



Growth and anthropometry: clinical application

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Evaluation of growth and physical development is one of the most important aspects of pediatric clinical practice, due to the close relationship between the normality of a child's growth and his or her health status. Anthropometry is an objective indicator whose purpose is to quantify the variation in the physical dimensions and composition of the human body at different ages and with varying degrees of nutrition. Anthropometric indicators are classified as described in Table 1.¹⁻⁶

Anthropometry and the newborn

In particular, **birth weight** is closely associated with neonatal and postnatal mortality. **Weight for gestational age** determines a child's intrauterine growth. The classification used most commonly is: a) small, b) adequate, and c) large in relation to the expectations established in accordance with the Jurado Garcia parameters or the international classification adapted from Battaglia and Lubchenco.^{7,8}

Length at birth is another indicator of neonatal size, which reflects the mean rate of growth from conception to birth.

The **cephalic perimeter** is useful to evaluate the degree of intrauterine nutrition. The periodicity of anthropometric evaluations varies between one and two months.^{3,9,10}

Anthropometry in infants and children

Body weight evaluates the body's mass and is the result of changes in its various components: lean or muscle mass, fatty or adipose mass, skeletal mass, visceral mass, and total body water. To evaluate it it is necessary to consider age, gender, and a reference standard. It is recommendable to quantify it every three to six months. Weight can be evaluated in three ways: weight for age, weight for height, and body mass index (BMI).¹¹

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Table 1. Basic anthropometric indicators

Age group	Anthropometric indicator	Component evaluated	Tissue of greatest interest
Newborn	Weight	Body mass	Fat, muscle, bone, and water
	Height or length	Skull, spine, pelvis, and legs	Bone
	Cephalic perimeter	Encephalic mass	Neuronal
Infant	Weight	Body mass	Fat, muscle, bone, and water
	Height or length	Skull, spine, pelvis, and legs	Bone
	Cephalic perimeter	Encephalic mass	Neuronal
	Arm perimeter	Body mass	Muscle and fat
Preschool and school age and adolescent	Weight	Body mass	Fat, muscle, bone, and water
	Stature or height	Skull, spine, pelvis, and legs	Bone
	Arm perimeter	Body mass	Muscle and fat
	Adipose panicles	Subcutaneous fat	Fat

Various indices can be constructed with these indicators.

Source: Avila-Rosas H, Tejero-Barrera E. Evaluación del Estado de Nutrición. In: Nutriología Médica. Casanueva E, Kaufer-Horwitz M, Perez-Lizaur AB, Arroyo P. (Eds). 2nd Reprint. Mexico City: Editorial Medica Panamericana, 2004. pp. 594-618.

Weight for age compares a child's weight with a reference group represented by children of the same age.

Weight for height quantifies a child's weight in relation to his or her own height, more accurately evaluates body composition, and distinguishes consumption (acute malnutrition) from atrophy (chronic malnutrition).^{4,11}

The **body mass index** (BMI) is determined by dividing the person's weight in kilograms by their height in meters squared:

$$\text{BMI} = \text{weight (kg)} / [\text{height (m)}]^2$$

It shows mass as a function of stature and is a screening tool used to identify different degrees of nutrition.^{4,11}

Height represents the sum of the length of bodily segments and subsegments; it can be used as a reference point when analyzing the proportionality of the body.

Height for age evaluates a child's height in relation to the height expected for children of the same age, and expresses the consequences of chronic malnutrition with alteration in linear growth or the existence of a disease to be studied.^{3,4,10}

Length in decubitus, expressed in centimeters, is recorded from **birth**, whereas **stature standing is recorded from two years of age**.

Cephalic perimeter is often used in clinical examinations as part of the detection of possible neurological or developmental disabilities in children. In infants the measurement is helpful to determine nutritional status or to monitor response to nutritional interventions.^{10,11}

To report these relationships, two different systems are commonly used:

1. The **Z scores** system expresses the anthropometric value as the number of standard deviations or Z scores below or above the reference mean.^{10,12}



2. The system of **centiles** indicates an individual's position in a given reference distribution, objectively visualizes the dynamic process of growth through regular and sequential measurements in the child, facilitates timely detection of problems, and generates actions by the healthcare team; its interpretation is direct.^{3,10,12}

Anthropometry and adolescents

During puberty, weight gain follows a rate similar to growth in height. In general, for each centimeter an individual gains one kilogram of body weight. After reaching adult height, height does not change but weight does, either in excess (overweight or obesity) or in deficit (emaciation).

The composition of total body mass differs by gender; women proportionally gain fatty mass and men gain lean mass. **In adolescents BMI for age is recommended as the best indicator of total body fat, more so when correlated with other measurements of obesity (waist circumference).**¹

Adipose panicles or skinfolds examine only one of the four main deposits of adipose tissue, subcutaneous fat. They help measure the reduction or excess of fat deposits.

The **triceps skinfold** estimates generalized or peripheral obesity, while the **subscapular skinfold** estimates truncular obesity, with greater predictive value in relation to obesity in adult age.

The **ratio of the two skinfolds** is a good indicator of the pattern of distribution of fat and is correlated with the lipid profile in blood associated with greater cardiovascular risk.¹³

GROWTH AND ANTHROPOMETRY: METHODOLOGICAL DESCRIPTION

For an adequate estimate, anthropometric measurements should be adjusted to certain practices, and be performed systematically:

Weight. The child should be nude or wearing the smallest possible quantity of clothing, with bladder and rectum empty, standing at the center of the base of the scale and remaining immobile during the measurement. The person taking the measurement should ensure that the subject is not leaning on any nearby object, the reading is recorded when the mobile bar aligns with the fixed indicator at the end of the bar; it is recommendable to take the measurement under fasting conditions or at a similar time of day (to facilitate comparison over time).^{3,4,6}

Height or length in decubitus. (vertex-calcaneum distance). The child should recline on a hard surface with a graduated device (infantometer). The center line of the body should coincide with the center line of the measuring table, legs extended and arms resting laterally. The assistant will hold the soles of both feet against the fixed edge of the horizontal surface, the measurer will slide the infantometer bar to the edge of the head held in Frankfort plane, with traction at the level of the corners of the horizontal and vertical branches of the jaw and the mastoid apophysis to achieve maximum physiological extension.^{3,4}

Stature or height. Distance from the vertex (highest point of the head) to the floor. The subject barefoot, standing with heels together, legs straight, spine extended, shoulders relaxed, should be touching the vertical surface holding the stadimeter. The head in Frankfort plane (the outer edge of the eye should be at the same level as the upper implantation of the auricular

pavilion) (Figure 1) and the measurer will lower the mobile bar to it, taking the measurement with gentle but firm traction of the head upward, thereby achieving maximum physiological extension.³⁻⁵

Cephalic perimeter. Surround the head with a measuring tape taking as reference points the occiput and the glabella, keeping the tape tense to compress the hair against the skull.^{6,9}

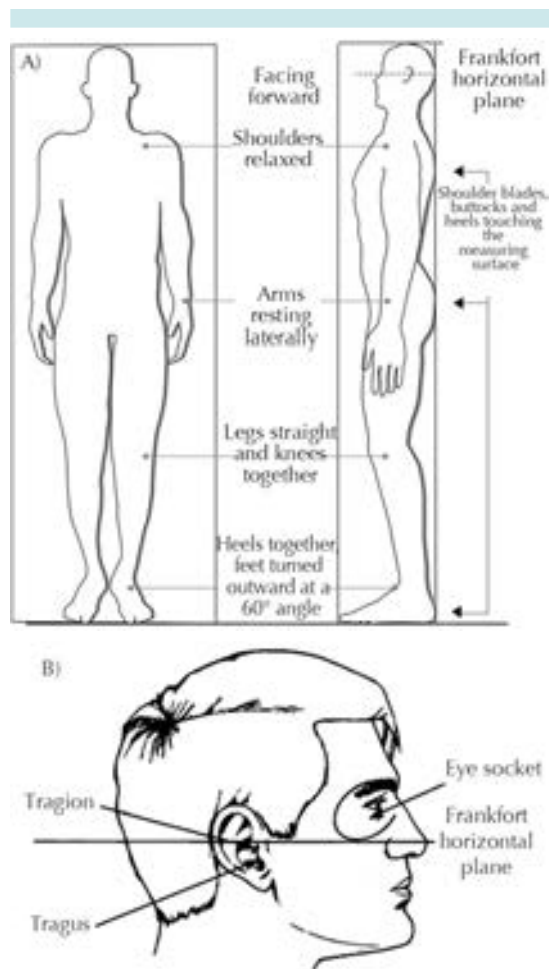


Figure 1. Technique for measuring height. **A)** Adapted from: Carol Hamilton, "PhenXToolkit".¹⁴ **B)** Diagram of Frankfort horizontal plane. Adapted from: "Nutritional Assessment".¹⁵

Arm circumference. The child should have the arm bent at a 90° angle with the palm facing upward. The length will be determined by placing the measuring tape (fiberglass) at the upper vertex of the acromion of the scapula to the olecranon of the cubitus (and the head of the radius), mark the midpoint of the distance obtained, where the measurement will be taken with the arm extended, horizontally and without applying pressure.^{4,5}

Adipose panicles. Practice and knowledge of the reference points, their usefulness, and a plicometer are needed (Figure 2).

1. Hold the skinfold with the thumb and index finger: moderate pinch.
2. Place the plicometer perpendicular to the crest of the skinfold.
3. Place the branches of the plicometer 1 to 2 cm distally to the pinch. Take the reading 2 or 3 seconds after the arms of the plicometer freely apply pressure on the skinfold.
4. The reading is expressed in millimeters.
5. Remove the plicometer opening the arms and then the fingers.^{4,5,9}
 - a) **Tricipital.** Measure on the underside of the non-dominant arm and in a relaxed position, at the level of the reference midpoint obtained (arm circumference) using the technique described.⁵
 - b) **Bicipital.** Measure the vertical panicle at the frontal midpoint of the non-dominant arm, directly above the cubital fossa, at the same level as the tricipital panicle.⁹
 - c) **Subscapular.** The measuring site is the inner angle below the scapula and should

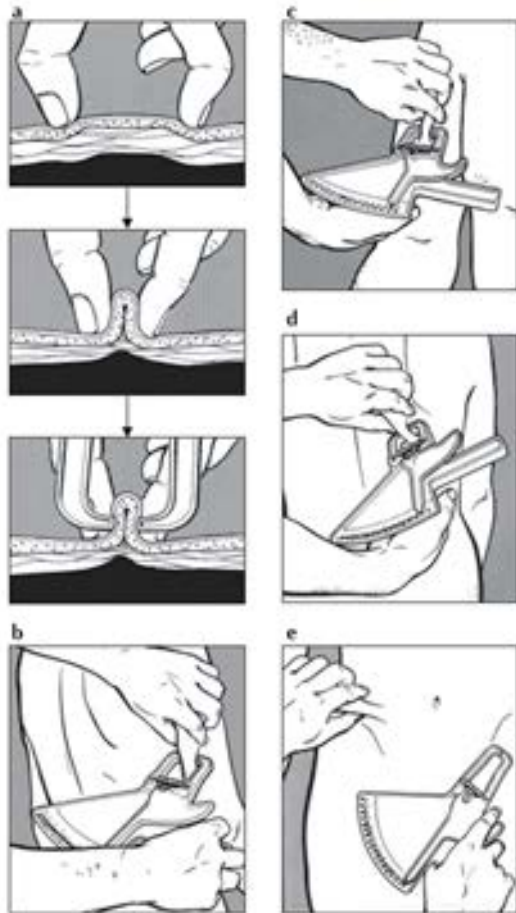


Figure 2. Measurement of adipose panicles. a) technique; b) tricipital skinfold; c) biceps skinfold; d) subscapular skinfold; e) suprailiac skinfold. Adapted from: *How to measure your % bodyfat*.¹⁶

have a 45° angle in the same direction as the inner edge of the scapula (toward the spine), using the technique described.⁵

- d) Suprailiac.** Measure immediately above the iliac crest, 1 to 2 centimeters from the axillary midline, obliquely and toward the genital zone.⁵

At the Instituto Nacional de Pediatría Endocrinology Service, in addition to the measurements

described, other anthropometric indices are quantified which provide information useful for evaluating growth.

Lower segment. Distance from the symphysis (midpoint of the upper edge of the pubic symphysis) to the calcaneum measured in dorsal decubitus; is analyzed based on the length of the upper segment and evaluates the proportionality of growth.³

Upper segment. Is determined by subtracting from the length (height in decubitus) the length of the lower segment. Represents the sum of lengths of the trunk (thorax, abdomen and pelvis) and the height of the skull.³

Arm span. Dactylion-dactylion distance (antero-inferior edge of the tip of the middle finger), with the subject's arms extended to the physiological maximum and perpendicular to the spine; is representative of both longitudinal growth of the lower segment (arms) and transverse growth of the thorax (collarbones).³ In relation to height it evaluates the proportionality of growth.

Waist circumference. The child should be standing, relaxed, and with the abdomen uncovered; the person taking the measurement stands facing the child and with the tape around the waist touches the midpoint between the lower costal edge and the upper edge of the iliac crest, at the end of a normal aspiration, without compressing the skin with the tape, and takes the corresponding reading.⁵

Hip circumference. The child should be relaxed and uncovered at the hips; the measurer, facing the child and with the tape around the hips, touches the greater trochanters of the head of the femur, proceeding to take the reading.⁵

Thigh circumference. Measure at the level of the joint between the middle and upper thirds of the

thigh, with the tape perpendicular to the leg; the measurement is determined by muscle mass and is representative of body protein content.

Penile volume index. Used to evaluate pubertal growth and progression based on age and reference values. The square of the circumference of the penis (flaccid and at the midpoint of the length of its body) is multiplied by the length (distance between the symphysis and the tip of the glans, with the penis flaccid) and the product is divided by 4π (12.5664).³

Testicular volume. Like penile volume, testicular volume is useful to quantify a child's pubertal growth and development. The size of each testicle is compared with a 35° 16' isometric template determining the orifice where the longitudinal and transverse diameters coincide with its edges.³

CONCLUSIONS

In pediatric clinical practice the use of anthropometry is indispensable in ill or healthy patients to monitor or improve the individual's health. The application of the parameters studied will be based on anthropometric measurements that aid the diagnosis to be established. Weight and height are the minimum measurements used in evaluating growth; any alteration will be an object of study for the healthcare team.

Suggested material

- Official Mexican Standard NOM-007-SSA2-1993., Care for women during pregnancy, childbirth and postpartum and care for the newborn. Criteria and procedures for providing service.

- Centers for Disease Control and Prevention Growth Charts. Available at: <http://www.cdc.gov/growthcharts/>

- World Health Organization – The WHO Child Growth Standards. Available at:

<http://www.who.int/childgrowth/standards/es/>

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