grow more slowly and have less energy for learning and exploring. When there is severe undernutrition, brain growth may be slowed and affect physical and emotional development.

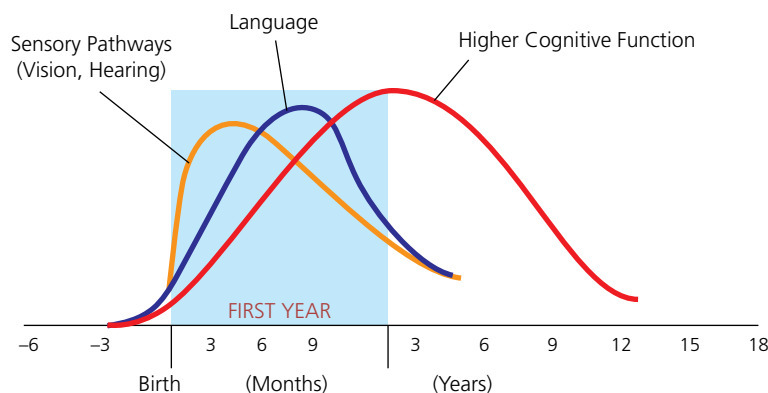


Figure 1.2 Sequence of development of neural circuits illustrating developmentally sensitive periods.

Stress

Stress can have a profound effect. Three different levels of stress are described:

- *Positive stress* – everyday events such as minor injuries, meeting new people or experiencing frustration are inevitable and contribute to building emotional resilience.
- *Tolerable stress* – time-limited events such as moving home, parental separation, changing child care or a sibling's birth can profoundly affect a child but are usually tolerable if there is a nurturing adult supporting the child emotionally.
- *Toxic stress* – when a child experiences physical and emotional abuse, neglect or severe parental mental health problems, long-term damage can occur resulting in learning, behaviour and emotional problems.

Figure 1.3 shows structural changes in the brain that were found in a child suffering from severe neglect.

Poverty

Children growing up in extreme poverty are particularly susceptible to stress, poorer nutrition and less nurturing stimulation. MRI scans show that in these circumstances the brain's grey matter is reduced, with lags in the development of areas of the brain responsible for language, cognition and spatial perception.

If babies and young children's life circumstances are not ideal for optimal development, it does not inevitably mean that brain development is affected. The brain has a good degree of plasticity, so some effects of early deprivation can be subsequently mitigated. It is, however, more difficult for the child to develop skills once specific periods of sensitivity have passed and, in some areas, such as vision, emotional stability and language, early damage can never be completely repaired.

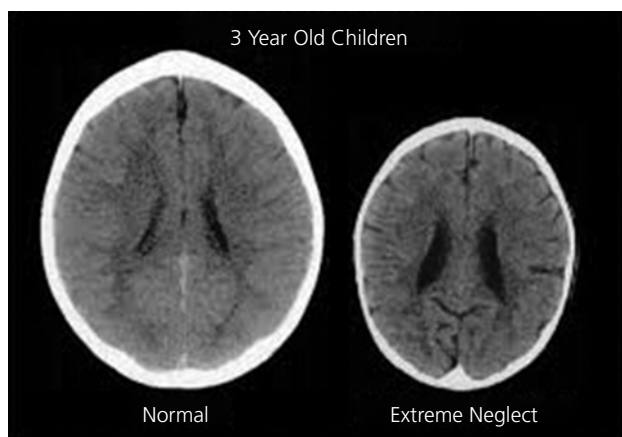


Figure 1.3 Abnormal brain development following neglect in early childhood: The CT scan of a healthy 3 year old (left) and a 3 year old suffering from severe sensory-deprivation neglect, showing microcephaly, enlarged ventricles and cortical atrophy. *Source:* Permission obtained from Springer Nature.

The parent–child relationship

The relationship between baby and parent has a particular impact on the emerging capacity for rational thought, empathy and self-control, which develop almost entirely in response to social experiences. How parents talk and listen to their baby, play with them, comfort them and cuddle them influences their development. When babies and young children experience consistent emotionally responsive parenting, it helps to develop neurological pathways that, over time, help them to manage their feelings and calm themselves as they grow older.

Babies need stressful experiences managed for them. Being held and cuddled regulates babies' arousal system, triggering a hormonal response to reduce the stress they are experiencing. If they do not get the soothing they need in early life, children can grow up with an over-sensitive stress response – prone to experiencing the world as a hostile and threatening place and making them more vulnerable to depression, anxiety and stress-related physical illnesses in later life.

Attachment

Attachment has been defined as the propensity to make strong emotional bonds and is a basic component of human nature. A human baby is extremely immature and dependent at birth and has to rely on motivating adults to protect, feed, care for and comfort them. From the moment they arrive in the world, they are focused on the adults around them – showing a preference for faces and face-like patterns, and quickly learning to show a preference for their mother's voice, smell and face. They quickly develop an understanding of facial expressions, distinguishing surprise, fear, sadness, anger and delight, and express this by making corresponding expressions of their own.

The fact that babies are able to make connections between what they do and the response they get primes them to learn from early interactions. Children whose early interactions communicate that they matter and are loveable are more likely to grow up with self-respect and confidence in their own worth and trust others. Babies and young children with secure attachment feel able to rely on their parents as a source of comfort and safety in times of upset and stress. This is related to greater self-confidence, improved social skills and higher school achievement.

Parenting styles and their influence

How parents respond to their children has an enduring impact on children's sense of self, relationships and wellbeing. Studies of parent–child interactions describe four core parenting styles that are based on the extent to which the parent is more or less responsive to their child, and is in charge as an adult (see Figure 1.4).

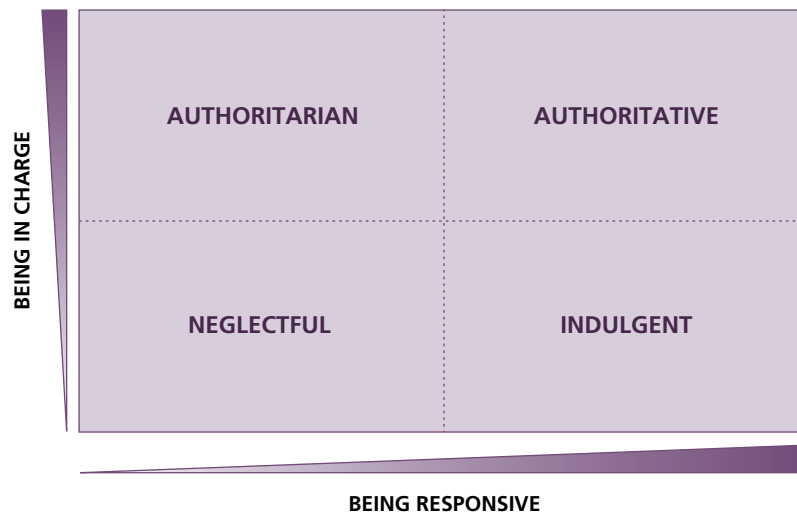


Figure 1.4 Styles of parenting: the four styles relate to how responsive parents are to the child and how much they are in charge within the family.

Authoritative style The optimal style is authoritative where the parent is sensitive and responsive to their child's needs and emotions, yet maintains appropriate boundaries for behaviour. Authoritative parenting is linked to a number of positive outcomes such as social development, self-esteem, mental health, higher academic achievement, lower levels of problem behaviour, less depression and less risk taking.

Authoritarian style Parents with a largely authoritarian style exercise a high degree of control and tend to be very restricting without taking children's needs, feelings and preferences into account. Children raised in this way are likely to become anxious and withdrawn, or rebellious and defiant.

Indulgent style The indulgent style is a kind but weak approach to parenting, in which the parent is responsive to the child's wishes and demands but is unable or unwilling to set limits and maintain boundaries. Children as a result may tend to become demanding and lack security.

Neglectful style A neglectful parenting style differs in that the parent is disengaged, neither in charge nor responsive to the child. Parents may be unaware of the child's needs and set few boundaries. Children as a result may be confused or resort to extreme behaviour as a way of attracting attention.

Parenting is influenced by many factors. How comfortably parents relate to a baby depends on their mental health, ability to provide for the baby, confidence and self-esteem, levels of support, emotional maturity and their cultural background. Health professionals have a key role in supporting parents, particularly as parents are so often bombarded with conflicting advice from family and friends. Common parenting difficulties and how they can be addressed are discussed in Chapter 21.

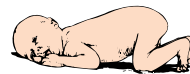
Psychomotor development and social interaction

Babies are born into a social world and through interacting initially with their parents, then other close carers and eventually other children and adults achieve full social development.

Early social development is divided into discrete periods corresponding to developmental landmarks; each period being an important milestone. More detail about developmental milestones and how to assess them are covered in Chapter 6. Here you are provided with an outline of a child's development through the stages of childhood. Development cannot be accelerated from outside, but external factors, particularly environment and to a lesser extent illness, can retard it.

Babyhood and the preschool years

0-2 months



Mothers of new babies 'bond' with their baby during the first hours and days after birth. This is not an automatic process and is facilitated by close physical contact. Mothers who are separated from their babies after birth (e.g. because they are sick or premature and require admission to a neonatal unit) find bonding more difficult. For this reason, parents should be encouraged to handle their babies even when their baby is receiving intensive care.

Infants are born with a variety of needs that must be met by their parents. In the first 2 months babies start to adapt their behaviour into states of arousal. Sleep and wake cycles begin to emerge and are influenced by routine in the house. The longest period of sleep usually occurs in the night.

Infants show a great degree of alertness and are particularly attracted to human faces and the spoken word. Contact is

achieved with the mother particularly during feeding. Mothers and babies coordinate their behaviour and take turns to initiate contact by means of alternating sucking with pauses for eye contact. It appears that infants are programmed to respond to their carers in particular ways, and in turn carers are profoundly influenced through their own programming to stimulate the infant and to respond to the baby's contact. A major milestone in the development of babies as social beings in these early weeks is the start of the first smile (at around 6 weeks).

2-5 months



A major developmental change that occurs in the first weeks is the infant's visual development. At 2 months a baby can sustain eye contact, and this is a vital stimulus for parent-child interaction. Over time infants show progressively more gaze interaction, and parents respond with facial expression, speech and intonation.

Another important milestone is the beginning of vocalization. When babies start to babble, carers respond as if engaging in 'conversation'. They respond to their baby's sounds by questioning or talking to the infant, with pauses for a response. Although infants do not understand the meaning of their carer's speech, the pattern and interaction are essential for the child's own language and social development.

5-8 months



At this age babies begin to pay more detailed attention to objects. They begin to reach for toys and so start to explore the inanimate world. Through interaction with their carers, simple play starts to emerge. At 6 weeks of age babies spend about 70% of contact time regarding their carers, but by 6 months two-thirds of the time is taken up with regarding the rest of the world. First contact with objects is by gaze and later by pointing.

At this stage too, infants transform from being egocentric to realizing that they live in a world which is shared with people and objects.

8-18 months



During this period mobility rapidly develops and children start to leave the safety of their carer to interact further with the environment. They begin to initiate contact rather than simply reacting to it, and the concept of reciprocity begins to emerge. They can play 'peek-a-boo' and control the game by adapting their response to the adult's. They begin to 'learn the rules' of games and of social interaction in general. They begin to use carers to obtain a desired object, and can also manipulate objects to attract adults' attention.

At this stage, babies also learn to associate their cry with response and, for example, know that if they are uncomfortable

due to a dirty nappy, relief will be provided. Babies who are institutionalized become apathetic if their cries are unanswered, because communication has been extinguished.

In the first half of the second-year babies begin to take more interest in other children. Initially children play side by side, occasionally sharing a toy. By 18 months they may play together, but there is less vocal contact than when they are engaged with an adult. Carers, particularly parents, are the principal influence on social development at this stage.

18 months and beyond



By 18 months children begin to communicate verbally using speech to describe an event or effect a wish. Make-believe play develops by 2 years, when children use familiar objects to reconstruct events. Examples include using a brush to brush their hair or 'cooking' with pots and pans.

They also develop the ability to recognise shapes, including letters (which is the first stage of reading), and then to copy shapes with a pencil.

School-age children

Motor, language and social skills continue to develop rapidly during the school years. Horizons are broadened by starting school, and often for the first time, children need to learn to function outside the security and safety of their own home. Expectations for appropriate behaviour in a variety of situations increase. During school years children also begin to develop a conscience and an understanding of right and wrong.

Socialization is particularly important at this age, and children need to learn to relate to a variety of other children and adults. Play is an extremely important part of this process and brings benefits far beyond its impact on physical development and motor skills. It is necessary for children's happiness and well being, impacts on the quality of friendships, cultural understanding, and social, emotional and cognitive functioning, and allows the development of imagination, creativity and exploration. Through play children practise adult roles, learn a variety of competences, enhance their academic performance, and work out how to handle challenges, work in groups, make decisions and develop leadership skills.

Adolescence

Adolescence bridges childhood and maturity and is a period of biological, psychological and sociological maturation. This is discussed in detail in Chapter 25.

Physical growth

Growth and development are intimately related but are not necessarily dependent on one another. *Growth* is a combination of increase in the number of cells (hyperplasia) and in the size of cells (hypertrophy). *Development* is an increase in

complexity of the organism due to the maturation of the nervous system. A child may develop normally but be retarded in growth, and vice versa. Brain injury does not necessarily cause impaired growth, although many children who have severe intellectual disabilities are small due to malnourishment.

Factors that affect growth

Growth is influenced by a number of semi-independent factors (see Box 1.1):

- **Genetics.** Growth patterns and final height are largely genetically determined. A normal child's final height can be predicted to fall close to the centile midway between the parents' centiles.
- **Hormones.** The principal hormones influencing early growth are growth hormone and thyroid hormone. The sex hormones play an important part in the pubertal growth spurt. Disturbance of any of these affects a child's growth.
- **Nutrition.** World wide, malnutrition is an important factor that influences growth, and is the major factor accounting for differences in height observed between developing and more developed countries. Overnutrition, a leading cause of obesity, is on the increase.
- **Illness.** Illness causes a child's growth to slow down. If the illness is short-lived, rapid catch-up occurs. Chronic illness can affect growth profoundly and irreversibly.
- **Psychosocial factors.** Sociodemographically, children and adults from higher socioeconomic classes are taller than their peers from lower classes. An adverse psychosocial environment, particularly if there is emotional neglect, can have a profound effect on a child's growth.

Growth through the life course

Growth in infancy

The rate of growth in the first year of life is more rapid than at any other age. Between birth and 1 year of age, children on average increase their length by 50%, and triple their birth-weight. Head circumference increases by one-third. During the second year of life the rate of growth slows down and babies change so their shape takes on the leaner and more muscular appearance of childhood.

Box 1.1 Factors necessary for normal growth

- Genetic potential (mid-parental height)
- Optimal intrauterine nutrition
- Appropriate postnatal nutrition
- Good health
- Normal psychosocial factors (nurture)
- Normal hormonal milieu

Growth in the preschool and school years

In the preschool years a child continues to gain weight and height steadily. Beyond the age of 2 or 3 years until puberty, the growth rate is steady at about 3–3.5 kg and 6 cm per year.

Growth in adolescence

Adolescence is characterised by a growth spurt which occurs under the influence of emerging sex hormone levels. During the 3 or 4 years of puberty, boys grow about 25 cm and girls 20 cm. Growth in the pubertal years is discussed in Chapter 25.

Catch-up growth

During a period of illness or starvation the rate of growth is slowed. After the incident children usually grow more rapidly, catching up towards, or actually to, their original growth ('catch-up growth'). The degree to which catch-up is successful depends on the timing of onset of slow growth and its duration. This is particularly important in infants who have suffered intrauterine growth retardation (see pp. 434–6), and who may have reduced growth potential.

In nutritionally compromised children, weight falls before height is impaired, and head growth is the last to be affected. If growth has been slowed for too long or into puberty, complete catch-up is not achieved. Early detection of children with abnormal growth velocity patterns has important therapeutic implications. Early treatment is more likely to ensure that acceptable adult height is achieved.

Organ growth

Not all body systems grow at the same rate, and in some respects the growth rates of some organs are independent of others. Full maturation is not complete until the end of the second decade.

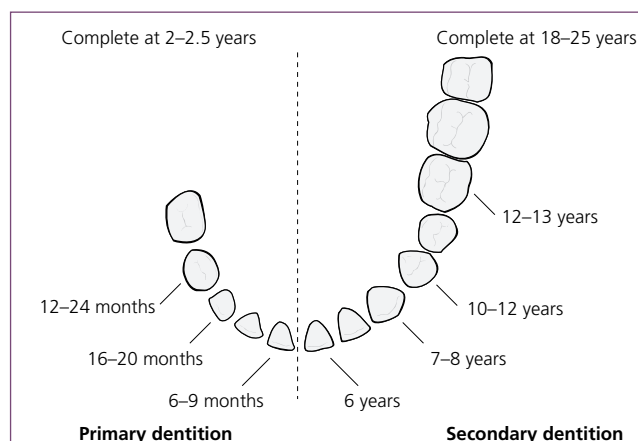


Figure 1.5 Dental development, showing the age at which teeth generally erupt.



Differential organ growth at a glance

Brain growth

Neuronal development complete by 20 weeks after conception. Myelination continues until mid-teens. Synaptic development throughout childhood

Dental maturation

Dental development occurs in sequence (see Figure 1.5). By the end of the second year the child has 20 teeth. First tooth of the permanent dentition appears at the end of 6 years

Lymphoid tissue growth

Reaches maximum development by 5 years

Skeletal growth

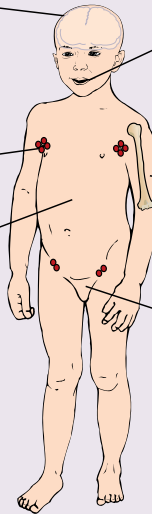
Bone development proceeds in a regular sequence. 'Bone age' can be determined by a radiograph of the wrist (see Figure 15.1)

Adipose tissue growth

Fat increases rapidly during the first year. Steady loss until the age of 7 years. Prepubertal growth spurt with a rapid increase

Gonads (see also Chapter 25)

Little development in prepubertal years. At puberty they change from the infantile to the adult state over a period of 4 years



Nutrition

Milk is the food of babies and is capable of meeting the infant's entire nutritional needs for the first 6 months of life. Breast milk is the ideal food for human babies, but may be unavailable for some infants, in which case alternative formulae are available.

Nutrition – breast-feeding

Breast-feeding (see Figure 1.6)

Breast milk contains all the fluid, energy and nutrients a baby needs in the first 6 months of life. It protects both the mother's and baby's health, and supports emotional bonding. Although infant formula can adequately meet nutritional needs, it is not able to replicate the unique, dynamic composition of breast milk, and does not contain antibodies that provide protection against infection. Long-term protection has also been demonstrated against a number of medical conditions including sudden unexplained death in infancy and childhood (SUDIC), leukaemia, diabetes and coeliac disease. There is also evidence that breast-feeding provides some protection against obesity. Breast-fed babies have more diverse gut bacteria, and it is thought this may play a role in obesity prevention.

The World Health Organization (WHO) recommends exclusive breast-feeding for the first 6 months, followed by a mix of breast milk and solid foods. Mothers are encouraged to continue breast-feeding for longer, and at least to 12 months. In the UK, 74% of women are breast-feeding at birth, but only 45% are still breast-feeding at 6–8 weeks and less than 1% are exclusively breast-feeding at 6 months.

In order to support breast-feeding more widely, the World Health Organization and UNICEF established the Baby Friendly Initiative as a worldwide programme to encourage maternity hospitals and community services to promote successful breast-feeding and to practise in accordance with the International Code of Marketing of Breastmilk Substitutes.

In developed countries, the benefits of breast-feeding are psychological as much as physical. In developing countries, the argument for breast-feeding is very strong: formula feeds may easily be contaminated by polluted water used in making up the feed, with the risk of fatal gastroenteritis. Everywhere, breast-feeding has the advantages of being free of cost, and convenient.



Figure 1.6 Mother breast-feeding her 6-week-old baby.

Physiology of lactation

During pregnancy there is a marked increase in the number of ducts and alveoli within the breast, in response to changes in maternal and placental hormones. The size of the nipple also increases. In the third trimester prolactin sensitizes the glandular tissue, causing small amounts of colostrum to be secreted.

At birth, oestrogen levels fall rapidly while prolactin rises. This is stimulated further by the infant's sucking at the breast. The prolactin secretion from the anterior pituitary maintains milk production from the breast alveoli. The volume of milk produced relates to the frequency, duration and intensity of sucking.

The flow of milk from the breast is under the control of the let-down reflex. The baby's rooting at the nipple causes afferent impulses to pass to the posterior pituitary, which secretes oxytocin. This acts on the smooth muscle fibres surrounding the alveoli so that milk is forced into the large ducts. As the baby takes less milk, the stimulus for prolactin production reduces and lactation is inhibited. The hormonal maintenance of lactation is summarized in Figure 1.7.

The let-down reflex is stimulated by contact with the baby, including hearing the baby cry and handling the child. Anxiety and embarrassment suppress the reflex by action of the sympathetic nervous system. Every step possible should therefore be taken to put the mother at her ease and avoid unnecessary anxiety.

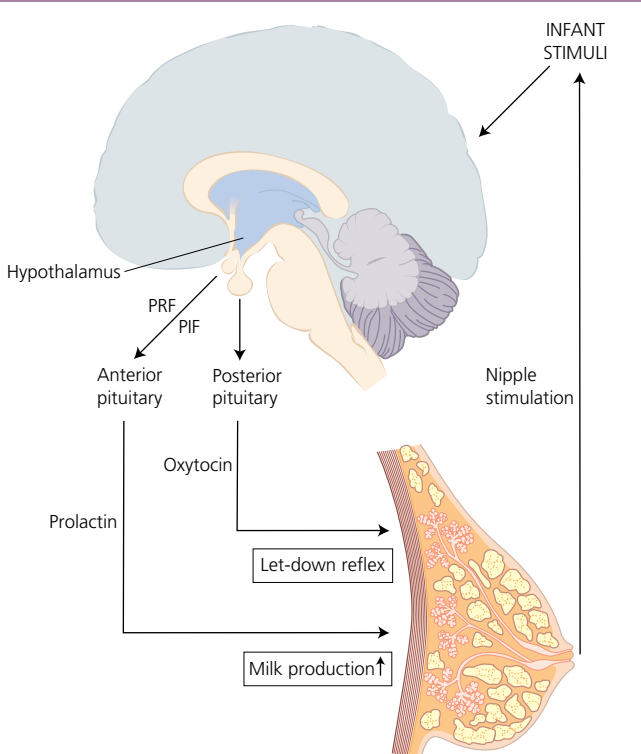


Figure 1.7 Physiology of lactation. PIF, prolactin-inhibiting factor; PRF, prolactin-releasing factor.

Colostrum The milk produced in the first few days after birth is called colostrum and is a thick, yellowish fluid. It is particularly valuable for the establishment of lactobacilli in the bowel and contains less fat and energy but more immunoglobulins than later milk.

The constituents of milk do not reach their mature proportions until 10–14 days after birth. The secretion from the breast between colostrum and mature milk is referred to as transitional milk.

Technique of breast-feeding

Most of the milk taken by a baby from the breast is consumed in the first 5 minutes of the feed. Much of the rest of the time at the breast is spent in non-nutritive sucking. Mothers should be aware of the feeling of her breast being 'emptied' by her baby shortly after commencement of suckling, but the time spent at the breast following this is also very important.

Mothers should be encouraged to put the baby to the breast directly after birth. A normal baby immediately attempts to suck. Little milk is produced, but the stimulation is important in the establishment of lactation. Mothers should then be encouraged to put the baby to the breast on demand and should also feed the baby during the night. The time the baby spends on the breast should be gradually increased so that the nipples become accustomed to the baby sucking.

Trauma to the nipple in the first few days after birth has to be minimized. The baby exerts strong suction on the nipple and a baby should never be pulled off the breast. The mother should be shown how to release the baby by using her finger to depress the breast away from the corner of the baby's mouth. Babies are often given complementary formula feeds in the early days of life by well-meaning staff in order to let the mother rest, but this is counterproductive and should be avoided.

It is common for mothers to encounter difficulties in establishing breast-feeding in the first weeks, and to feel that their milk is inadequate. The difficulties often relate to positioning of the baby, and expert support from breast-feeding counsellors can often help resolve the problems.

It is now common for women to pump breast milk and give it by bottle, especially when they are proposing to return to work. Some choose to do this exclusively. This choice sometimes follows time spent in neonatal intensive care, where feeding may be harder to establish, and anxiety may follow about not 'seeing' the quantity of milk the baby consumes. A variety of breast pumps are available on the market

Advantages of breast-feeding

The advantages of breast-feeding are summarized in Table 1.1, and ways to encourage successful breast-feeding are shown in Box 1.2.

Breast-fed infants have a significantly lower risk of respiratory and gastrointestinal infections in the early months of life

Table 1.1 Advantages of breast-feeding

Perfect balance of milk constituents
Little risk of bacterial contamination
Ideal food for brain growth and optimal development
Establishes a healthy microbiome
Anti-infective properties
Convenience
No expense to purchase milk
Psychological satisfaction
Possibly reduces risk of atopic disorders
Exposes baby to a variety of flavours
Some protection from obesity
Possible IQ enhancement

Box 1.2 Ways to encourage successful breast-feeding

- Introduce the concept to both parents antenatally
- Place the baby on the breast immediately after delivery
- Allow the baby to feed on demand, in the early days especially
- Avoid offering any formula feeds
- Ensure the mother receives good nutrition and plenty of rest

compared with formula-fed infants. Breast milk has a number of important anti-infective properties which are summarized in Table 1.2.

Contraindications to breast-feeding

For healthy infants there are no disadvantages to breast-feeding. Infants born with anomalies such as severe cleft lip and palate and obstructive bowel problems may not be able to feed, although every effort should be made to provide them with expressed breast milk rather than formula feeds.

There are very few contraindications to breast-feeding. The most important reason is if the mother is HIV-positive: the risk of transmitting the HIV virus to her baby is doubled by breast-feeding. A mother who is excreting *Mycobacterium tuberculosis* should also not breast-feed. Mastitis (inflammation of the breast) is a common problem but, far from being contraindicated, it is alleviated by continued and frequent breast-feeding.

Drugs in breast milk

Most drugs given to the mother are excreted to some degree in her milk, but the exposure to the infant is usually so little that the risk is minimal. Examples of drugs that are clearly

Table 1.2 Role of anti-infective agents in breast milk

Cells	Milk is teeming with white cells, mainly macrophages, polymorphs and both T- and B-lymphocytes
Immunoglobulins	Secretory IgA is the predominant immunoglobulin. Particularly high concentration in colostrum
Lysozyme	Lyses bacterial cell walls
Lactoferrin	Binds iron necessary for the replication of some bacteria and reduces bacterial growth
Interferon	Present in low concentrations in breast milk and has antiviral properties
Bifidus factor	The carbohydrate bifidus factor encourages lactobacilli to flourish in the bowel, inhibiting overgrowth of <i>Escherichia coli</i>

contraindicated are tetracyclines (which stain developing teeth), antimetabolites (impair cell growth) and opiates (drug addiction). If in doubt, the Drugs in Breastmilk Information Service provides valuable information.

Nutrition – formula feeds

Parents who feed their babies using infant formula must know how to use infant formula safely and need non-judgemental support. It is important that they understand about responsive bottle feeding so they neither under- or overfeed their baby.

Formula milks are based on cow's milk, but are highly adjusted to meet the basic nutritional requirements of growing immature infants. A variety of components are utilized. Skimmed milk is produced by removing the fat content, and the curd can be separated, leaving whey and lactose together with minerals. These are the building blocks of infant formula.

Virtually all formula feeds have added carbohydrate, usually lactose or maltodextrins. Most milk manufacturers replace the fat with polyunsaturated vegetable oil or butterfat blend. This alters the fatty acid profile to resemble breast milk more closely. The protein base of formula milk is usually demineralized whey to which the appropriate mixture of minerals, vitamins and trace elements are added.

Although there are similarities between breast and formula milks, the constituents are chemically quite different. The protein in formula milk is based on cow's milk protein and the fat content is quite different to breast milk fat content.

Preparation of feeds

The preparation of formula feeds is summarized in Figure 1.8. Parents need to understand and be instructed to use a level measure of powder and not a heaped one, as this would produce too concentrated a feed, especially in its electrolyte content,



Figure 1.8 Preparation of formula feed.

and could lead to hypernatraemic dehydration (see p. 113). To obtain a level measure, the excess powder is removed with the blade of a knife.

Scrupulous attention should be paid to sterility: bottles and teats should be sterilized either in a microwave, by boiling or by a cold-water sterilizing solution (such as Milton®). It is essential that the bottles are filled with the solution and the teats are totally immersed. The solution should be made up each day according to the manufacturers' instructions.

Most parents like to give the milk warm. To ensure that it is not too hot it should be tested by shaking out a little onto the back of the hand. The teat should not be touched, or it will

become contaminated. The hole in the teat should be large enough so that when the bottle is inverted, milk comes out rapidly in drops, but not in a stream. Too large a hole causes the baby to choke on the feed, and too small a hole leads to excessive air swallowing as a result of the baby's vigorously sucking to obtain the milk.

Promoting optimal bottle feeding

If families are using infant formula it is important that they feed the baby 'responsively' and mimic the body closeness that is natural when breast-feeding. Table 1.3 shows ways to promote optimal bottle feeding.

Table 1.3 Ways to promote optimal bottle feeding

Bonding	• Baby fed predominantly by parent(s) in early days/weeks • Treat feeding as 'special time' of closeness • Encourage skin-to-skin contact
Avoiding overfeeding and excess weight gain	• Follow baby's signs of fullness and stop feeding even if there is still milk in the bottle • If the baby seems hungry, but has recently fed, try comforting before feeding again • Don't sweeten or add cereal/rusks to milk • Avoid hungry infant formula or follow-on milk, which are not recommended in the UK
Avoiding tooth decay	• Feed baby in a semi-upright position rather than lying down • Do not 'prop' bottle • Do not sweeten infant formula
Reducing risk of gastro intestinal infections	• Sterilize bottles and teats before and after use • Make up bottles freshly for each feed and discard any leftover milk • Use made-up formula within 2 hours at room temperature, or within 4 hours in a cool bag with an ice pack

Nutrition – weaning

See Boxes 1.3 and 1.4. Breast or formula milk provide all infants' nutritional requirements in the early months. WHO recommendations are that solid foods should not be started until 6 months when their gastrointestinal and renal systems are mature enough and the swallowing reflex is adequately developed. Early introduction has been linked to obesity and may increase risks of infection.

By 6 months most babies can manage a range of textures and a wide array of foods. Developmentally they should be able to sit with support. By 7 months most are adequately coordinated to pick up food, and put it in their mouths themselves, move it to the back of their mouths and swallow it. As most of the nutritional needs in the first year of life are provided by milk, the main goal in weaning is to help babies to accept and enjoy a wide range of textures and flavours. On starting new foods, babies commonly screw up their faces, look worried and spit out new foods. This should not be interpreted as dislike. If babies are only given bland, sweet and familiar foods, they are more likely to eat a limited repertoire as they grow older.

Box 1.3 The weaning process

0–6 months	Breast or formula milk only
6 months	Introduce solid foods – pureed and finger feeds. Start with less sweet tastes and accustom babies to: • Vegetables such as broccoli, avocado, carrots, parsnip, green beans • Starch foods such as potato, rice, oats mixed with milk • Full fat dairy foods such as plain yoghurt • Once readily eating these, move on to soft fruits
7–9 months	Give more soft feeds before milk feeds Encourage finger feeding Give water in a cup Gradually move to three meals per day
9–12 months	Mash food with a fork or chop it Three meals a day, at least one with the family
1 year and beyond	Undiluted cow's milk in a cup (no need for formula milk) Baby should be eating family meals (provided they are healthy) Add two healthy snacks between meals Continue breast-feeding as long as mother wants

Box 1.4 Principles of infant nutrition

- Breast milk is the optimal and exclusive feed for the first 6 months
- Continue breast or formula milk for the first year
- Introduce solid foods from 6 months
- Once a baby is able to chew, mashed and then cut up food can be given
- Babies can usually feed themselves biscuits or rusks at 7 months and use a spoon by 15 months
- Cup feeds should replace breast-feeds, and bottles be discouraged beyond the age of 1 year
- Vitamin supplements (Vitamins A, C and D) should be given to all breast-fed babies from 6 months to 5 years, with Vitamin D supplementation from birth. Formula-fed infants will also need daily vitamin supplements once they change to normal cow's milk, rather than supplemented infant formula. Iron supplementation is also recommended (WHO) between 6 and 23 months of age in countries with a high incidence of iron deficiency

Although there are commercial foods, simple home prepared fresh foods, such as mashed, unsalted vegetables are cheaper and often more nutritious. They should be introduced gradually, starting with vegetables and introducing fruit after the baby has accepted a range of savoury foods. Food may be started blended but can rapidly move onto being mashed by fork and then given as finger foods. It is important to encourage independence in eating and give babies control of eating as soon as they are ready to pick up food themselves. In recent years there has been a move towards 'baby-led' weaning where food is put into the mouth by the baby alone. This prevents undue pressure to eat and overfeeding. Some professionals are concerned by baby-led weaning as nutritional needs may not be met when the only foods consumed are those that can be held by a baby.

Certain foods should be avoided in babies and toddlers as shown in Table 1.4.

The principle of responsive feeding (Figure 1.9) is especially important when it comes to weaning as the risk of overfeeding is higher when babies start solid foods. Carers should be encouraged to recognise signs of fullness and hunger which differ at different ages. Ensuring babies learn to respect their satiety cues teaches them to avoid eating beyond when they are full.

Table 1.4 Food and drinks to avoid in babies and toddlers

Food and drinks	Reason to avoid
Salt	Renal system too immature to cope Primes taste for salty foods
Sugar	Encourages preference for sweet foods Tooth decay
Honey	May be contaminated with botulinum toxin
Nuts and chunks of food	Choking hazard
Low fat foods	Fat is needed for growth and development
High fibre foods, e.g. bran	Inhibits absorption of other nutrients
Additives	Certain E numbers in sensitive individuals. Implicated in hyperactivity
Fruit juices, cordials	Unnecessary sugars
Rice milk	Contains arsenic at levels that may be harmful for babies
Coffee, tea, cola etc.	Stimulants



Figure 1.9 Mother feeding her 6-month-old baby. She is seated so she can interact with him and pick up on his hunger and fullness cues, ensuring that she does not under- or over-feed him.

Nutrition – the preschool and school years

Nutrition in the preschool years

See Box 1.5. As toddlers become increasingly dextrous and coordinated, they should be encouraged to eat independently using a spoon and drinking from a cup. Alongside this independence comes a change in eating habits where toddlers tend to eat unpredictably, consuming large amounts on some occasions and

Box 1.5 Principles of good nutrition in children

- Allow no more than 350 mls milk each day.
- Give three meals and two nutritious snacks each day.
- Try to ensure that children eat with others in a social setting.
- Avoid grazing outside of meals and snack times.
- Encourage a diet with food from each of the basic four food groups.
- The majority of foods should be fruit, vegetables and starchy carbohydrates with the rest made up of foods high in protein and dairy foods.
- Drink 6-8 cups of water or milk and limit juices to < 1 cup per day.
- Choose unprocessed foods if possible, and choose those lower in saturated fat and free sugars.
- Avoid added salt.
- Avoid sugar in the form of sweet drinks and sweets.
- Limit snacking on crisps, sweets, biscuits and cake.
- Avoid an excess of fat.
- Avoid foods which are likely to be aspirated, e.g. nuts, boiled sweets.

almost negligible at others. It is also usual for a wariness of new foods to develop and ‘pickiness’ is very common.

Although milk is no longer the main source of nutrition, children should still drink 350 mL of milk per day. It is important to ensure that the child becomes used to eating a well-balanced diet, including foods from the four basic food groups:

- meat, fish, poultry and eggs;
- dairy products (milk and cheese products);
- fruits and vegetables;
- cereals, grains, potatoes and rice.

Children of this age have different requirements from adults. A diet low in fat and high in fibre is unlikely to provide the calorie content that is essential for active, rapidly growing children. For this reason, whole-fat milk rather than semi-skimmed milk should be given until the age of 2 years. It is also important to discourage a taste for sweet and salty foods.

The development of independence and inconsistent eating habits often causes problems within the family (see pp. 385–6). Parents may become very anxious and resort to a variety of tactics to make their child eat. This can be extremely stressful for all concerned and may be associated with weight faltering (see pp. 283–5).

The other common problem of this period is iron deficiency anaemia (see p. 374) resulting from a low intake of iron-rich foods. Excessive milk intake may contribute by leading to a reduction in appetite for other nutrients, and may also be responsible for poor weight gain.

Nutrition in the school years

The Food Standards Agency has produced the ‘Eatwell Guide’ (see Figure 1.10) to guide families on how to balance their diet.

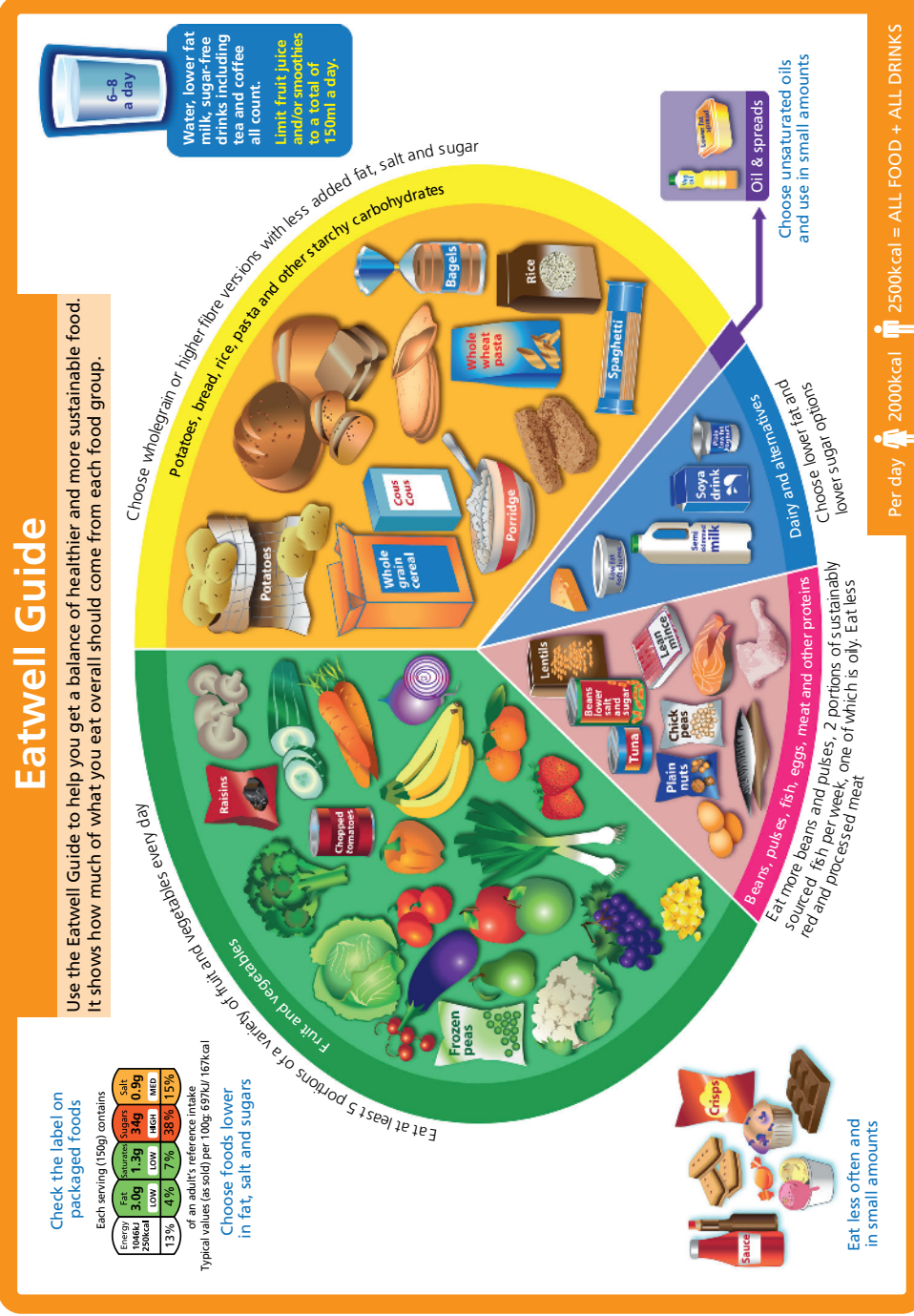


Figure 1.10 The Eatwell Guide, showing how a balanced diet is made up of foods from each of the five food groups. Source: Public Health England in association with the Welsh Government, Food Standards Agency in Northern Ireland © Crown copyright 2016.

Table 1.5 How different food groups support young children's health and growth

Food group	Needs	No. of portions:	
		< 5 years	> 5 years
Fruit and vegetables	At least five types of fruit and vegetables needed to accustom children to a wide range of tastes	5	5+
Potatoes, bread, rice, pasta and other starchy carbohydrates	A mix of whole grain and refined starchy foods. Excessive fibre can reduce intake of energy and other nutrients	4	5
Beans, pulses, fish, eggs, meat and other proteins	Important for growth Omega 3 and other essential fatty acids needed for brain development	2-3	2-3
Dairy and alternatives	Calcium, vitamins A and D, riboflavin, zinc and iodine needed in growing children	3	2
Oils and spreads (fats)	Energy needs for growth and activity but excess leads to obesity. Saturated fats (in meat, butter cakes) should be limited. Fats for absorption of Vitamin A and D	Minimal	Minimal

**Figure 1.11** A family mealtime. Eating regularly together as a family is associated with a broad range of benefits in such areas as social behaviour, language development and academic achievement.

It visually emphasises how prominent fruit and vegetables should be in the diet, and how little fat and sugar are required relative to the other foods. Maintaining healthy eating is often a challenge, particularly compounded when children are introduced to snacking on sugary and salty foods by their peers. Schools are well placed to educate about nutrition and provide well-balanced meals, and regulations are in place to make sure that food eaten on the premises is nutritious.

Table 1.5 shows the key food groups, the needs they meet and the number of portions recommended daily.

As important as *what* children eat is *how* they eat. Family mealtimes (Figure 1.11) are associated with many benefits including enhanced language development, psychosocial well-being, fewer high-risk behaviours, reduced obesity levels and lower academic dropout rates.

The adolescent years bring increased requirements for energy, calcium, nitrogen and iron. Unfortunately, in this criti-

cal period, when good nutrition is so important, young people often develop lifestyles which lead to a very poor nutritional intake. Particular problems include an increase in snacking and skipping meals, inappropriate consumption of fast foods, dieting, and restrictive cult diets. The problems of obesity (see pp. 292–4) and eating disorders (see pp. 462–4) often have their onset at this time, while teenage pregnancy has nutritional consequences for both the baby and the mother.

Active play and physical activity

In the past children were engaged in active play, often outdoors, for much of the day. Nowadays many spend much of the day being sedentary. Building physical activity into daily routines is important as it increases fitness, improves emotional health, and reduces the risks of heart disease and diabetes. Benefits also include musculoskeletal strengthening, mental alertness, reduced risk of illness and effects of stress, and maintenance of healthy weight. Active play also improves behaviour, and encourages children to take safe risks. Table 1.6 shows recommended levels of activity at different ages.

TV and other screen time

Television and other screen time are often used by busy parents to occupy and entertain their children. Unfortunately, it easily becomes habitual. Too much TV and screen time is harmful as it:

- affects brain and language development
- reduces time playing and being active
- is habit-forming
- is often accompanied by snacking
- contributes to excessive weight gain

The National Institute for Health and Care Excellence recommends no more than 2 hours/day spent watching TV or engaged in other screen time, with some TV-free days. The American Academy of Paediatrics goes further and recommends that children under 2 years should have no screen time.

Table 1.6 Recommended levels of activity at different ages

Infants who are not yet walking	Under 5s	Children aged 5-18 years	Adults
• encourage physical activity from birth through 'tummy time' • minimise time spent being restrained for extended periods	• physically active for at least 3 hours a day, spread throughout the day	• at least 1 hour of physical activity every day • strength-based exercises 3 times a week – hopping, skipping, jumping	• at least 150 minutes of physical activity a week (moderate intensity); or 75 minutes of vigorous exercise • activity to improve muscle strength on at least 2 days a week – weights or heavy loads

Sleep

Sleep is restorative, and crucial for the maintenance of physical, emotional and cognitive functioning. Sleep disruption affects children's ability to concentrate and learn; children who do not get enough sleep cope less well with daily life and stress, and are more likely to have behavioural difficulties. Lack of sleep is also associated with excess weight gain and obesity, partly because the more hours a child is awake, the more food and drink they are likely to consume.

Parents whose children wake frequently in the night are also likely to suffer from sleep deprivation, making it much harder to cope well. Children's lack of sleep can dominate family life, resulting in exhaustion, stress, relationship conflict, affecting physical and mental health, as well as ability to work.

Sleep patterns at different ages

Sleep rhythms are irregular in the first few months of life, but become more regular as a child grows older (see Table 1.7).

Struggles around bedtime are one of the most common challenges of family life. Establishing consistent and effective bedtime routines can help both parents and children:

- Starting the bedtime routine at the same time each day.
- A sequence of 'wind-down' activities that signal it is bedtime and help children to relax: having a bath; a milk feed; brushing teeth; a bedtime story or song.

- Having objects that a child associates with bedtime, such as a blanket or cuddly toy.

How parents approach daytime naps and bedtimes has a big influence on a baby's sleep patterns. It is very tempting to feed, hold, rock or take the baby into the parental bed – even if this does not help establish good sleeping habits in the long-term. 'Sleep training' can be helpful but should not be started before the age of 4-6 months. The methods include:

- 'Controlled crying' which involves putting the baby down to sleep at regular times and leaving them to go to sleep. Parents leave the room and return periodically to settle the baby, or stay without removing the baby from the cot.
- The 'no tears' approach which is more gradual, with the parent offering comfort right away when their child cries, but slowly changing how this is provided so that the child becomes used to getting to sleep on their own.

Child care and education

Not so long ago, children were cared for by their mothers until they started school. Now, most parents work outside the home and arrange alternative care for their young children. Options may include a nanny or minder in the home, or child care outside the home. Child minders who take other children into their own home have to be legally approved and registered with the Department of Social Services.

Table 1.7 Sleep patterns at different ages and stages

Age	Optimum sleep	Sleep patterns
0-3 months	16-17 hours	Newborns sleep a lot in the early weeks – broken by the need for frequent feeds.
3-6 months	15 hours	Sleep patterns start to settle at about 4 months into shorter daytime naps and longer periods of night-time sleep.
6-12 months	13-15 hours	Most babies start to follow a daytime schedule with morning and afternoon naps. By 10 months most babies sleep through the night or wake for one feed.
1-2 years	12-15 hours	By 18 months many toddlers nap just once a day for 1-3 hours.
3-4 years	11-13 hours	Most children drop their daytime nap by the age of 5.
School age	9-11 hours	Children may get less sleep than they need and/or have difficulty getting to sleep.
Teens	9 hours	Many teenagers stay up late but need as much sleep.

Alternative care is available in **day nurseries** staffed by nursery nurses. These may be run by Social Care, privately or by voluntary organisations. Unfortunately, they are in limited supply and are often expensive. In disadvantaged areas family centres may be provided, which not only provide child care, but are also attended by parents with the aim of improving parenting skills.

The majority of children grow up away from an extended family network, and many parents appreciate the opportunities for their children to mix with other children from a young age. **Mother and toddler groups** and **playgroups** are available in most areas. The former are attended by children accompanied by a carer. Playgroups are run by trained and registered leaders, where children attend for a few sessions per week and have the opportunity to meet, play and socialize with others.

School education

In Britain compulsory education begins at the age of 5 years, although there is limited availability of **nursery school** places from the age of 3 years. From 5 to 11 years children attend **primary school**, then move to **secondary school** until the school-leaving age of 16 years. At 16 years teenagers have the option to continue their education in a **secondary school sixth form**, **sixth form college**, or **college of further education**, or to start an apprenticeship or traineeship.

Educational provision for children with special needs is discussed on pages 50–1.

Determinants of health in children

Children's health is affected by a wide range of factors that operate at many different levels, from within the child (such as

genetics) to broader conditions in the home and in society. Socioeconomic and environmental factors play a very large part and account for much of the variation in children's lives and their health. When considering a child's health, it is important to bear these in mind. A helpful framework for identifying and understanding the interaction of various determinants affecting children's health is the Dahlgren and Whitehead model (Figure 1.12) which places the child at the centre, surrounded by the other influences on their lives.

Inequality and social disadvantage

A large and increasing number of children, in both developed and developing countries, grow up socially disadvantaged. Disadvantage may arise as a consequence of poverty, poor housing, homelessness, inadequate parenting and problems resulting from immigration. It is important to appreciate that these all have a significant impact on children's health and extend to affect their health and wellbeing throughout their lives.

Alleviation of these problems is mainly a political issue for society, but doctors need to understand the impact of the problems and, where necessary and possible, to act as the child's advocate in improving their circumstances. Table 1.8 shows some of the factors that impact on children that are associated with long-term adverse outcomes.

Poverty

It is hard to bring up a family on a low income. Not only is it hard to feed and clothe children and provide them with the care and conditions required for them to develop and thrive, but poverty also often diminishes the capacity of parents to be supportive, consistent and involved with their children.

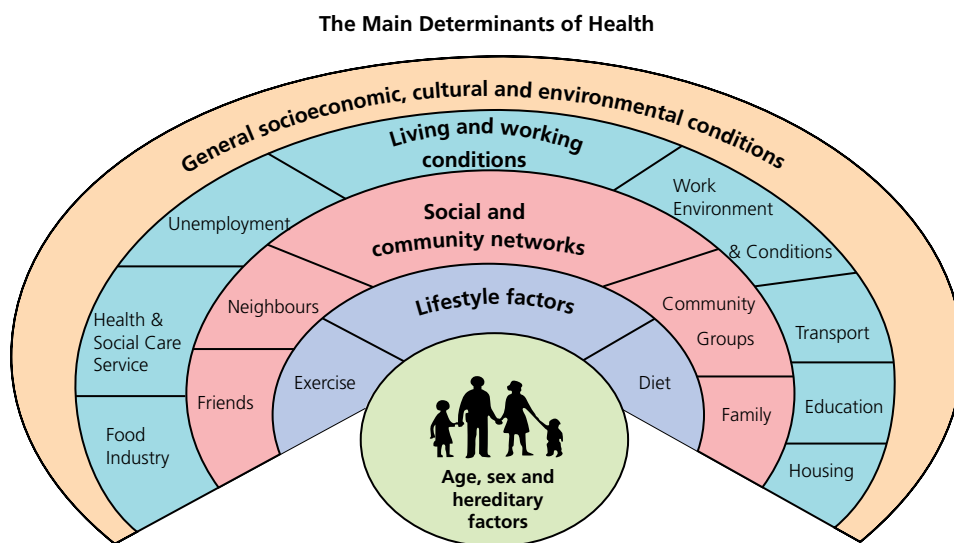


Figure 1.12 The main determinants of health. *Source:* adapted from the Dahlgren and Whitehead model (with permission) [3].

Table 1.8 Adverse factors in childhood and their long-term outcomes

Factor	Long-term outcomes
Poverty	Unemployment, low income, low working hours
Abuse and neglect	Depression, anxiety, drug abuse, suicidal behaviour, STIs, health issues, trust problems
Early mental health problems	Emotional problems, leaving school early, criminal justice system contact, poor physical health
Conduct problems	Anti-social and criminal behaviour
Poor health and nutrition	More health problems; poor academic achievement, not graduating on time

Box 1.6 Morbidity associated with poverty

- Low birthweight
- Poor growth
- Obesity
- Respiratory infections
- Iron deficiency anaemia
- Lead poisoning
- Sudden unexplained death in infants and children (SUDIC)
- Hearing disorders
- Psychological problems
- More and longer hospitalizations
- Lower survival in some malignancies (e.g. leukaemia)
- Lower educational attainment and learning disabilities

Poverty also has a strong effect on the physical health of children, and children from poor families have higher than average rates of death and illness from almost all causes (Box 1.6). Many factors are responsible for the increased morbidity, including overcrowding, poor hygiene and health care, poor diet, environmental pollution, poor education and stress.

Housing

Housing conditions have a profound effect on children's health and development. Dampness and mould are associated with an increase in a wide variety of symptoms and illnesses. Overcrowding and poor sanitary conditions are related to the

spread of gastroenteritis and respiratory infections. Inadequate housing may lead to parental depression, affecting a child's psychosocial development and behaviour. Poor housing is also linked to a higher rate of accidents, including road traffic accidents as a result of a lack of safe supervised areas for play outside.

Homelessness

Homelessness exacerbates the problems of poverty. Homeless families have very restricted facilities, often living in bed and breakfast or hostel accommodation, with little space or privacy and little possibility of cooking. Moves are frequent, with disruption in the provision of health and social services and schooling for the children. Homeless children suffer from increased frequency of illness (infections, anaemia), neurological conditions and learning disorders, fits, mental illness, dental problems, trauma and substance abuse, and are more likely to be victims of abuse and neglect.

Family structure

There have been major changes in the structure of society in recent years. Fewer children in developed countries now live with both natural parents, and there are increasing numbers of parents bringing up children single-handedly. Although this does not necessarily imply that the children are disadvantaged, single parenting is difficult, particularly if it is associated, as it often is, with a reduced income, lack of support with resultant stress and depression, and family tensions and arguments. These all may have an effect on the child.

Ethnic minorities and immigrants

The other major change that has occurred in developed countries is absorption of a variety of different ethnic and cultural groups. While immigrant families are often well supported within their cultural framework, children may be disadvantaged in a variety of ways of which health professionals need to be aware.

Language and cultural barriers often lead to high degrees of social stress and isolation, and families may find it difficult to access services including health care. Specific health problems affecting some groups include nutritional deficiencies, higher perinatal and infant mortality rates, and inherited diseases if consanguinity is common practice.

To test your knowledge on this part of the book, please see Chapter 26.

