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Manual of Physical Diagnosis in PEDIATRICS

Foreword
N Anand

FOURTH EDITION

Contents

3 Chapter

Physical Growth Assessment

The general pattern of body or somatic growth is assessed by anthropometry. The children resemble their parents not only in their ultimate body configuration but also in growth pattern. The anatomical characteristics and functional maturity of organs at different ages can affect the growth and development of the child. The corrected age concept is used for assessment of growth and development in the 1st year of life.

LENGTH AND HEIGHT

Babies younger than 10–12 months cannot stand alone and most toddlers refuse to stand. Hence, any child younger than 2 years should be measured for length in the recumbent position. Standard growth charts for young children are based on the measurement of recumbent length. There are two types of length:

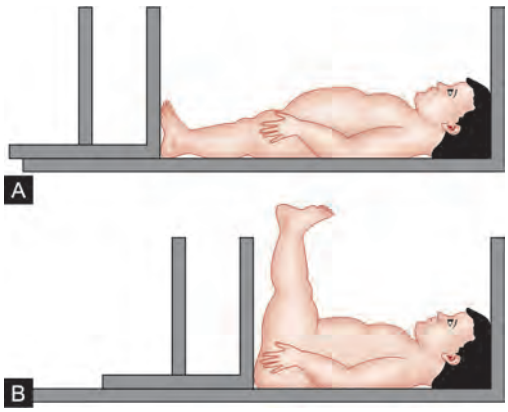
1. Crown-heel length: It is the measurement from the crown of the head to the feet of the infant. Here the child's body is fully extended by flattening the knees and maintaining the head in midline position. The headpiece is fixed to the measuring table at zero mark. The footpiece is made to slide along the measuring board till it touches against the sole of the feet (Fig. 3.1A).
2. Crown-rump length: It is the measurement from the crown of the head to the rump of the infant (Fig. 3.1B). It is equivalent to sitting height in the older child.

Height Measurement

Standing height can be measured when the child can stand straight and can hold the head, so that the line of vision should be parallel to floor surface. The child stands in bare foot against the wall on which there is a ruler. The child's occiput, upper back, buttocks and heels touch the wall. A flat object is placed on the head and against the ruler to obtain the accurate measurement. Older child may stand on the scale (Fig. 3.2).

The difference in the height and length can be up to 2 cm, as ligaments are compressed in standing posture.

Nutritional deficiency for long term will affect the linear growth. Acute malnutrition



Figs 3.1A and B: Length measurement. **A.** Crown-heel length; **B.** Crown-rump length.

will result in wasting of subcutaneous tissue and muscle mass.

Formula to calculate the expected height (cm) in 2–12 years

= Age (year) × 6 + 77

Height (Length)-for-age

Height should be taken in a standing position without footwear. If the height machine is not available, the measuring scale fixed to the wall can be employed. This arrangement is suitable for children of 2 years and above. The measuring scale should be capable of measuring to an accuracy of 0.1 cm. A very great effort should be made to measure children accurately. Errors in the measurement of a young child may lead to significant errors in the classification of the nutritional status. The WHO standards for height-for-age are as shown in the Table 3.1.

The length of a baby at birth is about 50 cm. It increases by about 25 cm during 1st year and by another 12 cm during the 2nd year. During growth spurt, boys add something around 20 cm in their height and girls gain 16 cm. The spurt is followed by a rapid slowing of growth. Indian girls reach 98% of their final height on an average by the age of 16.5 years and boys reach the same stage by the age of 17.75 years.

Height is a stable measurement of growth as opposed to bodyweight. Whereas weight reflects only the present health status of the child, height indicates the events in the past also. The use of growth (height) percentile chart is particularly valuable in studying the trend of height curve.

Low Height-for-age

Low height-for-age is also known as nutritional stunting or dwarfing. It reflects past or chronic malnutrition. The cutoff point commonly taken for the diagnosis of stunting is 90% of the height-for-age values. Waterlow recorded the use of 2 SD below the median reference as the cutoff point.

Fig. 3.2: Measurement of height

WEIGHT

Infants and young children should be weighed with minimal dress. Infants should be weighed at the same time each day, ideally in the morning before being fed. Usually there will be loss of weight in the first 10 days by 10% because of loss of extracellular fluid. Later newborn will gain 25–30 g/day till 3–5 months. Birth weight will double by 5 months and triple by 1 year.

Infant and younger children are weighed on platform type of electronic weighing scale. Older children are weighed on standing type of upright scale. Measure the nearest 10 g for infant and 100 g for children. Children who refuse to stand on a platform, mother and child should be weighed together, and then mother alone (Figs 3.3A and B). Then derive child's weight by subtracting the latter from the former.

Weight is the reliable indicator of nutritional status. Boys generally weigh more than girls up to the age of 10 years. During 12–13 years, girls will weigh more than boys due to early pubertal growth spurt.

Table 3.1: WHO standards for length/height-for-age of boys and girls up to the age of 5 years (cm)

Age (month)	–2 SD	Boys median	+2 SD	–2 SD	Girls median	+2 SD
0	46.1	49.9	53.7	45.4	49.1	52.9
4	59.7	63.9	68.0	57.8	62.1	66.4
8	66.2	70.6	75.0	64.0	68.7	73.5
12	71.0	75.7	80.5	68.9	74.0	79.2
16	75.0	80.2	85.4	73.0	78.6	84.2
20	77.7	83.2	88.8	76.7	82.7	88.7
24	81.7	87.8	93.9	80.0	86.4	92.9
28	83.8	90.4	97.0	82.2	89.1	96.0
32	86.4	93.4	100.4	84.9	92.2	99.4
36	88.7	96.1	103.5	87.4	95.1	102.7
40	90.9	98.6	106.4	89.8	97.7	105.7
44	93.0	101.0	109.1	92.0	100.3	108.6
48	94.9	103.3	111.7	94.1	102.7	111.3
52	96.9	105.6	114.2	96.1	105.0	114.0
56	98.8	107.8	116.7	98.1	107.3	116.5
60	100.7	110.0	119.2	99.9	109.4	118.9

Formula to calculate the expected weight (kg):

$$\text{3–12 months} = \frac{\text{Age (month)} + 9}{2}$$

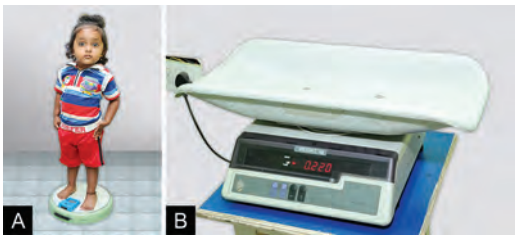
$$\text{1–6 years} = [\text{Age (year)} \times 2] + 8$$

$$\text{7–12 years} = \frac{[\text{Age (year)} \times 7] - 5}{2}$$

Weight-for-age

Measurement of weight and rate of gain in weight are the best single parameters for assessing physical growth. A single weight record only indicates the child's size at the moment; it does not give any information whether a child's weight is increasing, stationary or declining. This is because, normal variation in weight at a given age is wide.

Weight-for-age is careful repeated measurement at intervals, ideally monthly, from birth to 1 year, every 2 months during the



Figs 3.3A and B: Types of weighing machine. **A.** Standing type; **B.** Platform type.

2 years and every 3 months therefore up to 5 years of age, since this age group is at greatest risk from growth faltering. By comparing the measurements with reference standards of weight of children of the same age, the trend of growth becomes obvious. This is best done on growth chart (Table 3.2).

Serial weighing is also useful to interpret the progress of growth when the age of the child is not known. Thus, without the aid of a growth chart, it is virtually impossible to detect changes in the rate of growth, such as sudden loss of weight or halt in gain. Each baby should have its own growth chart.

A baby will gain at least 500 g/month in the first 3 months of life. This is the minimum. The children who gain less weight are malnourished. It is usual for babies to gain about 1 kg a month, especially in the first 3 months. Healthy babies, on an average double their birth weight by 5 months, and triple it by the end of 1st year and quadruple by the age of 2 years. During the 1st year, weight increases by about 7 kg. After that the increase in weight is not so fast—only about 2.5 kg during the 2nd year and from then until puberty by about 2 kg/year (Table 3.3).

Weight-for-height

Height and weight are interrelated. Weight in relation to height is now considered more important than weight alone. It helps to determine whether a child is within the range of 'normal' weight for the height. For example, a child on the 75th percentile of both his/her height and weight is neither overweight nor underweight, but a child on the 75th percentile of his weight chart and the 25th percentile of his/her height chart is clearly overweight.

Low Weight-for-height

Low weight-for-height is also known as nutritional wasting or emaciation (acute malnutrition). It is associated with an increased risk of

Table 3.2: WHO standards for weight-for-age of 5 years (cm)

Age (months)	–2 SD	Boys median	+2 SD	–2 SD	Girls median	+2SD
0	2.5	3.3	4.4	2.4	3.2	4.2
4	5.6	7.0	8.7	5.0	6.4	8.2
8	6.9	8.6	10.7	6.3	7.9	10.2
12	7.7	9.6	12.0	7.0	8.9	11.5
16	8.4	10.5	13.1	7.7	9.8	12.6
20	9.1	11.3	14.2	8.2	10.4	13.5
24	9.7	12.2	15.3	9.0	11.5	14.8
28	10.2	12.9	16.3	9.7	12.3	16.0
32	10.8	13.7	17.4	10.3	13.1	17.1
36	11.3	14.3	18.3	10.8	13.9	18.1
40	11.8	15.0	19.3	11.3	14.6	19.2
44	12.2	15.7	20.2	11.8	15.3	20.4
48	12.7	16.3	21.2	12.3	16.1	21.5
52	13.2	17.0	22.2	12.8	16.8	22.6
56	13.6	17.7	23.2	13.3	17.5	23.8
60	14.1	18.3	24.2	13.7	18.2	24.9

Table 3.3: Growth velocity of weight

Age	Increment
Weight increment per week	
1–4 month	200 g
4–6 month	150 g
7–9 month	100 g
10–12 month	50–75 g
1–2 year	2.5 kg
3–5 year	2.0 kg
Length increment per week	
1st year	25 cm
2nd year	12 cm
3rd year	9 cm
4th year	7 cm
5th year	6 cm

mortality and morbidity. A child who is less than 70% of the expected weight-for-height is classified as severely wasted.

HEAD AND CHEST CIRCUMFERENCE

Head Circumference

At birth, the head circumference is about 34 cm. It is about 2 cm more than the chest circumference. By 6–9 months, the two measurements become equal after which the chest circumference overtakes the head circumference. In severely malnourished children, this overtaking may be delayed by 3–4 years due to poor development of thoracic cage.

Head circumference is measured until the normal child is 3 years of age. It is measured by steel or plastic tape. The maximum circumference of the head is measured by placing the tape anteriorly over the supraorbital ridges and posteriorly over the occipital prominence. If the child has hydrocephalus, serial measurements should be made. Tape is positioned so that maximum circumference is obtained (Fig. 3.4, Figs 3.5A and B).

The neonate's head circumference is 33–35.5 cm. It is larger than chest circumference by 2–3 cm. It grows at the rate of 1–2 cm/month for the first 6 months. Then it grows at the rate of 0.6 cm/month for the next 6 months. Head circumference equals the chest circumference by 1 year. In preterm infant, the chest circumference may exceed head circumference by 6–9 months. In malnourished child, chest circumference may be significantly smaller than head circumference because brain growth is less affected by malnutrition. The chest circumference is greater than head circumference by about 5–7 cm during childhood.

The formula used to calculate head circumference in the 1st year of life is:

$$\frac{(\text{Length in cm} + 9.5) \pm 2.59}{2}$$

Chest Circumference

Chest circumference is measured at midrespiration at the level of the nipple line. The tape measure is placed at right angles to the vertebral column. It is measured in recumbent position up to the age of 5 years.

MID-ARM CIRCUMFERENCE

Mid-arm circumference is measured midway between olecranon process of ulna and tip of the acromion. Left arm is allowed to hang naturally by the side of the body. The circumference of the midpoint is measured. This is also considered as age-independent criteria. It has significance between the age of 1–5 years. It gives information about the nutritional status of the young children. It is a good indicator of muscle mass. The normal mid-arm circumference is 13.5–17 cm. A less than 12.5 cm indicates malnutrition. It is a very useful indicator to follow-up the child with malnutrition on treatment. It does not apply to the child above 5 years.

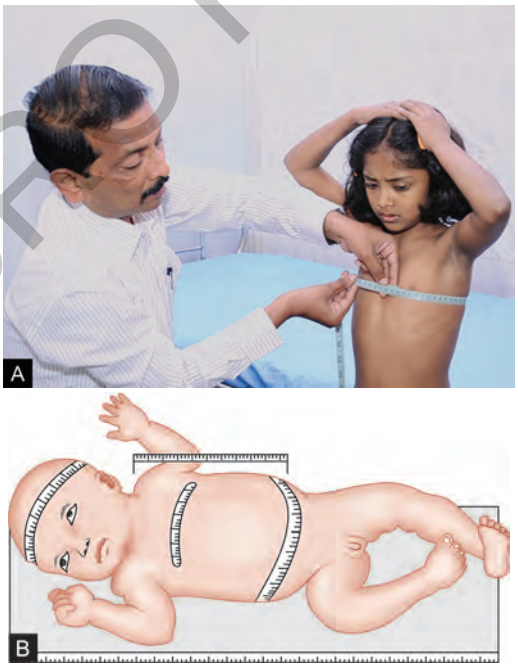
SKINFOLD THICKNESS

Skinfold thickness is useful in the estimation of muscle mass or body fat content. The subcutaneous tissue mass will be maximum by 9 months. It decreases gradually by about 6 years. Later, again there will be increase in subcutaneous tissue. In clinical practice, measurement of triceps and subscapular skinfold thickness is done.

The skinfold thickness is taken by measuring the fold of the skin running parallel to the length of the arm over the triceps muscle midway between acromion and olecranon.

Child's arm is flexed at 90°. Midpoint is marked on the posterior aspect of the arm. Skinfold is grasped 1 cm above the midpoint. Skinfold is gently pulled away from the underlying muscle and measured. It is measured to nearest 1.0 mm. It is measured by special calipers, i.e. Scofield's/Harpenden. The normal measurement is 10 mm in children.

Fig. 3.4: Measurement of head circumference



Figs 3.5A and B: Circumferential body measurements. **A.** Chest; **B.** Head, chest and abdominal circumference.

AGE-INDEPENDENT MEASUREMENT

Bangle Test

A fiber glass bangle is used for this test. The diameter is 4 cm. In malnutrition, the bangle passes above the elbow. It is the quick assessment of mid-arm circumference.

Shaker Tape

Shaker tape is the tape, which has got three colors. Green indicates more than 13.5 cm of mid-arm circumference; yellow indicates 12.5–13.5 cm; red indicates less than 12.5 cm, i.e. malnutrition. This is useful for paramedical staff to assess the nutritional status.

Quack Stick

Quack stick is a height-measuring rod calibrated in mid-arm circumference, rather than height. Value of 80% of expected mid-arm circumference for height is marked on the stick to the corresponding height levels. If the child is taller than his/her arm circumference level on the stick, it indicates malnourishment.

BODY PROPORTION

Body Mass Index

Body mass index (BMI) is calculated as weight/length. It is an important parameter used for the assessment of growth in adolescent, especially obesity. The normal BMI lies between 18.5 and 25. BMI between 25 and 30 are called overweight. Obesity is defined as BMI more than 30. Adults with BMI less than 18.5 are termed to have chronic energy deficiency. The BMI less than 15 is seen in undernutrition. In severe undernutrition, the BMI is less than 13.

Ponderal Index

Ponderal index is used to define intrauterine growth retardation (IUGR), given by the formula:

$$\frac{\text{Body weight (g)}}{\text{Length (cm}^3\text{)}} \times 100$$

In IUGR, it is less than 2, while it is more than 2.5 in appropriate for gestation (AFG) babies.

Arm Span

Arm span is the distance measured between the tips of the middle fingers of both arms outstretched at right angles to the body. Abnormal arm span, i.e. more than height is seen in Marfan's syndrome, homocystinuria, Klinefelter's syndrome. Arm span is less than height in achondroplasia and cretinism.

Normally it will be 1–2 cm less than the body length below 5 years. It equals by 10–12 years of age.

Upper Segment/Lower Segment Ratio

Lower segment is the measurement made from the symphysis pubis to heel. Upper segment is derived by deducting the lower segment value from the height. Upper segment is measured from the vertex to the upper end of the symphysis pubis (Table 3.4).

The ethnic and familial history should be kept in mind. Sometimes it may be necessary to measure the parents' height as well.

Table 3.4: Normal range of upper and lower segment

Normal ratio	Upper segment	Lower segment
At birth	1.7	1.0
At 10 year	1.0	1.0

Abnormally large and long limbs are seen in:

- Chondrodystrophy
- Cretinism
- Dwarfism.

Abnormally short trunks and long limbs are seen in:

- Rickets
- Chondrodystrophy
- Arachnodactyly.

Physical Diagnosis in PEDIATRICS

Salient Features

- Useful for undergraduate students working in clinical pediatrics, postgraduate students, and pediatric residents
- Helps as an essential guide
- Serves as a valuable reference book for practicing pediatricians
- Completely revised and updated
- Discusses common signs and symptoms with differential diagnosis and flowcharts
- Also discusses clinical cases in respective systemic chapters
- Includes new chapters on:
  - ❖ Genitourinary system
  - ❖ Hematology
  - ❖ Genetics
  - ❖ Immunizing agents
  - ❖ Instruments
  - ❖ Drugs
  - ❖ X-rays

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ISBN 978-93-5152-880-7