Anthropometric Measuring Tools and Methodology for the Measurement of Anthropometric Parameters

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1

1 INTRODUCTION

→ High-quality anthropometric instruments, together with thorough knowledge and precise observance of the standardized measurement method, prior specialized training, sufficient experience and the use of established measurement procedures, play an essential role in the acquisition of objective data that are needed for the evaluation of the variability of the human body and physical condition of an individual.

→ One of the most important anthropological methods is anthropometry, a system of techniques using the most accurate means and methods, designed for scientific purposes, to measure and monitor the human body and its parts. The only limitations to anthropometry are the properties and purpose of the measured problem itself. Anthropometry to an end, not an end in itself.
Anthropometry represents a system of standardized and unified methods for the measurement of the human body, which, in addition to application in anthropology, finds its use in kinanthropology, medicine, ergonomics, fitness centres, criminology, industry (manufacture of clothing, furniture, means of transport, etc.) and other.

→ The human body is measured with anthropometric measuring tools. Basic components include the anthropometer, personal scale, spreading caliper, pelvimeter, sliding caliper, soft metric tape and caliper. These are accurate, standardized instruments designed to measure the height, length, width and perimeter and determine the skinfold thickness.

→ This handbook introduces anthropometric equipment developed or modified by TRYSTOM specialists and anthropologists from the Department of Specialised Subjects and Practical Skills, Faculty of Health Sciences, Palacky University in Olomouc, Czech Republic. The handbook also defines selected anthropometric landmarks and provides a brief methodology for the measurement of selected body dimensions and skinfolds.

→ Anthropometric measuring tools manufactured by TRYSTOM have very good ergonomics and first-rate production quality which ensures accurate measurements of body parameters and a long service life of individual tools.

Authors

2 SELECTED ANTHROPOMETRIC LANDMARKS

→ Body dimensions are measured using defined anthropometric landmarks of the head, trunk and extremities (Figure 1 and 2).

2.1 Anthropometric Landmarks of the Head

→ Selected anthropometric landmarks of the head are illustrated in Figure 1:

→ **Glabella (g)** – the point above the nasal root at the bottom part of the forehead, foremost on the median plane between the eyebrows.

→ **Euryon (eu)** – the most laterally positioned point on the side of the head. Determined when measuring the maximal width of the head. It is the most prominent lateral point of the parietal or temporal bones.

→ **Opisthokranion (op)** – the point situated in the occipital part of the head on the median plane, most distant from the glabella.

→ **Nasion (n)** – the point on the median plane at the nasal bridge in the area of the frontonasal suture, on the superior edge of the nasal bones. This point therefore does not always lie at the most depressed point of the nasal root.

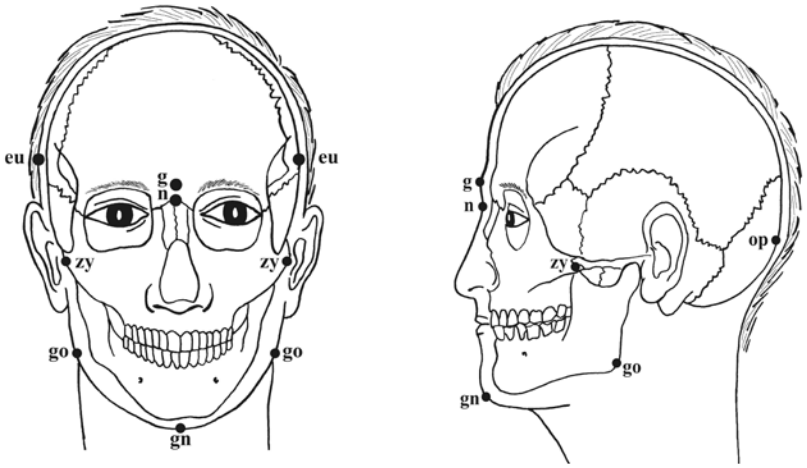
→ **Zygion (zy)** – the most lateral point on the zygomatic arch. Determined when measuring the maximal width of the face.

→ **Gnathion (gn)** – the most inferior median plane point at the bottom on the mandible. Palpated from below.

→ **Gonion (go)** – the lowest and most lateral point of the mandible angle.

Figure 1

Anthropometric landmarks of the head

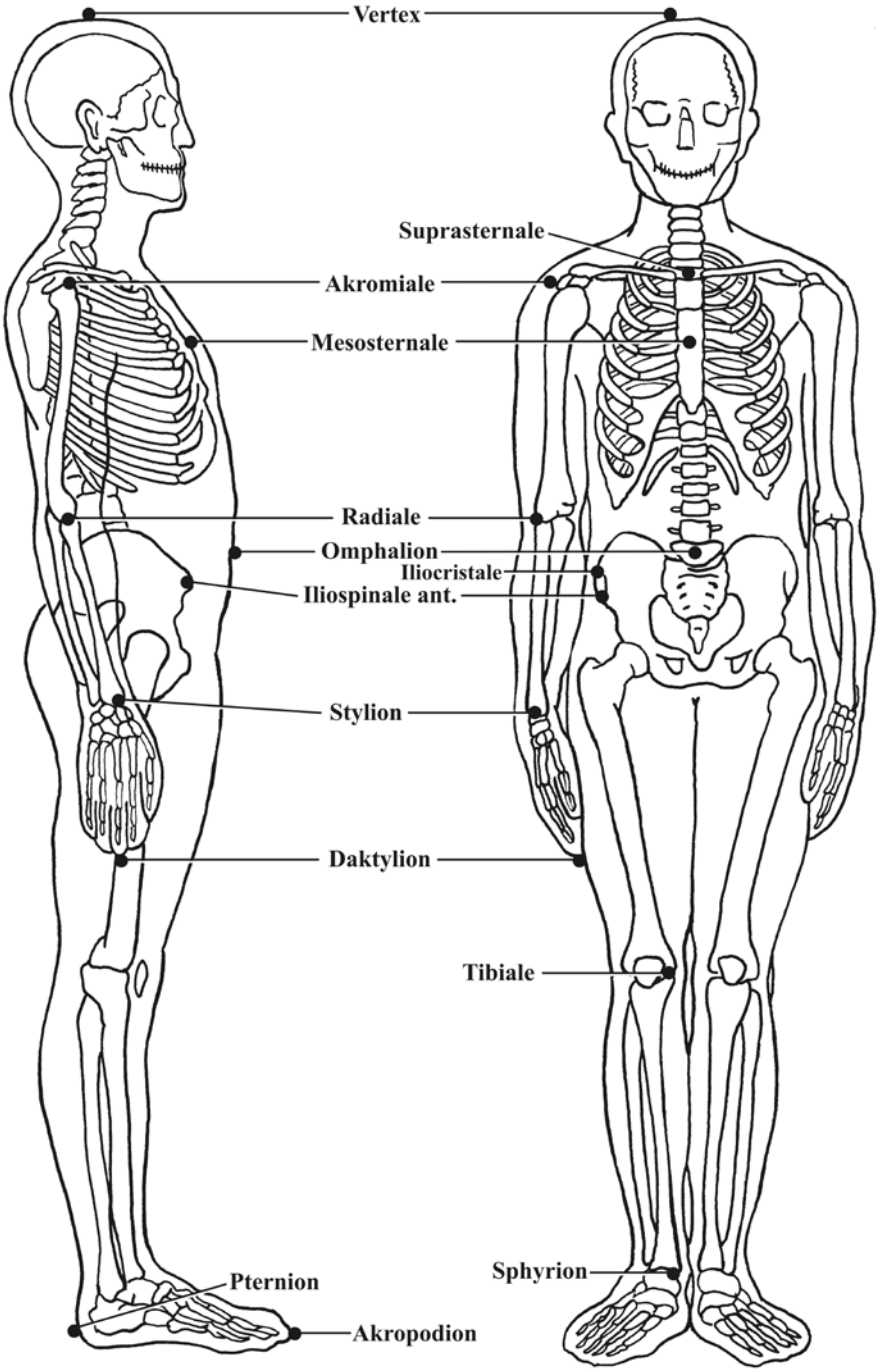


2.2 Anthropometric Landmarks of the Trunk and Extremities

- Selected anthropometric points of the trunk and extremities are illustrated in Figure 2:
- **Vertex (v)** – the most superior point of the head, in the mid-sagittal plane, when the head is held in the Frankfort plane.
- **Acromiale (a)** – the most lateral point at the acromial tip of the scapula (acromion) of a subject that is standing upright with shoulders relaxed.
- **Suprasternale (sst)** – the point on the superior edge of the sternum (or incisura jugularis) in the mid-sagittal plane.
- **Mesosternale (mst)** – the point in the front of the chest in the midline at the fourth rib articulation, in the middle of the sternum.
- **Thelion (th)** – the mid-point of the nipple.
- **Omphalion (om)** – the mid-point of the umbilicus.
- **Radiale (r)** – the topmost point on the superior edge of the head of the radius of a relaxed arm. The gap between the humerus and the radius palpated with a finger on the outer side of the arm.
- **Iliocristale (ic)** – the most lateral point on the crest of the ilium (iliac crest) (on the superior outer edge of the iliac crest).
- **Iliospinale anterius (is)** – the most prominent point located at the anterior superior iliac spine. Palpated by tracing the iliac crest forward.
- **Stylion (sty)** – the most distal point of the radial styloid process of a relaxed arm. Palpated on the thumb side of the forearm (in the "anatomical snuff box", with the thumb extended).
- **Dactylion (da)** – the lowest point of a finger tip, when the arm is relaxed and hanging by the side. Typically, this concerns the dactylion of the middle finger.
- **Tibiale (ti)** – the topmost and most median or lateral point (on the inner or outer edge of the tibia) on the proximal (superior) end of the shin bone (tibia) that is in an upright position.
- **Sphyrion (sph)** – the point that is the most distal tip of the inner malleolus (malleolus medialis); the leg is in an upright position.
- **Pternion (pte)** – the most posterior point on the heel of the foot when the subject is standing.
- **Akropodion (ap)** – the most anterior point of the toe when the subject is standing (at the tip of the first or second toe).

Figure 2

Selected anthropometric landmarks of the trunk and extremities

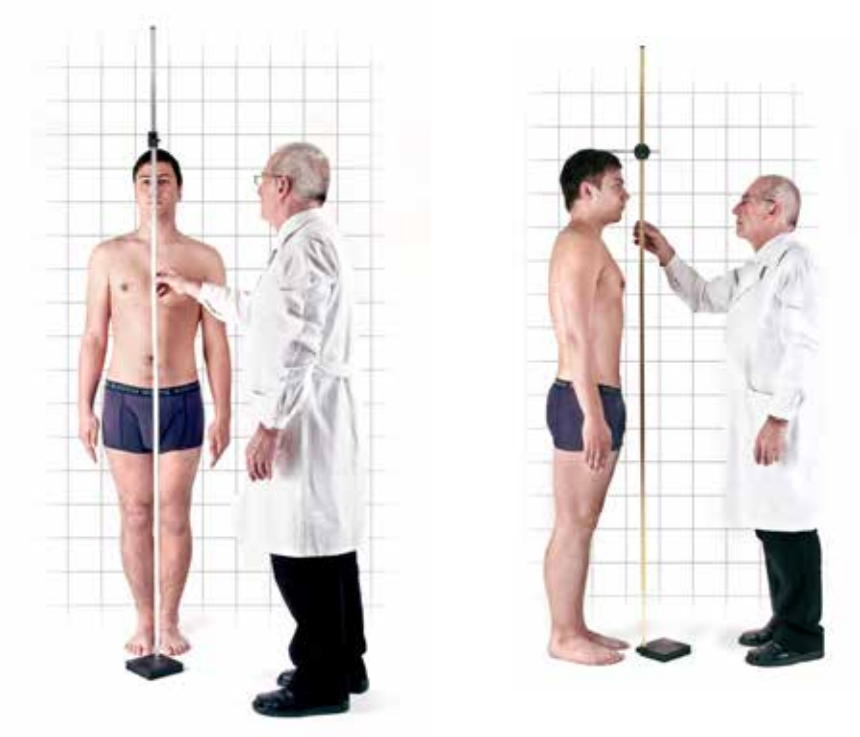


3 HEIGHT MEASUREMENT METHOD

→ Prior to measuring the height dimensions of the body, the barefooted subject (proband) assumes an active upright position which he/she maintains for the whole duration of measurements of this dimension group.
The subject stands with his/her back to a vertical wall (without baseboard). The heels, buttock, upper part of the back and usually, but not necessarily, the back of the head are in contact with the vertical wall (Figure 3). The subject is instructed to"look straight ahead" so that his/her head is in the Frankfurt horizontal plane, which ensures the desired position of the vertex landmark (the highest point on top of the head). Note: instruct the proband to look straight ahead at a point at eye level on the opposite wall of the room to prevent the subject from tilting his/her head back.

Figure 3

Basic position of the measured subject when measuring body height and other vertical dimensions

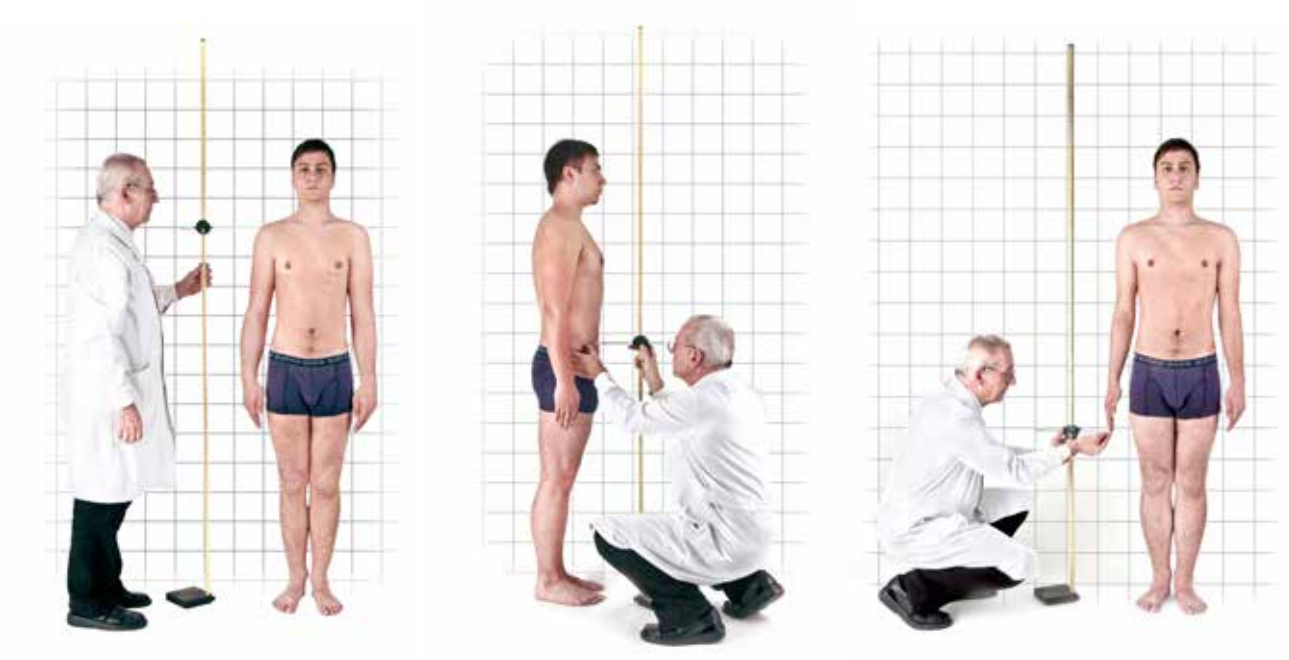


body height

body height

Figure 4

Use of the anthropometer in measuring vertical dimensions



height of acromiale point | height of iliospinale anterior point | height of dactylion point

→ The shoulders are in a natural position, i.e. relaxed (when determining the acromial point, some individuals tend to raise their shoulders), with arms lowered along the body, stretched at the elbow joint; the hand is aligned with the forearm, the fingers are together and stretched out.
When measuring the dactylion landmark, it is necessary to make sure the proband does not lean to the measured side (is not watching the tester).
Given that the length of the upper extremity is most frequently evaluated as a projective measure (i.e. the difference in the acromiale and dactylion heights), in order to obtain objective data it is absolutely essential that the subject strictly maintains the required position.

4 LENGHT, WIDTH AND DEPTH MEASUREMENT METHOD

→ Measurements carried out in this group of dimensions centre on the straight-line distance between the right and left anthropometric points (e.g. head width (Figure 5), biacromial (shoulder) width (Figure 6), transverse diameter of chest, biiliocristal width, biepicondylar width of the humerus and femur, etc.) and the anterior and posterior anthropometric landmarks (e.g. head length, sagittal diameter of chest).
Dimensions are calculated by subtracting the highest value observed when sweeping the instrument's arms (held in both hands at the end) across the relevant anthropometric landmarks.
When determining the pelvis width in obese or heavily muscular individuals, the tips of the instrument need to be pressed harder.

Figure 5

Using the spreading caliper to measure the length and width of the head and the width of the face

head length

head width

width of the face

Figure 6

Using the pelvimeter to measure the biacromial (shoulder) width and the sagittal diameter of chest

biacromial width saggital

diameter of chest

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5 GIRTH MEASUREMENT METHOD

→ Girth dimensions are measured using a soft metric tape.

→ **Chest circumference in the normal position** – in the back the tape measure runs directly below the lower angles of the shoulder blades, while in the front in men it goes directly above the breast nipples (thelion) and in women over the middle of the sternum (mesosternale).
The chest shifts to the normal position when the subject is asked a question.
The moment the subject replies, his/her chest is neither in the inspiratory or the expiratory position (Figure 7). To measure **the minimum and maximum chest circumference**, the tape remains in the same position and is tightened or relaxed.

→ **Arm circumference relaxed** – measured at the greatest protuberance of the biceps brachii (musculus biceps brachii), perpendicular to the axis of the arm, with the arm relaxed and hanging by the side, at the level of the mid-point between the acromiale point and the elbow´s tip (olecranon) (Figure 7).

→ **Arm circumference flexed** – measured at the same level as the arm circumference relaxed, with the maximum contraction of the flexors and extensors. The upper limb is bent at right angle at the elbow joint.

→ **Waist circumference** is measured at the narrowest point above the iliac crests, half the distance between the iliac crests and the lower edge of the ribs.

→ **Abdominal circumference** is measured at the level of the navel (omphalion) horizontally; abdominal muscles are relaxed.

→ **Gluteal circumference (hip girth, buttock girth)** – measured horizontally in a standing position with feet together, at the level of the greatest protuberance of the buttocks (over underwear or thin sportswear) (Figure 7).

Note: Do not confuse the above dimensions of waist circumference and abdominal circumference!

Figure 7

Measurement of chest circumference in normal position, arm circumference relaxed and gluteal circumference

■ chest circumference in normal position

■ arm circumference relaxed

■ gluteal circumference

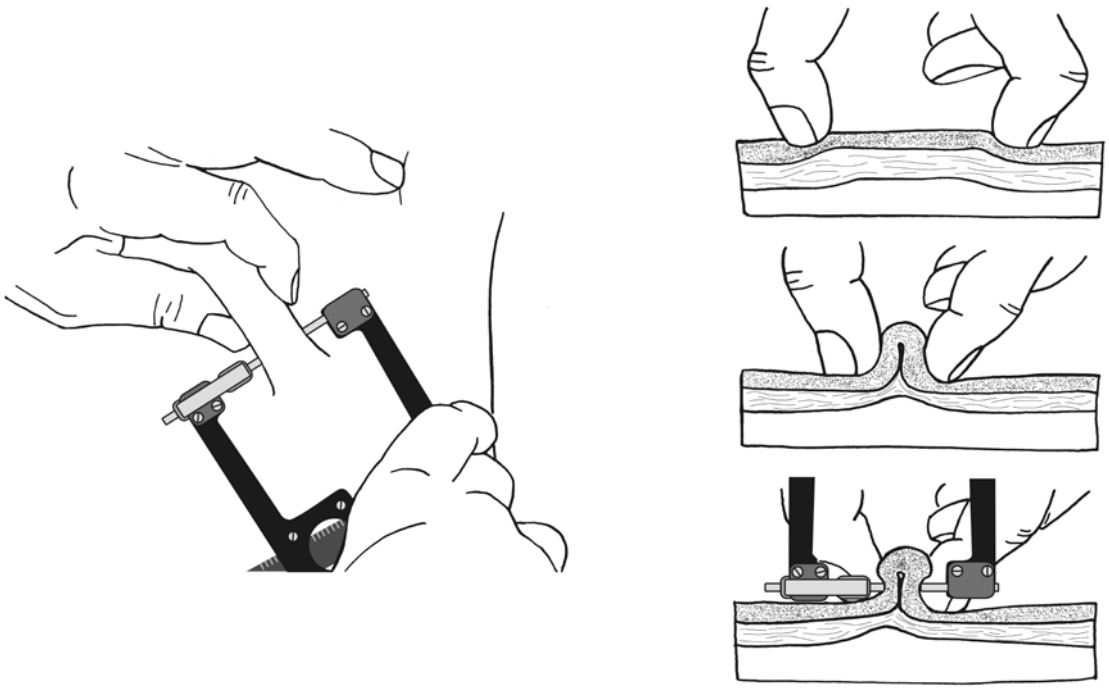
6

6 SKINFOLD MEASUREMENT METHOD

→ Skinfold thickness is measured at precisely specified locations on the right side of the body with an accuracy of 0.5 mm. The skinfold is lifted with the thumb and the index finger of the left hand pressing against each other: the skin is palpated and pinched to form a double layer of skin and the subcutaneous connective and adipose tissues (Figure 8). The caliper is held typically with the right hand. The measuring tips are then applied about 1 cm away from the fingers towards the fold base. The axis running through the caliper tips is perpendicular to the axis of the lifted skinfold; the calipers are applied flatwise relative to the surface of the body. The skinfold thickness is read on the caliper scale. (Figure 8).

Figure 8 .

Skinfold measurement method



Location of selected skinfold measurement landmarks

Skinfold landmarks on the right side of the body (Figure 9):

1. **Triceps skinfold** – the fold runs vertically; measured on the posterior surface of the arm above the triceps brachii muscle, half the distance between the bony tip of the shoulder (acromion) and the elbow joint (olecranon). The arm is relaxed, hanging by the side(Figure 10).
2. **Biceps skinfold** – measured at the anterior surface of the arm above the biceps brachii muscle, at the same level as the arm girth; the fold runs vertically; the arm is completely relaxed, with the palm of the hand facing forward (Figure 10).
3. **Volar forearm skinfold** – measured on the volar (palm) aspect of the forearm, where the girth is at its maximum. The arm is relaxed, hanging by the side.
4. **Subscapular skinfold (below shoulder blade)** – the fold runs slightly obliquely along the rib line; measured directly below the bottom angle of the shoulder blade (Figure 10).
5. **Abdominal skinfold** – the fold runs horizontally; it is lifted one third the distance between the navel and the anterior superior iliac spine, i.e. closer to the navel (Figure 10).
6. **Chest skinfold II** – the fold runs obliquely along the rib line; it is lifted at the intersection of the 10th rib and the anterior axillary line.
7. **Suprailiac skinfold** – the fold runs along the iliac crest; measured at the point of intersection of the crest and the anterior axillary line.
8. **Thigh skinfold** – the fold runs vertically at the anterior surface of the thigh, above the quadriceps femoris muscle; measured at half the distance between the trochanterion (greater trochanter) and tibiale landmarks; the subject stands with the feet slightly apart.
9. **Calf skinfold II** – measured in a seated position; the leg is resting on a pad so that the knee is at a right angle. The skinfold is pulled vertically on the medial (inner) side of the calf at the point of the maximum girth.

Figure 9

Skinfold measurement landmarks:

1 - triceps
2 - biceps
3 - volar forearm
4 - under shoulder blade (subscapular)
5 - abdomen
6 - chest II
7 - suprailiac
8 - thigh
9 - calf II

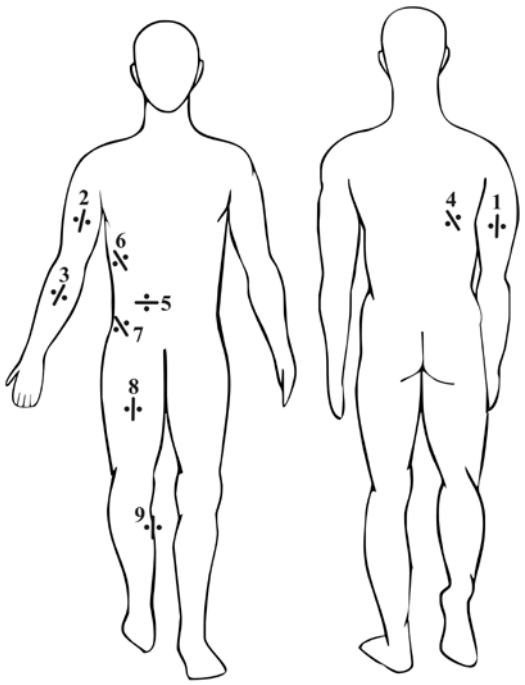


Figure 10

Measurement of selected skinfolds

triceps skinfold

subscapular skinfold

biceps skinfold

abdominal skinfold

7 ANTHROPOMETRIC MEASURING TOOLS

7.1 A–226 ANTHROPOMETER

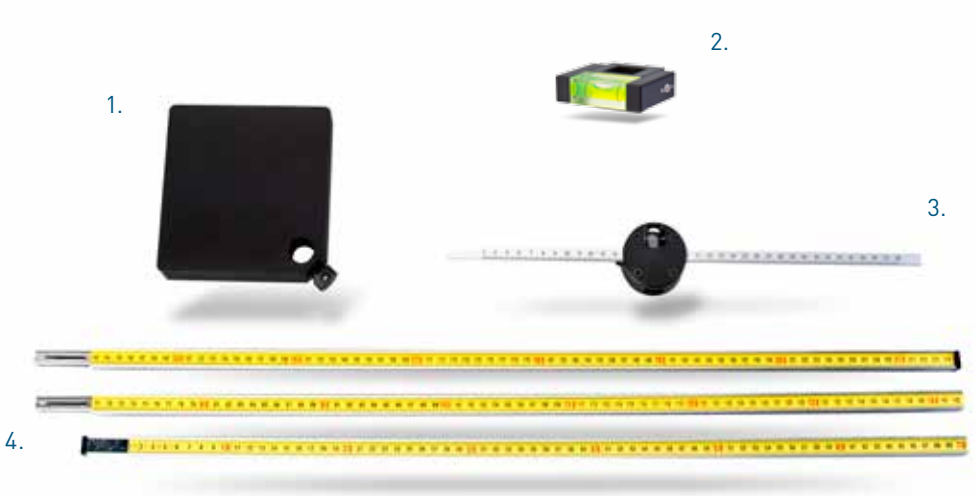
→ **Technical description (characteristics of the instrument)**

→ Designed to measure only the vertical dimensions of the human body (Figure 11), the instrument consists of three aluminium square profiles and a double sided measuring system with a reading scale from 50 to 2,133 mm. The long axis of the instrument is mounted with a telescopic round sleeve with a double-sided groove that features a dimension reading index. The sleeve is mounted with a sliding needle, whose tip is applied to the appropriate anthropometric point. The needle also features a millimetre scale (ranging from 30 to 380 mm) designed to read smaller dimensions. In order to ensure the anthropometer is perpendicular, the instrument may include a spirit level.

Technical data of the instrument:
measuring range: 50 to 2,133 mm, instrument weight: 1.2 kg, max folded length: 2,170 mm

Figure 11

A-226 Anthropometer



1 - stabilizer, 2 - level, 3 - needle with sleeve, 4 - instrument

7

→ **Anthropometer Stabilizer**

→ One of the basic prerequisites for determining the exact vertical dimension of the body is that anthropometer is in the upright position. This requirement may be difficult to meet, especially when measuring small dimensions. Therefore, the anthropometer is supplied with an "anthropometer stabiliser", a square plate made of durable plastic (140 mm x 140 mm), complete with a sleeve to attach the anthropometer base (Figure 12).

Figure 12

Use of the anthropometer in measuring vertical dimensions

acromial height

A-226 Anthropometer detail of a stabiliser and measuring needle

7.2 K–211 SPREADING CALIPER

Technical description (characteristics of the instrument)

The instrument is a combination of the "classic" spreading caliper and the "classic" pelvimeter, fitted with sliding arms and rounded ends and covering the range from 0 to 430 mm (Figure 13). The instrument may therefore be used to measure not only the dimensions of the head, but also selected body width or depth dimensions in children up to the age of about 15 (e.g. biacromial width, biiliocristal width, bispinal width, bitrochanteric width, transverse width of chest, biepicondylar width of humerus, biepicondylar width of femur) (Figure 14). Made of light stainless materials (weight of 182 g), this highly practical instrument, whose arms are connected with a steel joint (Figure 13), to improve the balance of the gauge, contains a removable magnifier for easier reading of the scale. The magnifier is fitted on the instrument slantwise, in the viewing direction (Figure 13).

Figure 13

K-211 Spreading caliper

spreading caliper – general view

spreading caliper – magnifier

spreading caliper – steel joint

Technical data of the instrument:

measuring range: 0 – 430 mm, instrument weight: 182 g

Figure 14

K-211 Spreading caliper – application

head length

width of the face

biepicondylar width of humerus

7.3 P–216 PELVIMETER

→ **Technical description (characteristics of the instrument)**

→ The instrument is a classic pelvimeter, range 0 to 500 mm, fitted with sliding arms and rounded ends. (Figure 16). It is predominantly used for measuring the width and depth dimensions of the adult population (Figure 16). Made of light stainless materials (weight of 215 g), this instrument, whose arms are connected with a steel joint (Figure 15) to enhance the balance of the gauge, contains a removable magnifier for better readability of the scale.
The magnifier is fitted on the instrument slantwise, in the viewing direction (Figure 15).

Figure 15

P-216 Pelvimeter

pelvimeter – general view

pelvimeter – magnifier

pelvimeter – steel joint

Technical data of the instrument:
measuring range: 0 – 500 mm, instrument weight: 215 g

Figure 16

P-216 Pelvimeter – application

shoulder width

saggital diameter of chest

biiliocristal width of pelvis

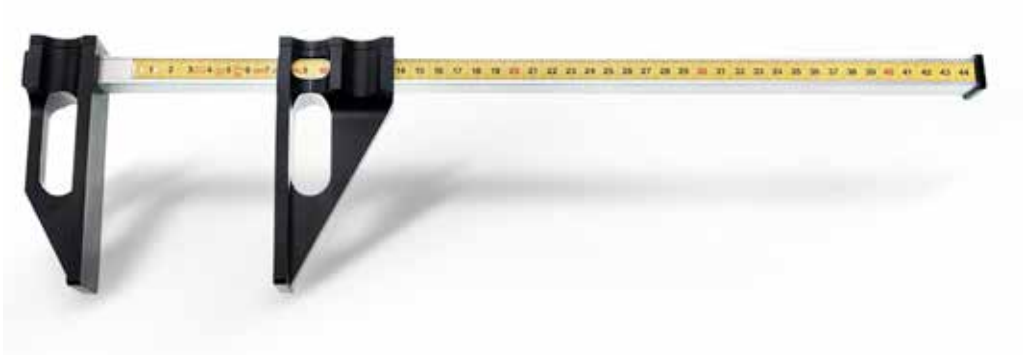
7.4 T–520 MODIFIED THORACOMETER

→ **Technical description (characteristics of the instrument)**

→ A modification of the "classic" Hrdlička's thoracometer, the instrument primarily serves for easy determination of the length of the foot (Figure 17). The device consists of an aluminium square section rod fitted on both sides with a millimetre scale (0 – 400 mm). The rod carries 100 mm long shoulders made of hard plastic. The width of the arms (30 mm) greatly facilitates the localization of the pternion and the acropodion.
A groove in the sliding arm enables reading the values from both sides of the instrument (to determine the length of both feet, simply turn the instrument over) (Figure 18). While measuring the foot length, the subject stands with his/her feet slightly apart, with the weight distributed evenly on both legs. The axis of the instrument is parallel to the inner edge of the foot, the bent toes need to be pressed against the floor.

Figure 17

T-520 Modified thoracometer



Technical data of the instrument:
measuring range: 0 – 400 mm, instrument weight: 260 g

Figure 18

T-520 Modified thoracometer – application in measuring the foot length

7.5 V–372 SMALL HEIGHT ROD

→ **Technical description (characteristics of the instrument)**

→ The instrument consists of a stand-alone height scale (20 to 106 mm), along which the head with a reading slot and a retractable tip move (Figure 19).
Due to the scope of its scale, the instrument is primarily designated to determine selected vertical dimensions of the lower extremity (e.g. sphyrion height) (Figure 20).

Figure 19

V-372 Small height rod

Technical data of the instrument:
measuring range: 20 – 106 mm, instrument weight: 220 g

Figure 20

V-372 Small height rod – application in measuring the sphyrion height

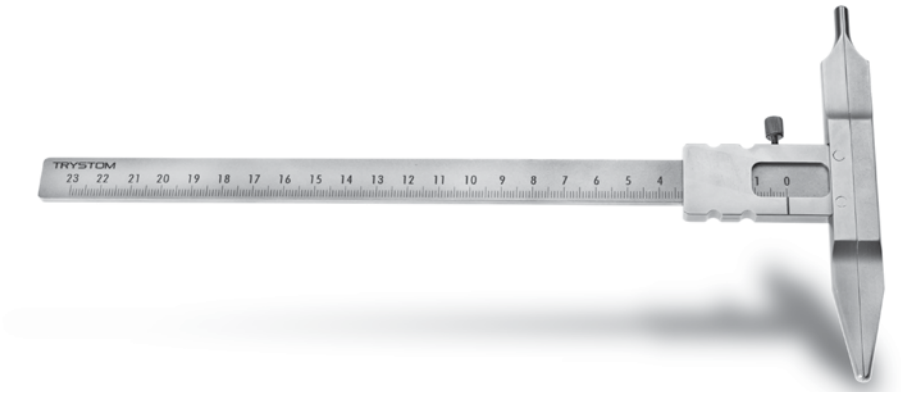
7.6 M–222 SLIDING CALIPER

→ **Technical description (characteristics of the instrument)**

→ A sliding caliper (Figure 21) featuring a double sided measuring scale from 0 to 230 mm and two measuring arms (with rounded and sharp ends). The slot of the sliding section (containing an arresting bolt) features a highlighted index that provides the measured value. Made from stainless steel with a matte finish, the instrument is designed to determine selected dimensions of the head (e.g. morphological facial height (Figure 22), nasal height and width, the distance between the inner/outer eye corners, lower jaw height, mouth width, physiognomical ear length, etc.), hand width, foot width, etc. The rounded ends serve for measurements carried out on live bodies, while the sharp ends are used for determining the dimensions of skeletal material. The instrument weighs 193 grams.

Figure 21

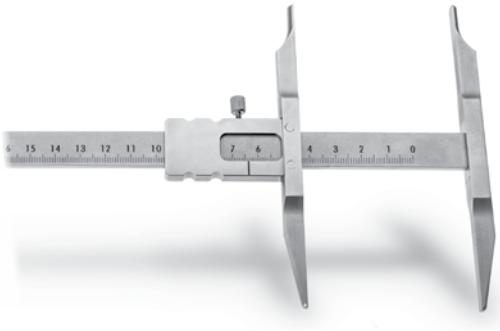
M-222 Sliding caliper

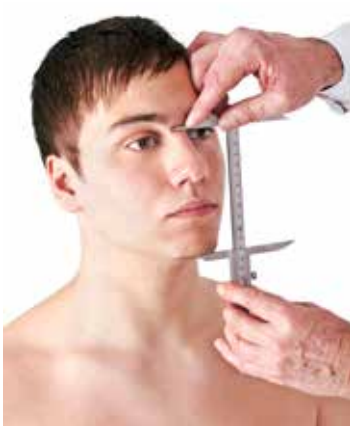


Technical data of the instrument:
measuring range: 0 – 230 mm, instrument weight: 193 g

Figure 22

M-222 Sliding caliper application





morphological height of the face

7.7 BEST II K–501 CALIPER

→ **Technical description (characteristics of the instrument)**

→ The modified BEST II K – 501 Caliper is designed for standard measuring of skinfold thickness (Figure 23).
The instrument has two arms, of which one is fixed to a 0 to 80 mm calibrated scale (note: the measuring range can be expanded to 120 mm upon request). The base of this arm features a circular opening for the index or middle finger. The other (sliding) arm with a slot for measurement of the skinfold thickness has a base with a larger circular opening for the thumb. Both the arms are fitted with 3 mm – diameter measuring circular tips.
The spring-loaded measuring tip on the sliding arm meets the pressure requirements of 2 N. The thickness of skinfold held between the measuring tips is measured when the index at the end of the sliding arm aligns exactly with the index on the body of the measuring tip (Figure 24). The equipment is supplied together with calibration weights that control the correct pressure in the tip of the instrument (Figure 23).

Figure 23

BEST II K-501 Caliper

general view

caliper calibration

detail of 2 N pressure setting

Technical data of the instrument:
measuring range: 0 – 80 mm (0 –120 mm), instrument weight: 273 g, measuring tip diameter: 3 mm, nominal compressive strength of the tips: 2 N, caliper dimensions: 142 x 116 x 10 mm

Figure 24

BEST II K-501 Caliper

7.8 SOFT METRIC TAPE

Technical description (characteristics of the instrument)

In measuring girth dimensions, the tape measure (Figure 25) needs to follow the girth accurately, i.e. adhere to the body and at the same time not compress the soft tissue. Girth dimensions (Figure 26) are determined with the help of a 1,500 mm measuring tape. It is recommended to add an extension loop (e.g. made from a thin string) to the tape measure to facilitate the dimension reading. The tape measure should undergo regular review for accuracy.

Figure 25

Soft metric tape

Technical data of the instrument:
measuring range: 1 – 1,500 mm, instrument width: 18 mm

Figure 26

Soft metric tape – application in girth measurement

chest circumference

arm circumference relaxed

gluteal circumference

8 ANTHROPOMETRY KIT

→ The shape and functioning of the kit are designed for safe storage and transportation of anthropometric measuring tools (Figure 27). The upper layer is made of waterproof fabric that is highly resistant to mechanical damage and requires minimal maintenance. The side walls are reinforced to ensure shape retention and impact resistance in the event of a fall, keeping the measuring tools safe from damage. The soft padded interior is divided into compartments that contain elastic bands to securely hold the instruments in place (Figure 28).

Figure 27

Anthropometry kit

List of instruments and equipment that the kit is designed for:

1. A–226 Anthropometer
2. K–211 Spreading caliper
3. P–216 Pelvimeter
4. T–520 Modified thoracometer
5. V–372 Small height rod
6. M–222 Sliding caliper
7. BEST II K–501 Caliper
8. Soft metric tape
9. Writing pad and data sheet (notepad) pocket
10. Pen pocket
11. Disinfectant pocket
12. Pocket for the "Instructions for Use of Anthropometry Measurement Tools"
13. Spare pocket

Figure 28

Bag with secured anthropometric measuring tools

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Anthropometric Measuring Tools and Methodology for the Measurement of Anthropometric Parameters

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