2 Growth and Development

Physical growth and mental development are the two most distinctive attributes of children that distinguish them from adults. Growth refers to increase in the body weight and height. It is a sensitive indicator of the nutritional status, health, and well-being of children. Development refers to a functional maturation of various neuromotor skills so that from a state of total dependence, children gradually become independent in day-to-day activities. In normal children, growth and development depend on the interaction between genetic endowments and environmental pressures such as adequacy of nutrition, availability of safe and stimulating environment, freedom from diseases and development defects, and love and affection by well-adjusted parents.

2.1 Growth of Various Body Systems and Organs

There is a unique pattern of anatomical growth of various body systems and organs in children (**Figure 2.1**). The physical or somatic growth follows an s-shaped curve with two peaks of growth velocity, one during infancy and toddler age period and the other during adolescence. Neural or brain growth is maximal during fetal life and is completed by the age of 5 to 6 years. At birth, infant has a large head size because 70% of the brain growth occurs in utero and 15% during preschool years. Therefore, nutritional deficiencies and metabolic defects have profound effects on the integrity of brain and neuromotor development during late fetal life, infancy, and preschool years. There is an excessive lymphoid growth in some children as a protective response to prevent the entry of pathogens through the nose and throat and to generate high levels of cell-mediated and humoral immune responses to fight microbial diseases. Some school-going children have large tonsils and adenoids as a protective mechanism to ward off droplet infections. Large tonsils or adenoids are an asset and not a problem or indicative of a disease in children. It is a common observation to find generalized lymph node enlargement in some children as a normal physiological response. The hyperresponsive lymphoid tissue tends to regress in size after the age of 12 years to achieve adult size when adolescence is completed. There is a minimal growth of genital organs during childhood. Adolescence is triggered by sudden release of gonadotropins from pituitary–hypothalamus axis during 10 to 12 years (at 10 years in girls and 12 years in boys) with the appearance of secondary sexual characteristics and sudden spurt in the growth of genitals, which is completed by the age of 16 years in girls and 18 years in boys.

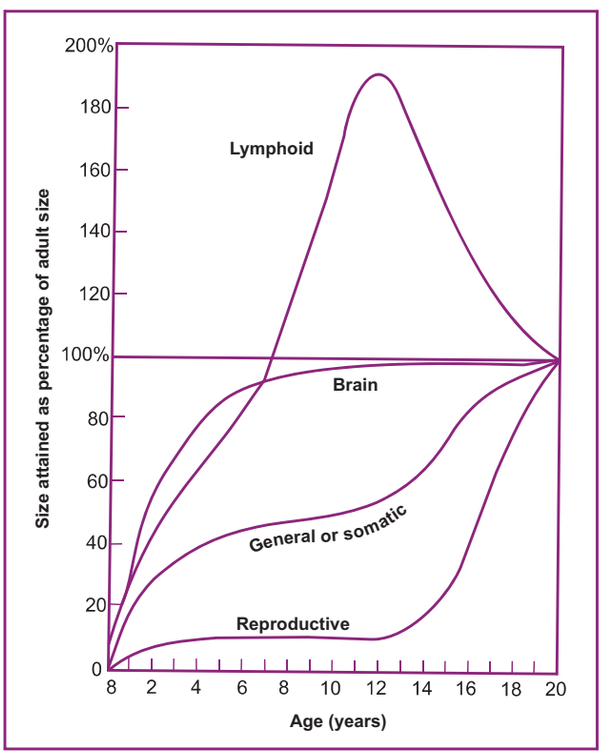

Figure 2.1 Different organs and tissues of the baby grow at different rates during childhood.

2.2 Physical Growth

The physical growth depends on the genetic stock, adequacy of nutrition, and freedom from illnesses. Growth is a steady continuous process, but there are phases of very rapid growth. For example, maximum velocity of growth takes place during fetal life. Around 8 weeks of pregnancy, fetus weighs 1 g, while at birth (after 40 weeks) an average weight of baby is 3 kg (6.5 lb). Most infants double their birth weight by the age of 4 to 5 months and triple it by the age of 1 year (**Table 2.1**). Smaller infants are likely to have relatively faster growth velocity. After birth, growth is extremely fast during the first year of life and again during adolescence (phase of sexual maturation). Most infants are plump during infancy, but as their activity level increases they become lean and tall. Parents should not be unduly worried about the weight gain of their preschool child because he or she is normally expected to gain around 2 kg weight in 1 year. *Boys usually weigh more than*

Table 2.1 Average weight gain during childhood

Age	Weight gain
0–4 mo	1.0 kg/mo (30 g/d)
5–8 mo	0.75 kg/mo (20 g/d)
9–12 mo	0.50 kg/mo (15 g/d)
1–3 y	2.25 kg/y
4–9 y	2.75 kg/y
10–18 y	4.0–5.0 kg/y (up to 0.5 kg/mo)
Weight at 4–5 mo	2 × birth weight
Weight at 1 y	3 × birth weight
Weight at 2 y	4 × birth weight
Weight at 7 y	7 × birth weight

Abbreviations: d, day(s); mo, month(s); y, year(s).

Source: Based on National Center for Health Statistics standards.

Note: Weight in kg = (age in years + 3) × 2.3

girls except during the age of 12 to 13 years when most girls weigh more than boys due to early onset of puberty.

During early life, nutrition has the strongest regulatory effect on growth. Formula-fed babies are likely to have higher growth velocity and greater risk of obesity compared with breastfed babies. Growth hormone secretion and insulin-like growth factor-1 (IGF-1) play an important role after infancy, while sex hormones regulate physical growth during adolescence.

Road-to-Health Card

Isolated weight record does not provide any useful information regarding well-being of a child, but a serial or periodic record is more useful. Weight and height should be recorded on road-to-health card during the first 5 years of life (**Figure 2.2**). These measurements should be recorded every month (during visits for vaccinations) during first year, every 2 months during second year, and every 3 months subsequently. Parents should be explained the importance of growth charting and they should keep the road-to-health card safe. *The periodic and regular weight*

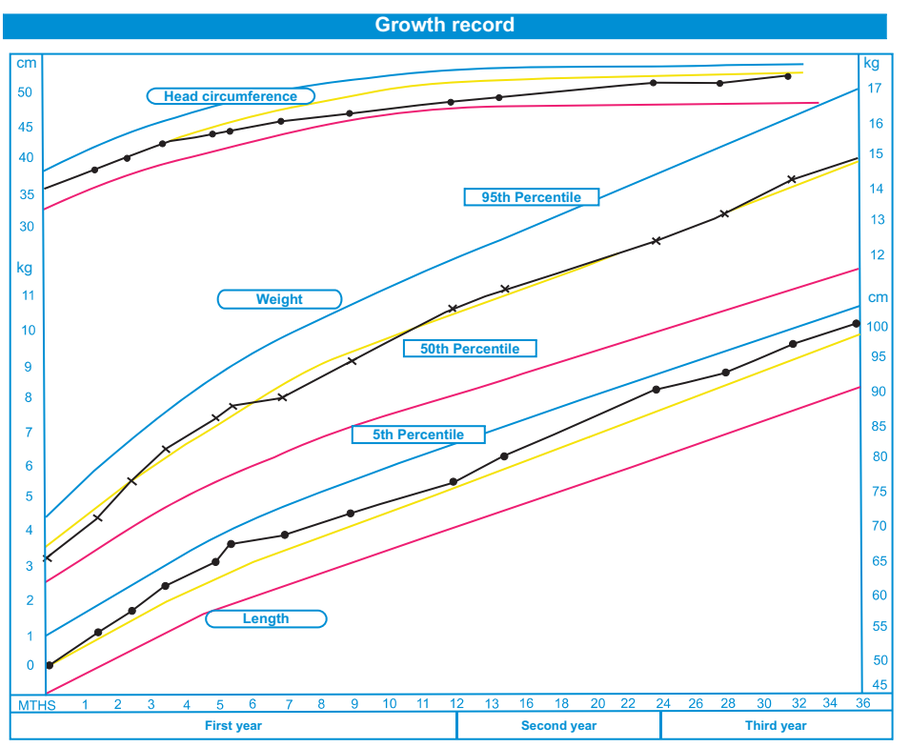

Figure 2.2 Road-to-health card for monitoring the growth of under-5 children. The card also gives messages for immunizations, feeding, and developmental milestones on the reverse. The mother should be explained the importance of growth monitoring and given the responsibility to keep the card safe. The periodic weight record provides valuable information regarding growth velocity of the child as opposed to a single weight on a particular occasion. The trend or slope of the weight curve is more important than its location on the chart. The satisfactory growth curve is directed upward and lies parallel to the thick lines of the chart. If the growth curve is flat or directed downward, the child needs urgent attention to identify the cause and reverse the trend. During early infancy, weight gain depends on the gestational age, birth weight, health and well-being of the mother, and adequacy of breastfeeding. By 1 to 2 years of age, most children would find their constitutional or genetic growth curve and maintain their growth velocity along their genetically appropriate growth curve. The growth chart serves as a useful tool to promote nutrition education and interaction between the health worker and mother. Source: National Center for Health Statistics (NCHS).

record provides valuable information regarding physical growth and well-being of the child as opposed to a single weight record. The trend or slope of the weight curve is more important than its location on the chart. The size of the baby at birth (weight and length) depends on the health, well-being, and nutritional status of the mother during pregnancy. After birth, growth is influenced by genetic potential, adequacy of nutrition, and freedom from illness. The growth pattern of the child aligns with the "genetic potential" of the family during 1 to 2 years of age. The growth curve of the healthy child should be directed upward or it should run parallel to the 50th percentile line. It is recommended to use the National Center for Health Statistics (NCHS) charts or the World Health Organization (WHO) multinational growth charts published in 2006.

Corrected Age

About 10% of infants are born prematurely without completing 40 weeks of gestation. For example, if a child is born on April 2, 1999, while the expected date of delivery was June 2, 1999, this means his or her gestational age at birth is 32 weeks. The child will be 0-day-old on June 2, 1999. Therefore, the corrected postnatal age of this child on August 2, 1999, would be only 2 months (not 4 months). His or her physical growth and mental development on August 2, 1999, would correspond to a normal 2-month-old child. The concept of corrected age is used during the first year of life for evaluation of growth and development.

Correlates of a Healthy Child

Depending on the genetic background and regional variations, healthy children vary a great deal in their weight and height at different ages. Some may be relatively taller than others, some may have narrower frame with lighter bones, while others have broad built with heavy bones depending on the constitution and build of their parents and grandparents. What is more important is the growth rate of the child and direction of his or her growth curve rather than any single weight record. Healthy child is active, energetic, happy, and playful. There should be no cause for any concern when child is eating well, does not fall sick frequently, runs around, and is busy with his or her naughty pranks. The overall vitality, exuberance, and sense of well-being are more important than actual weight of the child. In fact, active, wiry, and restless babies spend so much energy in their day-to-day activities that they are usually lean and never become chubby.

Body Mass Index

To provide optimal health care to children, we should try to ensure optimal nutrition by preventing undernutrition as well as overnutrition or obesity. Surveys have shown that in affluent families in India, almost 20 to 25% of adolescent children are overweight and at an increased risk to develop obesity, type 2 diabetes mellitus, hypertension, coronary artery disease, and osteoporosis in adult life. Body mass index (BMI) is calculated by the formula: weight (kg)/height^2 (m^2). When BMI of a child is above 85th percentile of the median BMI for age of the reference population, the child is considered overweight and when it is more than 95th percentile the child is diagnosed as obese.

Length or Height (Stature)

Although weight is more convenient and easier to record, length or height is a more reliable parameter of physical growth. In infants younger than 2 years, length is measured by placing the child on an infantometer. When a child can stand steadily, his or her standing height can be measured, which is more reliable than measurement of length. **Table 2.2** gives average height velocity of children during various age periods. When a child is otherwise healthy and free from any systemic disease, his or her ultimate height depends on the height of his or her parents, constitutional factors or genetic potential, and adequacy of nutrition. For example, children from Punjab and Haryana tend to be taller and heavier than those from the southern states of India. *In a school-going child when height velocity is less than 4 cm/y, it is a cause for concern.*

Table 2.2 Average rate of increase in height in children

Age	Height/length
■ At birth	20 in (50 cm)
■ Gain during 1st year	10 in (25 cm)
■ Gain during 2nd year	5 in (12.5 cm)
■ Gain during 3rd year	3.5 in (7.5–10 cm)
■ Gain during 3–12 y	2–3 in (5.0–7.5 cm)
■ Adolescence	
□ Girls	12–16 y: 8 cm/y
□ Boys	14–18 y: 10 cm/y

Abbreviation: y, year(s).

Source: Based on National Center for Health Statistics standards.

Prediction of Adult Height

Practical Tip

All attempts should be made to ensure optimal nutrition of preschool children because height at 3 years is a reliable predictor of ultimate adult height. The short stature of adults in developing countries is largely due to poor physical growth during the first 3 years of life. According to the National Family Health Survey 2005–2006 (NFHS-3), almost half of children under the age of 5 years are stunted.

Early growth pattern of the child and height of parents can be used to predict the ultimate adult height of the child. In a healthy child, who has no constraints (such as congenital defects, systemic disease, dietary deficiency, and emotional deprivation), his or her adult height can be calculated as follows:

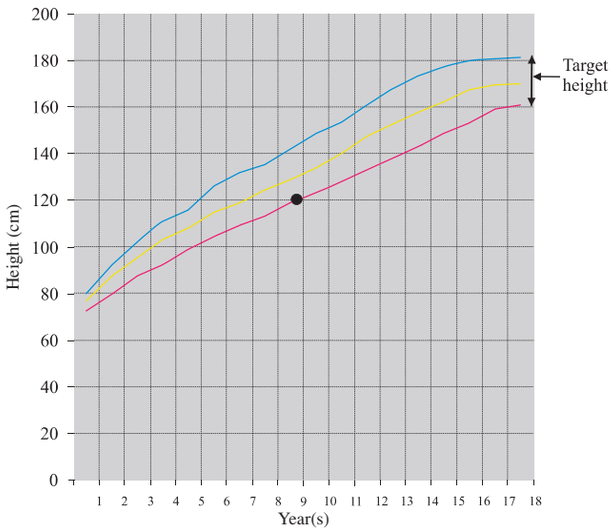

Figure 2.3 Calculation of target height and target height centiles.

- Adult height = height at 2 years × 2
- Adult height = height at 3 years × 1.37
- Adult height in inches:
  - Boys = 0.545 H_3 + 0.544 P + 14.84
  - Girls = 0.545 H_3 + 0.544 P + 10.09

where, H_3 is the height of the child at 3 years and P refers to mean height of parents.

- Target height

The expected target adult height of a child can be calculated on the basis of adjusted midparental height as follows:

- Boys (cm): (mother's height [cm] + father's height [cm])/2 + 6.5
- Girls (cm): (mother's height [cm] + father's height [cm])/2 − 6.5

The calculated target or projected height of the child is plotted at 18 years mark on the growth chart. The range of target height is depicted by the arrow by plotting two points, 6 cm above and below the target height, which corresponds to the 97th and 3rd centile of the reference standard (**Figure 2.3**).

Secular Trends in Growth

During the past couple of decades, there has been a progressive increase in the weight and height of people living in developed countries by eliminating the dietary and environmental constraints. The most striking evidence for this has been the success story of Japan after the Second World War. Following improvements in the socioeconomic status, dietary intake, and environmental conditions, the Japanese children have shown progressive improvement in their growth status as they surpassed the anthropometric indices achieved by their parents over successive generations. The secular trends in growth and development are usually evident after nearly four to five decades before a "plateau phase" is achieved when maximum attainable height or a full genetic growth potential of a nation or ethnic group is achieved.

Because of several nutritional, environmental, and health constraints in our society, more than 48% of children younger than 5 years are stunted and 43% have suboptimal weight (the National Family Health Survey-3). There is thus an ample opportunity to improve the growth indices and stature of children by improving their nutrition, environmental conditions, and health status. *It is important to do so because height achieved at 3 years of age is a good predictor of ultimate adult height. The short stature of adults in developing countries is largely because of poor physical growth during the first 3 years of life.*

Taller Child

Every mother wants her child to be tall. The height of a child depends on a variety of factors: (i) the genetic potential of the child (height of parents, grandparents, uncles, aunts, and so on); (ii) freedom from any developmental defect or systemic or endocrinal disease; (iii) adequacy of nutrition; and (iv) health-friendly environment (love, emotional support, play activity, healthy environment, and so on). Parents cannot do anything to change the inherent genetic potential or genetic stock. But they must ensure that their child is able to achieve full genetic potential for height by providing him or her with a nutritious balanced diet with adequate calories, proteins, and essential micronutrients. There are no "magic nutrient(s) and tonics" that are known to enhance the linear growth. The child should be provided a healthy and clean environment; early and effective medical care; protection against vaccine-preventable diseases; and recreational, sports, and fun activities. Good balanced food, healthy and stimulating environment, and freedom from illness are crucial to achieve full genetic potential for growth and development. Unless there is a specific deficiency of a hormone, there is no role of administration of hormones for increasing the height of the child. Indiscriminate use of anabolic hormones is harmful and should never be used for promotion of growth. Above all, parents should not have unnecessary concern for height. What is more important for the parents is to mould the character and personality of their child in such a way that he or she has pleasing outgoing manners, caring attitude, self-confidence, poise, interest in arts (music, dance, and painting), and qualities of a good human being.

2.3 Brain Growth

The birth weight of a newborn is 5% of the weight of an adult, while the weight of the brain at birth is approximately 70% of an adult brain. Therefore, almost two-thirds of the brain growth is completed during fetal life. Maternal health and nutrition during pregnancy (especially intake of omega-3 fatty acids and docosahexaenoic acid [DHA])

Table 2.3 Head circumference in children under the age of 5 years (10th–90th percentile)

Age	Head circumference (cm)	Growth velocity
Birth	32.0–35.5	–
3 mo	38.0–41.5	2 cm/mo
1 y	43.5–46.5	2 cm/3 mo
3 y	46.8–50.3	1 cm/6 mo
5 y	48.1–51.5	1 cm/y
Adult	55–56	

Abbreviations: d, day(s); mo, month(s); y, year(s).

have profound effects on the growth of the brain in utero. During the first year of life, 15% of the brain growth occurs (importance of breastfeeding), while the other 15% of brain growth is achieved during 1 to 3 years of age (importance of balanced complementary feeds). By the age of 5 to 6 years, almost 90% of brain growth is completed. **Table 2.3** gives the growth velocity of the head circumference during preschool years.

At birth, skull bones are separated by gaps or sutures and soft spots or fontanels to facilitate the growth of the brain. There are a total of six fontanels, one anterior, one posterior, and four lateral fontanelles, two on each side of the skull (anterolateral and posterolateral). The lateral fontanelles are usually closed at birth, while posterior fontanel usually closes by 3 months of age. Anterior fontanel is clinically important. It is located over the top of the skull, at the junction of frontal and parietal bones, and is quadrangular in shape. It is normally flat and usually pulsatile because of transmitted pulsations of the cranial arteries. Anterior fontanel may be depressed by dehydration and it starts bulging (and pulsations may disappear) when intracranial pressure rises because of meningitis, hydrocephalus, or space-occupying lesion in the brain. Anterior fontanel usually closes by the age of 18 months but may be large in size or remain open in some children with rickets, hydrocephalus, cretinism, Down syndrome, thalassemia major, pituitary dwarf, and certain developmental disorders.

2.4 Process of Development

Unlike calves or colts that are up on their legs soon after birth and can search for their food, human babies are dependent on their parents and caretakers for at least 4 to 5 years. The slow process of neuromotor development in human babies is the price we pay for highly evolved and complex brain that we are endowed with. Human brain is more sophisticated and versatile than any advanced computer. It is a most fascinating experience to watch children grow as they learn new skills and pranks every other week or month. The dependent baby gradually becomes more independent and interactive to explore the world around them. Development is a continuous process from conception to maturity and is intimately related to maturity of the central nervous system (CNS). *The sequence of development is identical in all children, but the rate of development varies from child to child.* Children must hold their head and sit before they can stand and walk. The rate of development depends on the interaction between genetic potential and the environment. In certain families, children learn to walk or speak earlier compared with others, but normal children must be able to learn various skills within a normal range of development. The environmental factors that facilitate the process of development include stimulating home environment, emotional security, love and attention, optimal nutrition, and ethnic and cultural factors. The stimulatory messages to the brain are received through special senses, namely, hearing (voices of parents and siblings, music, nursery rhymes, lullabies, and so on), sight (objects, pictures, flowers, lights, colors, and so on), touch (caressing, uddling, kissing, massaging, and so on), smell, and taste. The sensory inputs stimulate maturation of various areas of the CNS. Children in orphanages tend to have slower rate of neuromotor development because of lack of environmental stimulation. In general, development is advanced in girls (especially development of language) compared with boys. Whenever there is a damage or disorder of the CNS before, during, or after birth, it can adversely affect neuromotor development and intelligence.

Principles of Development

1. It is the most distinctive attribute of childhood and is a continuous process from conception to maturity.
2. Development is intimately related to the maturation of CNS.
3. The sequence of development is identical in all children, but the rate of development varies from child to child.
4. The generalized mass activity of early infancy is replaced by specific and subtle individual responses. It is a common observation that when shown a bright object, an infant shows wild excitement by babbling and moving arms and legs, while an older child merely smiles and reaches for the object.
5. The development proceeds in a cephalocaudal direction. Infants initially develop head control followed by ability to roll over, grasp, sitting, crawling, standing, walking, and so on.
6. Certain primitive reflexes, such as grasp reflex and walking reflex, must be lost before corresponding voluntary movements are acquired.
7. The development of language is earlier and advanced in girls as compared with boys.
8. Timing of dentition is unreliable and should not be used for assessment of neuromotor development.
9. Children with an odd-looking face or head do not necessarily have associated mental subnormality.

10. Attributes, such as creativity, future potentiality, intelligence quotient (IQ), and mental superiority, cannot be predicted in an individual child by developmental assessment.

Sequence of Development

The development process proceeds in a downward manner—from head to toes. Head control is achieved before a baby is able to use his or her hands, sit, stand, and walk. The skills are not learnt overnight, the process is gradual and slow, gross and uncoordinated body movements are followed by attainment of perfection in due course of time.

Newborns

A newborn is totally dependent on the mother for all his or her needs. Crying is the only signal to draw the attention of mother to the needs of hunger, discomfort, and pain. The newborn may momentarily look toward the mother but cannot fix his or her gaze on her. He or she is fascinated by the flickering lights, bright objects, and soothing music. He or she is comforted by cuddling, caressing, and skin-to-skin contact. He or she is suddenly dazzled by a bright light and startled by a loud sound. He or she lives in his or her own world and often smiles during sleep as if having a dream or while passing wind.

Social Smile

By the age of approximately 4 to 6 weeks, the baby tries to fix his or her gaze on the mother and look into her eyes (**Figure 2.4**). When she talks to the child or tickle the chin, he or she responds by smiling. The child cannot differentiate between mother and a stranger and obliges everyone with an interactive smile. After a couple of weeks, his or her smile becomes a broad grin and the child expresses his or her pleasure by kicking wildly with his or her arms and legs and by producing cooing, babbling, and gurgling sounds.

Head Control

When you pick up a newborn or an infant, you need to support his or her head with your hand or elbow while carrying him or her. By the age of approximately 3 to 4 months, most babies achieve a satisfactory head control and you need not support their head while holding them (**Figure 2.5**). At this stage, when baby is lying on the abdomen, he or she can lift the head and shoulders off the cot and turn the head from side to side.

Rolling Over

Most babies are able to roll over in bed once the head control is achieved. In India, as most babies are made to sleep on their back, they learn to roll over first from back to stomach and subsequently from stomach to back. The baby achieves gradual mobility and parents have to be careful that he or she may not fall or hurt him or herself. The cot should have a side railing or pillows should be placed around the baby to protect him or her against the fall.

Figure 2.4 A baby giving an interactive social smile at the age of 6 weeks.

Figure 2.5 A baby having steady head control at the age of 4 months.

Sitting

By the age of approximately 5 months or so, most babies can sit up with props of pillows or cushions. Mother can help the child to sit, but she cannot hasten the process of development because a new skill is achieved only when the specific part of the brain responsible for that skill matures. Initially, infants are wobbly and take the support of their arms to sit (**Figure 2.6**). They can sit with the support of one hand while playing with a rattle in the other. By the age of 6 to 8 months, most children can sit independently without any support with their back straight (**Figure 2.7**). At this stage, children can pivot around on their bottom without losing balance.

Crawling

By the age of 8 to 9 months, most babies develop control over their legs and back and begin to crawl (**Figure 2.8**).

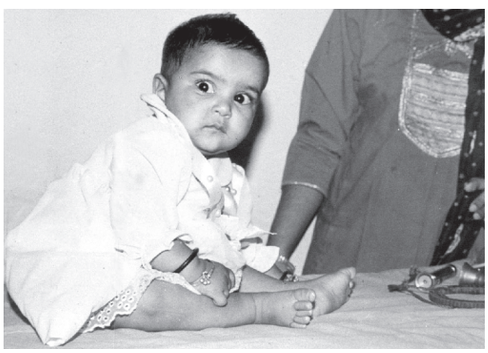

Figure 2.6 A baby sitting with the support of arms at the age of 5 months.

Figure 2.7 A baby sitting stable and independently with a straight back at the age of 6 months.

Some babies learn to crawl on their buttocks giving themselves a push with their legs. Others crawl more gracefully on all the four limbs and can reach at every place. At this age, children are ready to explore their environment by poking their fingers into everything and "mouthing" every object that they can lay their hands on. Children of this age need constant supervision and vigilance round-the-clock so that they are protected against various hazards during the process of exploration and learning. Their hands, knees, and leggings would remain soggy all the time. During this phase, parents should make sure that children have no access to electrical wires, knives, blades, beads, pot of tea or pail of hot water, and so on. Parents must keep dangerous and breakable things out of their way and reach.

Standing and Walking

By the age of 9 months or so, most babies can hold on to furniture and stand with support (**Figure 2.9**). They can

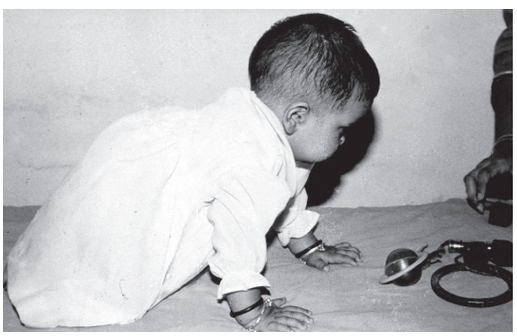

Figure 2.8 A toddler crawling at the age of 8 months.

Figure 2.9 A toddler standing with support at the age of 9 months.

walk few steps or cruise by holding mother's hand or furniture. By the first year, most babies are able to take a few steps independently without any support (**Figure 2.10**). This is a moment of great pride for parents. Between the age of 12 and 18 months, babies are able to walk fairly well, though they are prone to frequent falls with minor bumps. Most parents buy a "walker" when their baby is able to crawl so that he or she can move around on the props of the walker. But walkers are fraught with dangers of accidents and injuries and should preferably be avoided. Moreover, walkers eliminate the motivation and desire to walk because child can move around in the walker with a minimal effort. Walkers have been banned in several countries. Around 2 years, most children can walk up and down the stairs by placing two feet on each stair (**Figure 2.11**). Between 2 and 3 years, most children can climb stairs by placing one foot on each stair, but they come down by placing both the feet on each stair.

Figure 2.10 A toddler standing without support and trying to walk at the age of 1 year.

Figure 2.11 A 2-year-old toddler trying to climb upstairs.

Holding Objects

Newborns are endowed with a grasp reflex. When a finger is placed in their palm, they automatically and involuntarily grasp it firmly but do not know how to release it. By the age of 3 to 4 months, babies can deliberately hold an object like a rattle with their palm and fingers (like a monkey grasp). The initial hold is crude and they cannot transfer the object from one hand to the other. By the age of around 6 months, babies want to hold the spoon and try to take it to their mouths. At this stage, their coordination is poor and they succeed in taking food to their nose or ears. But soon their coordination improves and they are able to do a better job. Babies can hold two objects in one hand and can transfer objects from one hand to the other. By the age of 9 to 10 months, babies develop a finer grasp and can hold a button or a bead between their thumb and index finger (pincer grasp). They can now pick up small objects from the floor and can indulge in all types of mischiefs unless they are closely supervised. By the first birthday, baby's grasp is mature, coordination is better, and he or she can transfer objects from one hand to the other, can throw a ball, and enjoys dropping and picking objects from the floor.

Milestones of Development

Development is assessed in multifaceted spheres such as gross motor, fine motor, social and adaptive, language, vision, and hearing. Every baby is unique and each baby develops at his or her own pace but within the broad range of normality. Every normal baby will eventually smile, lift head, babble, hold things, sit, crawl, stand, cruise, and walk at his or her own pace. But children do need encouragement, cuddling, stimulation, interaction, and confidence from parents and other people around them to achieve their full genetic potential. The process of development is continuous, and children learn new skills as they grow. Children learn many new skills and attributes at different ages and it is impossible to list all of them. There is a wide range of ages for acquiring various milestones that have been summarized below:

1 to 1.5 Months

- Sleeps most of the time and cries when hungry, wet, or uncomfortable.
- Fists are always closed or clenched.
- Blinks to strong light, startles, stretches, or cries on loud sound.
- Stops whimpering on being picked up or by listening to a soothing sound.
- Turns toward the source of light and tries to fix his or her gaze and looks into mother's eyes.
- Gives a social smile (when talked to or tickled on the chin) and makes gurgling or bubbly sounds.

3 to 4 Months

- Recognizes mother and becomes more responsive and lively to mother's overtures.
- Starts to look at his or her hands that are mostly open and there is no grasp reflex.
- Can support his or her head when held in the lap or over the shoulder.
- When placed on the tummy, raises chest and head off the cot and turns the head to one side.
- Laughs aloud and shows pleasure by gurgling sounds and vigorous movements of arms and legs.
- The anticipation of bath and feeds evokes coos, smiles, excited gestures, and movements of limbs. Enjoys being bathed and gurgles happily when picked up or tickled.
- Can briefly hold a toy with his or her clumsy monkey-like grasp.
- Turns head toward sound.
- Can roll over from back to stomach and later on from tummy to back.
- Puts his or her fingers into mouth especially when hungry or bored and for self-stimulation.

5 to 6 Months

- Puts everything into his or her mouth (oral phase of development).
- Can sit with support with hands kept forward for support.
- Bears all the weight of body on the legs when made to stand.
- Can handle objects better and when offered a second toy, drops the first one.
- Squeals and chuckles when excited during play activity and screams if annoyed.
- Smiles at his or her mirror image (**Figure 2.12**).

Figure 2.12 A baby enjoying and laughing on seeing his mirror image after the age of 6 months.

- May make sing-song noises and two syllable sounds such as "ma-ma," "ba-ba."
- May show fear of strangers.
- Grabs toes and puts them in his or her mouth.

7 to 9 Months

- Can crawl poking his or her fingers everywhere; needs constant supervision and vigil against accidents and choking.
- Can pull himself or herself up to stand by holding on to a piece of furniture.
- Can hold small objects such as buttons, coins, peas, peanuts, beads, and so on between his or her thumb and index finger (pincer grasp).
- Pats his or her image in the mirror.
- Can hold a cup in both hands and hold a piece of bread or biscuit and take a bite.
- Makes constant non-sensible babbling and says repetitively "ma-ma" and "da-da."
- Plays simple games, such as peek-a-boo (*cha*) and hide-and-seek, and can clap hands.

10 to 12 Months

- Can stand without support and walk or cruise with support, may take few steps independently.
- Can use a cup and small glass or feeder independently.
- Holds a spoon but cannot use it effectively because of lack of coordination.
- Gives back the toy when asked.
- Enjoys finger foods (biscuits, French fries, and slices of fruits).
- Uses gestures and shakes head for "No" and understands the meaning of "No."
- Responds when called by his or her name.
- May kiss on request.
- Enjoys deliberately throwing toys and watching them fall.
- Uses a jargon speech.
- Enjoys playing hide-and-seek and make-believe games.
- Can say "bye-bye" and "ta-ta."

In prematurely born babies, corrected age should be used for evaluation of milestones of development. Refer to the section "Corrected Age" for understanding the concept of corrected age.

13 to 18 Months

- Runs around and can cruise up and down the stairs without help.

- Enjoys picking up small objects from nooks and corners.
- Can drink with a cup and use a spoon to eat but with spillage.
- Enjoys looking at picture books or magazines by turning two to three pages at a time.
- Plays with pushing and pulling toys.
- Makes a tower of three to four blocks.
- Copies various household chores such as sweeping, dusting, and mopping.
- Develops awareness of bowels and may fidget or make gestures and sounds to express the toilet needs.
- Says 15 to 20 meaningful words.
- Points to his or her own body parts such as eyes, nose, ears, and lips, when asked.

19 to 24 Months

- Obeys simple commands.
- Loves to run and likes to be chased.
- Walks up and down stairs with two feet on each step.
- Usually possessive of his or her toys and shows jealousy when mother takes interest in another child.
- Enjoys dismantling toys and trying to mend them.
- Makes a tower of six to seven blocks.
- Can hold pencil between two fingers and thumb and scribble horizontal and vertical lines.
- Washes and dries hands.
- There is a fair control over the bowels and bladder.
- Tries to take off socks, shoes, and pants.
- Uses own name to refer himself or herself, loves songs and nursery rhymes, and has a fairly large vocabulary.

24 to 36 Months

- Goes upstairs by placing one foot on each stair, comes down by placing both the feet on each stair.
- Can hop, skip, and jump.
- Can pedal a tricycle.
- Can draw a circle.
- Enjoys saying "No" to everything.
- Can dress and undress himself (except buttons).
- Completely toilet trained.
- May speak endlessly and ask all sorts of questions all the time.
- May count up to 10 and recite nursery rhymes.
- Turns pages of a book one at a time.
- Knows his or her own sex.

Based on the achievement of various milestones[a], the developmental quotient (DQ) of the child can be calculated as follows:

$$DQ = \frac{\text{Development age of the child}}{\text{Chronological or corrected age of the child}} \times 100$$

A DQ of less than 70% demands detailed assessment of the child by a specially trained clinical psychologist.

Hearing

Adequate hearing is essential for the development of normal speech. Parents should carefully watch their children for their responses to various sounds. In infants, sudden loud sound may produce a startle response, blinking of eyes, or change in his or her activity. At the age of 4 months or so, a child would turn toward the sound of a rattle or temple bell or beating of a metallic plate with a spoon (**Figure 2.13**). As the child grows, he or she will respond to the banging of the door, sound

[a]In prematurely born babies, corrected age should be used for evaluation of milestones of development.

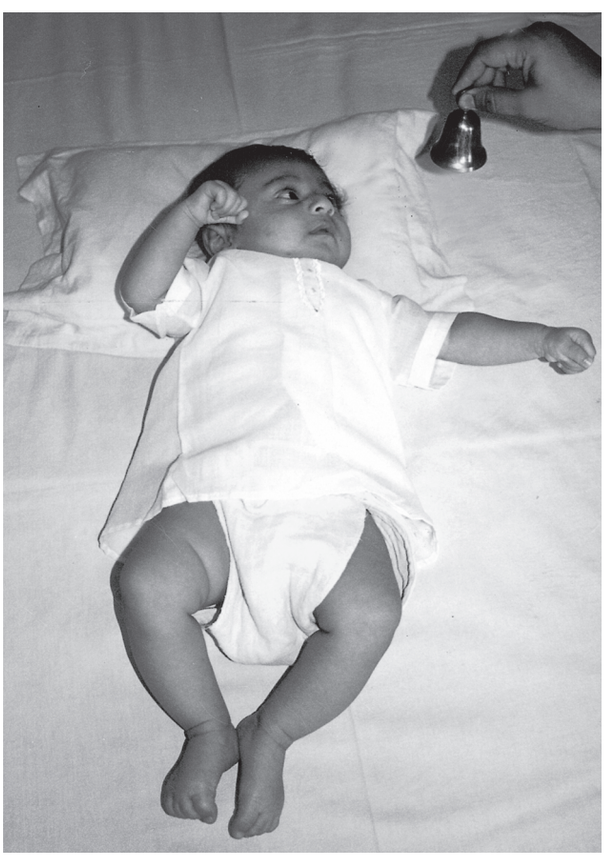

Figure 2.13 Baby turning head toward the sound of a rattle or bell at the age of 4 months.

of music (by making dancing movements or gestures), and noise of airplane. After 1 year of age, children will respond to their respective name when called from a distance. Whenever there is a doubt about the hearing capability of a child, he or she must be assessed by an otolaryngologist. Several hearing tests (auditory brain stem response, otoacoustic emission, and behavioral audiometry) are available to precisely assess the hearing of the child.

Vision

Newborns respond to bright light by blinking and turning their heads toward diffuse light or light of a torch. The newborn can see clearly up to a distance of 12 inches and can appreciate different colors, but red and black are perceived best. By the age of around 4 to 6 weeks, children are able to fix their gaze and look into your eyes and give a social smile when talked to. They follow and look toward a dangling red ring (**Figure 2.14**). During the first 6 months, infants love to look at stripes, checkerboards, bull's eyes, and squares. By 3 months of age, children can see objects up to a distance of 10 feet. The acuity of vision gradually improves as child grows and reaches the adult level by the age of 6 years. When a baby is unable to see, he or she will not blink in response to bright light, may have purposeless roving eye movements and persistence of squint or crossed eyes beyond the age of 6 months. He or she may not give any blink response when you suddenly bring your finger toward his or her eyes. A blind infant is extra sensitive to noise and gets easily startled by sudden noise. Whenever there is doubt about the vision of a child, he or she should be examined by an ophthalmologist for visual evaluation using a variety of modern tests (optokinetic nystagmus or visual-evoked responses).

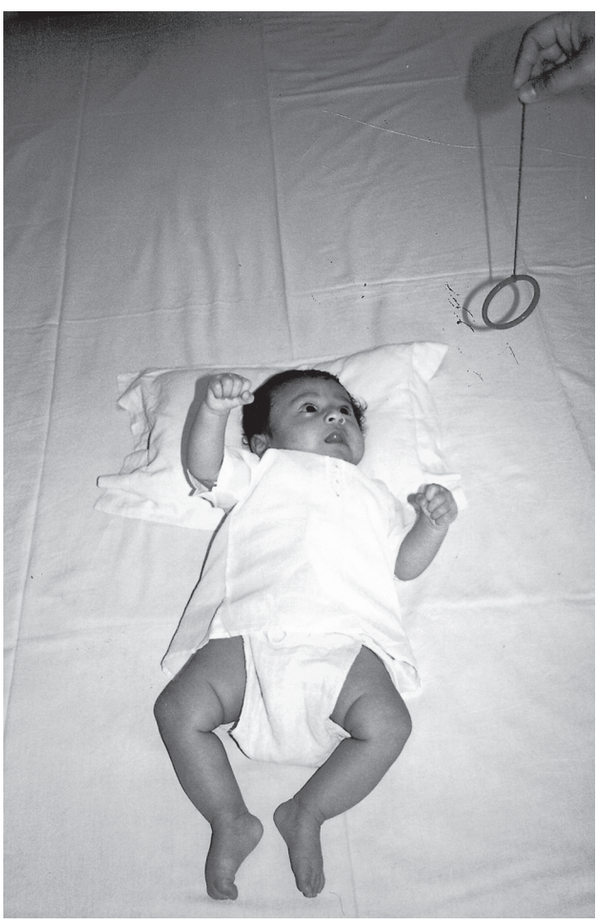

Figure 2.14 Around 4 to 6 weeks of age, most babies follow and turn toward a dangling ring.

Speech

Crying is the sole channel of communication during early childhood. Babies are able to signal all their biological needs and physical discomforts through cries and gestures. The earliest speech of a baby is cooing and gurgling sounds that are produced around 3 months of age. During the next couple of months, he or she makes all sorts of sounds and noises that mean nothing to the caretakers (he or she may have his or her own meaning and purpose attached to these meaningless sounds). By 6 months of age, a baby is constantly babbling and parents may be able to discern words such as "na-na, ma-ma, pa-pa, and da-da." Between the age of 9 months and 1 year, the jargon vocabulary increases and the baby may use a word of his or her own for water, another for milk, and yet another for mother, and so on. The first word with meaning is usually spoken anytime between the age of 9 and 15 months. During 1 to 2 years of age, vocabulary gradually increases and many children are able to express themselves and talk meaningfully. By the second year, most children are able to use pronouns such as "I," "me," and "you." By 3 years of age, most children ask questions, know their name, and gender. Some children may continue to indulge in "baby talk" much longer than others and it should be considered normal.

2.5 Delayed Speech

Like other milestones of development, there is a wide age range when normal children learn to speak. *Girls speak earlier than boys and this capability stands them in good stead throughout life*! Many parents get worried if their child is not speaking by 1½ years because many of his or her age-mates have started speaking. If the child has achieved other milestones of development such as sitting, crawling, standing, walking, and so on at the right time, there is no need to worry. He or she may outdo others later on and may indeed become a chatterbox in due course of time. It is not unusual to find a late talker, suddenly one day talking with meaningful words and sentences to the great surprise and pride of everyone. The development of speech depends on both normal intelligence and normal

hearing. Parents should make sure that their child hears normally. Ask the child to bring his or her favorite toy or shoes from the other room. Call him or her when he or she is playing in the next room and see whether the baby comes or not. Watch him or her whether he or she dances or responds to the tune of music. He or she should respond to every unusual sound such as a doorbell, horn of a car, and roar of an airplane.

High-frequency deafness is an important cause of delayed speech. The child may respond to the whispers, clicks, and clapping of the hands but is unable to understand human speech. The child may be able to listen to a passing car, banging of the door, and the sound of radio, and parents can never believe that the child is indeed deaf to certain high frequencies of sound. Deafness must be ruled out in every child with delay in speech. *Delayed speech or at times regression of speech is an important feature of autism. Autistic children lack social interactions and live in a world of their own.*

It is important to remember that children can comprehend and follow commands and instructions much better before they have the capacity to speak. It is desirable that the mother should talk to her child while she feeds, bathes, and plays with him or her. The baby will understand the rhythm and feelings of her words long before he or she learns what the words mean. Early motor indicators of delayed speech include inability to lick food with his or her lips, poor swallowing or trying to push the food with a finger, drooling, and inability to blow out the candles. Delay in the onset of speech is most commonly caused by genetic or constitutional reasons. In certain families, children learn to speak rather late. *Tongue-tie should never be considered a cause for delayed speech.* Tongue-tie, malocclusion of teeth, and cleft palate, however, may affect the clarity of speech. Most normal children develop meaningful speech by the age of 3 years. It is believed that Albert Einstein caused a good bit of anxiety to his parents as he spoke at the age of 4 years!

2.6 Developmental Delay

In normal children, developmental milestones are achieved within a wide range of ages. Children in certain families achieve some neuromotor skills earlier, and girls in particular mature faster than boys especially in development of speech. At times, a child develops a particular skill faster while he or she may be slow in achieving the other. For example, it is a common observation that a child may start walking as early as 9 to 10 months, but his or her speech may be delayed up to 3 to 4 years. *When there is retardation in all the developmental spheres, it is suggestive of mental retardation. However, isolated delay in walking may occur because of congenital dislocation of hips and isolated delay in speech is usually due to deafness.* It is not possible to predict IQ and personality or creativity level of a child on the basis of developmental assessment.

Table 2.4 Target ages for achievement of major milestones

Milestones	Upper age limit[a]
Social smile	2 mo
Stable head control	4 mo
Ability to recognize mother	6 mo
Ability to sit independently	8 mo
Crawling[b]	9 mo
Standing without support	1 y
Walking without support	1.5 y
Thumb–forefinger grasp	1 y
Disyllabic babbling (ma-ma, da-da)	1 y
Meaningful speech with sentences	3 y

Abbreviations: mo, month(s); y, year(s).

[a]In prematurely born babies, corrected age should be used.

[b]Some children may miss crawling and start standing with support.

Table 2.4 gives the upper age limits for achievement of major or target milestones. If a child has not achieved a particular milestone by the age limit mentioned in the table, he or she should undergo detailed developmental assessment. *The recommended corrected ages (calculated from the expected date of delivery) for undertaking detailed developmental assessment are 4, 8, 12 months, and then every 6 months till 3 years of age.*

Intelligence Quotient

Intelligence includes child's comprehension, analytical ability, reasoning ability, memory, and attention span. It is influenced by environmental and psychosocial factors and child's ability to properly receive and interpret stimuli from the environment. Several intelligence tests (such as Stanford–Binet and Wechsler) have been devised to measure a wide range of abilities including language development, drawing capability, spatial concepts, numbers, verbal and non-verbal reasoning, memory, and fine motor skills. In India, culture-specific tests for intelligence have been devised by the Central Institute of Education and the National Council of Educational Research and Training. On the basis of results of the standardized intelligence test, the examiner can calculate the mental age of the child. The mental age of the child, when compared with his or her chronological age (actual or corrected age in years) and expressed as a percentage, gives his or her IQ:

$$\text{IQ} = \frac{\text{Mental age}}{\text{Chronological age}} \times 100$$

There are some fallacies to do these tests. The child may not cooperate or may not perform well because of tension

and use of testing material with which he or she is not familiar. When a child is not doing well at school, these tests may be conducted to assess the IQ of the child. The child with an average ability has an IQ score between 85 and 115. Children with an IQ score of above 150 are exceptional or gifted, while an IQ score of less than 50 is suggestive of severe mental retardation. There is an increasing evidence to suggest that IQ alone does not determine one's success in life. It is equally important to have good and balanced outgoing personality, confidence, self-esteem, enthusiasm, determination, easy adaptability, and so on, which is expressed in terms of social, emotional, and confidence quotients. It is hoped that in the near future, people would look for spiritual quotient by assessing qualities such as mental peace, poise, balance of mind, compassion, and human qualities of heart (rather than head alone) as a barometer of real success in life.

2.7 Correlates of Cognition

There is recent evidence to suggest that you can create more connections through synapses, dendrites, and receptors by consuming brain-friendly diet, taking supplements of micronutrients, and by mental and physical or fun activity. Even adult brains are endowed with a capacity to grow new neurons.

Human brain is the most complex organ and superior to the most advanced computer. It is believed that if one were to create a computer to match the capabilities of an average human brain, it would have to be at least the size of England! Most of the brain growth takes place during fetal life, and by 1 year of age 80% of brain development is completed. Brain contains high levels of phospholipids, essential long chain fatty acids (omega-3 fatty acids, DHA, and arachidonic acid), amino acids, and antioxidants. It is true that we all are a product of our heredity and environment. We are born with some in-built characteristics that are inherited from our parents and grandparents. According to psychologists, less than 10% of our characters are handed down to us in our genes, while the rest of our thinking and behavior patterns are learnt. Most of the learning takes place in childhood. Our brain is divided into two equal halves or hemispheres. The left hemisphere is mainly responsible for logic, science, reasoning, cognition, or analytical skills such as language and math. The cortex of the right hemisphere is responsible for development of artistic and aesthetic characteristics such as music, dance, painting, platonic emotions, romance, extrasensory perception, intuitive thoughts, mythology, imagination, and spirituality. Any activity that stimulates both hemispheres simultaneously promotes development of intelligence. In general, most women are predominantly rooted in the right brain, while men mostly exploit their left hemispheres. *Optimal nutrition and stimulation during fetal life and preschool years are most crucial for enhanced growth and maturation of the brain.*

Nutrition

Mother's health, diet, and emotions profoundly affect the growth and development of her fetus. She must take balanced nutritious food with high quantity of proteins, fresh green leafy vegetables, fruits, and dairy products. Mother should take 2.6 g/d omega-3 fatty acids and 300 mg/d DHA during pregnancy and lactation. She must avoid smoking and taking alcohol during pregnancy, which may adversely affect the fetal brain growth. After birth, the baby must receive breastfeeding as long as feasible, at least for a minimum period of 1 year. Arachidonic acid and DHA (two key fatty acids), choline, zinc, and lactose are needed for the growth of brain. These essential brain nutrients are present in plenty in breast milk. It has been shown that breastfed babies have 8 IQ points higher cognition compared with bottle-fed babies.

Stimulation

"Apart from physical connection, there is an ethereal or spiritual bond between the mother and her baby in the womb. Every emotion experienced by the mother is transmitted as vibrations and vibes to her baby. Mother's thoughts and perceptions have a profound effect on her unborn baby—Be meditative and have positive and vibrant thoughts of love, peace and hope to touch the soul of your baby."

– Meharban Singh

Babies have a biological and physiological need to learn. Any stimulation through their special senses (hearing, sight, touch, taste, and smell) provided during fetal life and first 12 months has more impact on the growth and maturation of brain than at any other time period in life. It has been shown that stimulation program can promote faster growth, improve coordination of muscular movements, increase span of concentration, and raise baby's IQ by as much as 15 points.

Fetal Life

It is well known that fetuses respond to their mother's heartbeats and voice in the womb. In Indian mythology, there are several examples given in the holy texts that explains that a child starts learning in the womb of his or her mother. According to the epic *Mahabharata,* Abhimanyu learnt how to enter *Chakarvyuh* when Arjun explained the principles and techniques of the entry procedure to his pregnant wife Subhadra. It is believed that if mother recites religious or holy scriptures such as "*Hanuman chalisa*" and "*Kirtan sohla*" every night throughout pregnancy, her baby is likely to be brave and fearless. After 5 months of pregnancy, mother can rock gently and slowly in a rocking chair at the rate of 20 rocks per minute. It enhances neuromuscular development and coordination ability of the fetus. She can give positive suggestions to her baby whenever she is in a relaxed mood or before going to sleep. The fetus is most alert during the evening and night between 8 o'clock and about midnight. It seems

that when tired mother lies down for rest, her baby wakes up and kicks around. (This in-utero behavior may continue even after birth, so babies are usually more active, awake, and cranky at night for several weeks after birth.) Mother can call her baby by his or her pet name and say, for example, "this is your mummy, I love you, I adore you, you are going to be such a happy baby. You are going to be such a smart baby. You are going to be kind, generous, and compassionate human being." She can repeat the suggestions three to four times every night. She can hum a soothing song, recite a nursery rhyme, or sing a lullaby. Some music companies have produced audiocassettes such as *Garbh Sanskar*, *Garbh Raksha*, and *Wellness Mantras* for stimulation of the fetus.

Infancy and Childhood

Rats reared in a stimulating environment with rollicking fun games had 50,000 extra brain cells in each side of their hippocampus. The enjoyable physical activity induces the brain cells to produce a chemical known as "growth factor" that stimulates the growth of dendrites and neurons.

The best way for the baby to learn is when mother holds him or her and plays with him or her. Do not leave the baby alone in his or her crib or with his or her toys. Stimulate him or her when he or she is alert and attentive and not when exhausted, sleepy, or hungry. Stimulation should be provided not only by the mother but also by the father, grandparents, and elder siblings. We learn by using our special senses. Children should be taught the effective use and development of their senses, for example, how to hear keenly (listen), observe, touch, smell, and taste. We perceive and appreciate the bounties and beauties of nature through our special senses that must be effectively harnessed. Music has tempo, rhythm, melody, and harmony and it stimulates the brain in many ways. Babies love to listen to classical music. Toddlers like to dance to the tunes of foot-tapping music. Extra stroking, touching, caressing, cuddling, skin-to-skin contact, and massaging are very stimulating. During the first 6 months, infants love to look at black-and-white stripes, checkerboards, bull's eyes, and squares. Let the child focus and fix gaze on these and other objects of different colors. Children are attracted by different colors, though red color is appreciated most. Make sure the child has at least 15 minutes of "tummy time" play every day. Babies learn through repetition, and parents should repeat a stimulus till habituation occurs and baby is no longer interested or is bored. It is a great fun to actively interact and stimulate the baby and watch him or her learn and achieve perfection in newer skills.

Children are more susceptible to a suggestion while going to sleep because their subconscious mind is more receptive. The messages of valor, courage, confidence, compassion, hard work, honesty, and truthfulness given during the twilight state are imbibed and acted upon during the waking hours.

2.8 Gifted Child (Child Prodigies)

Even before entry to school, children who demonstrate unusual curiosity, early language development, and keen interest in books and magazines are likely to have advanced intellectual maturation. The exceptional capabilities of gifted child may be in the field of intellection or cognition (computer wizard or math genius) or in communication and fine arts such as music, dance, acting, and painting. Parents should be perceptive to appreciate and assess the unusual capabilities and qualities of their child so that they are effectively nurtured and harnessed.

The child who is smarter compared with most of his or her classmates may get bored because the class work may appear too easy, repetitive, and mundane to him or her. There is no real need to have special classes for gifted children or advance them to a higher class. A well-trained teacher can enrich the daily work of the extra-bright students so that they are adequately stimulated but they continue to interact socially with their age-mates.

The parents should spend more time with their gifted child to satisfy his or her curiosity and hunger for learning. They should be provided greater exposure to the bounties of nature by traveling, trekking, visiting zoos and museums, and so on. The capabilities of the gifted child can be further harnessed and enhanced by a specialized tutor to unravel his or her full inherent potential. Nevertheless, the parents should not be overambitious and such children should be encouraged to develop a well-rounded balanced personality with emotional stability because arrogance may seriously compromise their contributions to the society.

The world loves child prodigies; the classical examples include Mozart, Beethoven, Ramanujan, Lata Mangeshkar, Zakir Hussain, Nadia Comaneci, and Budhia Singh (who ran marathon from Puri to Bhubaneshwar at the age of 5 years). They certainly need special attention, encouragement, better opportunities, and facilities for flowering of their full potential, but they must be protected against exploitation by their parents, trainers, and teachers.

Handedness: Right or Left

Most individuals are right-handed (dominant brain on the left side), but around 10% of people are left-handed. Exact cause of left handedness is not known, but there is some genetic predisposition. When one parent is left-handed, there is 17% chance of a child being left-handed, and when both parents are left-handed, the probability increases to 50%. It is more common in boys than in girls. Most left handers are intellectually bright (with greater mathematical capabilities), though the incidence of stuttering and learning difficulties is higher. Majority of left-handed children are also able to use the right hand with fair dexterity (mixed handers or ambidextrous). Handedness is usually established by the age of 4 years. No coercive or punitive methods should be used to force the child to use right hand if biologically he or she is destined to be left-handed. The

manipulative tactics would never succeed but may lead to emotional disturbances. Let the child evolve and express himself the way nature has designed or destined him or her. Some eminent scientists, artists, and statesmen of the world including Albert Einstein, Alexander the Great, Napoleon Bonaparte, Leonardo da Vinci, Helen Keller, Beethoven, Bill Clinton (former President of the United States), and Amitabh Bachchan have been lefties! But the world caters to the needs of the majority—right handers, while the left handers are allowed to fend for themselves by adapting and adjusting for the day-to-day goodies that are created for the convenience of right handers. A store in London has taken up the cause for lefties and sells a variety of articles to serve the special needs of southpaws.

Further Reading

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Commonly Asked Questions

Which anthropometric parameters should be routinely monitored in children?

Body weight and height (or length during the first 2 years) should be recorded on the road-to-health chart during the first 5 years of life. These measurements should be taken every month (during visits for immunizations) during first year, every 2 months during second year, and every 3 months subsequently. The trend or slope of weight and height curve of the child is more important than its location on the chart. Head circumference should be recorded during the first 2 years of life for early diagnosis of microcephaly and macrocephaly or hydrocephalus. After recording these measurements by standard techniques, reference growth chart can be consulted for their percentile location for the assessment of weight-for-age, height-for-age, head circumference-for-age, weight-for-height, and body mass index (BMI). The child is diagnosed to be *underweight* if his or her weight is below −2 standard deviation (−2 SD) from median weight-for-age of reference population; *wasted* when his or her weight is below −2 SD from median weight-for-height of reference population; and *stunted* when his or her height is below −2 SD from median height-for-age of reference population. The child is considered *overweight* when BMI of the child is above 85th percentile of median BMI-for-age of the reference population and *obesity* is diagnosed when BMI is more than 95th percentile of the median BMI-for-age of the reference population.

What are the reference ages for assessing developmental milestones of children?

In clinical practice, the development of a child is assessed at the *corrected age* of 4, 8, 12 months, and then every 6 months up to 3 years of age. The earliest age at which delayed development can be reliably diagnosed is 4 months. The child is considered developmentally normal if he or she has achieved the following milestones at the reference ages mentioned below:

- **4 months** Social smile is present, there is stable head control, and child can roll over and turn toward sound.
- **8 months** Child can recognize mother, can sit without support, is able to crawl, and becomes anxious in the presence of strangers.
- **12 months** Child can stand without support, can walk with support, is able to grasp small objects with thumb and forefinger (pincer grasp), and has disyllabic babbling speech.

Is it possible to predict the ultimate adult height of the child?

Every parent is keen to know how tall their child would be when he or she becomes an adult. The ultimate adult height of a child depends on his or her constitution or genetic endowment (height of parents, uncles, grandparents, etc.), adequacy of nutrition (adequate intake of both macronutrients and micronutrients), freedom from chronic or recurrent diseases and developmental defects, stimulating environment with opportunities for physical and fun activities, and love and affection by well-adjusted parents. The height achieved at 3 years of age is a good marker to calculate the likely adult height by the following formula:

Predicted adult height (inches)

- Boys = $0.545\ H_3 + 0.544\ P + 14.84$
- Girls = $0.545\ H_3 + 0.544\ P + 10.09$

where H_3 is the height of the child at the age of 3 years and P refers to the mean height of parents. The predicted adult height has an error of ±2 in.

The expected target adult height of the child can also be calculated on the basis of adjusted mid-parental height by the following formula:

Expected target adult height (centimeters)

Boys: mean height of parents + 6.5
Girls: mean height of parents − 6.5

The range of target height is depicted by ± 6 cm (± 2 SD).

How to assess the nutritional status of the child when his or her exact chronological age is not known?

It is difficult to interpret the weight and height of the child when his or her exact age is not known. An effort should be made to calculate rough age of the child on the basis of timing of birth in relation to important festivals, seasons, or local calendar of events by recall. The clinical signs of protein–energy malnutrition (poor muscle mass, loss of subcutaneous tissue, edema, skin changes, and hepatomegaly) and signs of deficiencies of key micronutrients especially iron, vitamin A, iodine, and zinc should be looked for. The following *age-independent* criteria can be used (especially in community health surveys) to assess the nutritional status.

- **Weight-for-height** The degree of wasting can be assessed by checking the child's weight against his or her height and consulting weight-for-height charts of reference population. When weight is less than −2 SD of median weight-for-height, it indicates that the child is wasted and has suffered from acute weight loss. In chronic malnutrition, both weight and height are adversely affected.
- **Mid-upper arm circumference** During 1 to 5 years of age, the mid-upper arm circumference (MUAC) remains reasonably static between 15 and 17 cm among healthy children because fat of early infancy is gradually replaced by muscles. Mid-upper arm circumference is measured with a fiberglass or steel tape at the midpoint between acromion and olecranon. If circumference of upper arm is less than 12.5 cm, it is suggestive of severe malnutrition, while MUAC between 12.5 and 13.5 cm is indicative of moderate malnutrition.
  - **Shakir tape** It is a fiberglass tape with red (<12.5 cm), yellow (12.5 to 13.5 cm), and green (>13.5 cm) shading so that health workers can assess the nutritional status without having to remember the normal limits of MUAC.
  - **Bangle test** It can be used for quick assessment of arm circumference. A fiberglass bangle of internal diameter of 4 cm is slipped up the arm. If it passes above the elbow, it suggests that upper arm is less than 12.5 cm and child is malnourished.
  - **Quack stick** The Quack stick is a meter rod with two sets of markings. The expected height of the child against various sizes of mid-arm circumference is inscribed on the rod. The malnourished child would be taller than the anticipated height derived from the mid-arm circumference.

What reference growth norms should be used to assess the growth of a child in clinical practice?

To eliminate racial and ethnic variables, ideal weight and height standards obtained from healthy Indian children belonging to well-to-do socioeconomic status should be used. The data should be obtained meticulously on a large cross-section of healthy term children with known date of birth. Alternatively, reference growth standards published by the National Center for Health Statistics or World Health Organization multinational growth standards published in 2006 can be used. There is evidence to suggest that healthy Indian children belonging to well-to-do families grow at the same pace as children belonging to developed countries.

Should anabolic steroids be given to increase the height?

There are no magic tonics, nutrients, or rituals to increase height. The optimal or maximal potential for height can be harnessed by meeting the following criteria.

- The child should be term and healthy at birth.
- There should be no developmental defect or chronic recurrent systemic disease.
- There should be optimal intake of macronutrients (especially proteins with essential amino acids) and micronutrients (vitamins and trace minerals).
- The child should have access to outdoor play facilities and fun activities.
- The child should be accepted and provided tender loving care by both the parents who are well adjusted.

Unless there is a specific deficiency of a hormone (human growth hormone, thyroxin, insulin, and insulin-like growth factor-1), there is no therapeutic utility of hormone therapy for increasing the height of the child. *Indiscriminate use of anabolic hormones is harmful and is strongly condemned.* Anabolic steroids are credited to enhance skeletal maturation with earlier fusion of epiphysis with metaphysis leading to earlier cessation of linear growth and short adult stature.

Can physical measures such as yoga and stretching exercises on parallel bars help increasing the stature?

Physical activities, sports, yoga, aerobics, and stretching exercises are important to keep the body and mind active and agile. These measures improve the muscle tone and posture of the child. Apart from optimal nutrition, children should have healthy lifestyle for the balanced development of body, mind, and wholesome personality without undue focus or concern on height. There is no scientific evidence regarding the utility of several devices that are being promoted on television for enhancing linear growth or ultimate stature.