JÓZEF PIŁSUDSKI UNIVERSITY
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Anna Kopiczko, Monika Łopuszańska-Dawid,
Jakub Grzegorz Adamczyk,
Karol Gryko, Robert Gajda

KINANTHROPOMETRY - EXERCISE MANUAL

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INTRODUCTION

Research studies on the morphological determinants of motor skills fall within the field of interest of a relatively young discipline termed kinanthropometry. The name has its roots in the Greek words *kinein (to move), anthropos (human), and metrein (to measure).* The guide is an auxiliary material for conducting practical classes in the field of sport. The content of the guide is intended to show students what kinanthropometry is as a relatively new academic subject. Its purpose is to provide a set of reference methods for kinanthropometric diagnostics. Measurements are usually carried out using anthropometric methods and then used for analysis in the context of the effects of human movement activities.

The popularity of kinanthropometry is growing worldwide while it is used in many research areas, especially in physical culture and medical and health sciences. Kinanthropometry has applications in many fields including, for example, ergonomics, nutrition, healthcare, and injury prevention. Its goal is to gain a thorough understanding of the functioning of the human body by measuring its size, shape, proportion, and tissue composition in relation to health, physical activity, and motor performance. With the analysis of the relationship between morphological structure and motor effects, kinanthropometry contributes significantly to optimizing the training of athletes by reducing the risk of injury and development of appropriate therapeutic strategies. Studies conducted in children provide additional opportunities to identify, in the early stages of human development, their sports potential, whereas simultaneous tracking of changes over time in groups of non-athletes and athletes makes it possible to determine the impact of early sports training on the course of development and maturation. The practical part of the guide is organized so that it will be useful for future coaching work, independent scientific research, and undergraduate, master's, or doctoral theses. In all content, emphasis is placed on tests, protocols and procedures, data collection, data analysis, and correct interpretation of results.

Authors

1. BODY MEASUREMENTS IN KINANTHROPOMETRY

Anthropometry (somatometry and cephalometry) is one of the basic research tools in kinanthropometry. It deals with the measurement and description of the human body. It assumes that the dimensions of the human body are measurable biomarkers of its biological status. Kinanthropometry can be formally regarded as the study of the relationship between human structure and movement (figure 1).

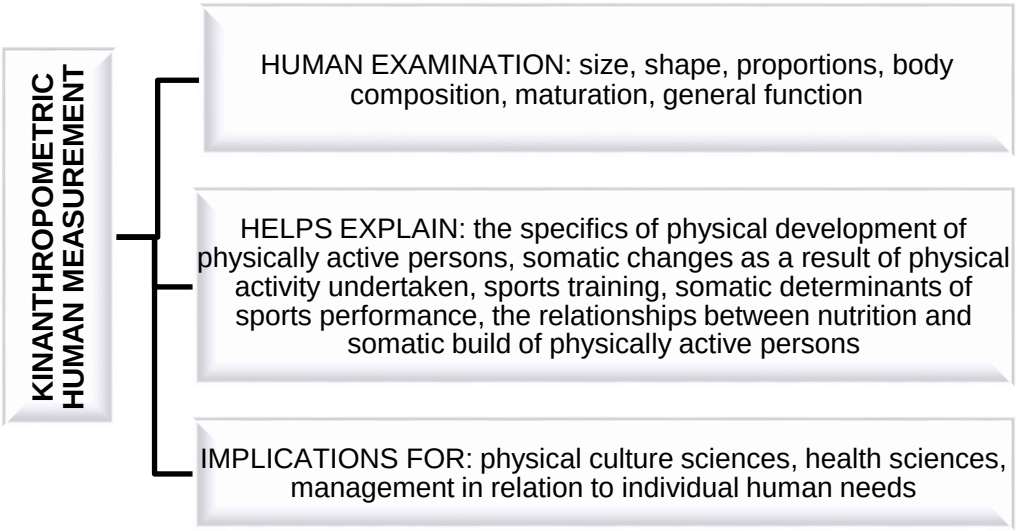

Figure 1. *Area and objectives of kinanthropometry.*

Kinanthropometry is generally defined as the study of size, proportion, maturation, body composition, and general body functions. Its purpose is to describe physical characteristics, assess and monitor growth, nutrition, and the effects of sports training.

When applied to sports, kinanthropometry provides tools for determining optimal fitness and identification of talented athletes. It can be said to be a tool for comprehensive morpho-functional assessment in physical education, medicine, physiology, and nutrition. The basis of kinanthropometry is the study of the dimensions of the human body and body movements.

The components of kinanthropometric diagnosis are:

1. The population to be measured.
2. The biological characteristics to be measured.
3. The instruments to take the measurements.
4. Standardization of measurements and methods.

Regular body measurements form the basis for the recruitment and selection of athletes for different sports. In team sports, they also facilitate the assignment of players to specific field positions. Finally, with the help of systematic body measurements of children, adolescents, and adults involved in professional sports, it is possible to assess the impact of physical exercise on the speed of development and changes occurring in the body and its individual components.

Based on anthropometric studies, sports anthropologists have identified the characteristics of the body structure of representatives of various sports. The most thorough analysis was made by the English scientist John Tanner (1964), who published a paper “Body structure of an Olympic athlete”. The author came to the conclusion that athletes of different sports have a specific body structure. Muscle tissue can be changed, while the proportions of the skeleton are constant. Better guidance when choosing a sports specialization is provided by models of somatic development.

In sports anthropology, there is another line of research in learning about athletic aptitudes. Sports aptitude is assessed based on differentiation into somatotypes. Somatotype changes due to physical development require a much longer time to observe individual development.

Body structure is one of the determinants of sports performance at the highest level. Morphological features can be one of the important selection factors. As a result of a study of athletes selected in various sports, a significant relationship was shown between body structure and achievement of high sports performance. In the analysis of morphological characteristics, certain characteristic proportions were observed, the direction and intensity of which are closely related to the sport practiced. If a certain type of body build is found in the majority of athletes representing a particular competition, these proportions can be considered to facilitate practicing certain movement patterns.

Sports anthropometry can be used in kinanthropometry to perform such tasks as:

a) measurements of the body in positions characteristic of particular sports, physical exercises,
b) evaluation of training-induced changes in body structure (hypertrophy, adaptive changes),
c) body measurements necessary for the selection of sports equipment and sportswear (helmets, clothing, ski length, etc.),
d) assessment of changes occurring in active tissues under conditions of immobilization caused by injury or trauma with a view to selecting appropriate compensatory exercises,
e) assessment of body symmetry and its changes, especially in asymmetrical sports (e.g. tennis, fencing).

Body structure is one of the important factors influencing sports performance and is an important component of the champion model. Body measurements make it possible to assess the differences in body structure between athletes and non-athletes. Differences in the physique of athletes participating in different sports are also critical.

Particularly important in the study of high-level sports are analyses of similarity in the physique of athletes practicing the same sport at the highest competitive level, as well as analysis of changes in physique induced by training. Learning about the physique of the top athletes in a given sport makes it possible to indicate the somatic physique patterns for particular sports.

1.1. Measurement instruments

Measurements used in kinanthropometry are made using classical anthropometric instruments and additional tools for measuring the range of motion. This is a set of standard measuring instruments with a certain accuracy of measurement (table 1).

Table 1. *Measurement instruments*

DESCRIPTION	Photography	SCALE, MEASUREMENT ACCURACY, APPLICATION
ANTHROPOMETER an instrument consisting of four parts with graduations in cm and mm, joined together (length from 2.00 m to 2.10 m) in a marked order and a movable needle, an arrow placed in the slide with which the measured height is set		The slider window, in which the reading is taken, moves along a graduated scale in 1 mm increments, progressing from the bottom to the top of the anthropometer. For height measurements, arm span, limb length, measurements of individual body sections, and height of individual anthropometric points. Accuracy: up to 1 mm.
STADIOMETER so-called wall gauge or stationary height gauge, featuring a wide measuring slide and heel positioner for accurate measurement. The built-in telescope makes it easy to read the result at eye level. Measures of this type are durable and sturdy but not portable		The gantry, seen in the photo, slides along the gauge. Used for measuring body height and sitting body height. Measurement up to 2.10 m. Accuracy: up to 1 mm.

SMALL SPREADING CALIPER/ LARGE SPREADING CALIPER consists of two bent arms and a scale perpendicular to them		Measurements of body diameters (e.g. width of shoulders, chest) and limb segments. Measurement range of 50/60 cm (with a large caliper), and up to 30 cm (with a small one). Accuracy: up to 1 mm.
METRIC TAPE/ ANTHROPOMETRIC TAPE - metal or plastic (ceramic)		Tape measures are used to measure body circumferences, distances between anthropological points, and, in the sports of disabled subjects, as well as body sections. The scale on the tape includes centimeters and millimeters. Accuracy: up to 1 mm.
SLIDING CALIPER consists of a longer arm, with a length of 25-30 cm, and two short arms perpendicular to the longer one, one of which is movable and determines the zero point of the instrument		It is used to measure the width and length of the hands and feet, as well as other small somatic measurements, such as the width of the nose, and eye crevice. Accuracy: up to 1 mm.

SKINFOLD CALLIPER It is used to measure the thickness of skinfolds. Its main feature is a constant pressure specified in g/mm2 of the jaw area		Depending on the manufacturer, there are fold gauges with different measurement accuracy, most often from 0.01 mm to 0.5 mm.
GONIOMETER - used to measure the range of motion in the joints. **a) Plastic,** transparent goniometer. It consists of a 360° rotating head and moving and stationary arms.		Plastic goniometers allow measurement on a scale from 0° to 360° in 1° increments. Goniometers differ in the size of the measuring arms and the type of graduation, depending on the area whose range you want to measure.
b) metal, for measuring small joints		Metal goniometer most commonly used with a length of 17-35 cm, measuring range of 18°, and measuring scale of every 1°.
c) digital		

d) multimedia applications **e) laser**	 	
INCLINOMETER - used to measure the range of motion and curvatures of the body, allows measurement of flexion and extension of the spine in the sagittal plane, measurement of the amount of kyphosis and lordosis, and the range of motion in other joints.		Measurement on a scale from 0° to 360°. Reading the range of motion (in degrees) is possible directly from the dial. Accuracy: up to 1°.

The procedures used in organizing anthropometric measurements include both the requirements for the person performing measurements and the person being measured. A distinction is made between direct and indirect body measurements:

direct measurements - the result is read from the measuring instrument,

indirect measurements - the result is calculated from direct measurements.

All unilateral measurements are taken on the left side of the body. In order to avoid so-called individual measurement errors, each measurement should be repeated twice. In the study of body asymmetry, measurements are taken on both sides of the body.

1.2. Measurement technique in kinanthropometry

Measurements are performed according to the classic Martin technique. The technique was developed by Rudolf Martin (1928), with some measurements being refined in subsequent years (Godycki, 1956; Martin and Saller, 1957; Malinowski and Bożiłow, 1997). Among the most important rules for taking measurements are:

- Before taking measurements with a particular instrument, its zero point should be checked so that the reading is taken at the correct location.
- The person being measured should be undressed (in underwear only) and anthropometric points should be marked (e.g. with markers) on his or her body.
- Measurements in sports (especially body circumference and skinfolds) should not be taken immediately after training or sauna-type wellness, as they can be subject to error and do not reflect adequate body dimensions.
- Before each measurement, the measured person should be placed in the correct body position, with great attention paid to the positioning of the head (in standing positions: evenly weighted, joined, and straightened lower limbs; in sitting positions: correct positioning of the back and lower limbs).
- In the course of taking several consecutive measurements, the position of the person being measured must not change.
- Unilateral measurements are taken on the left side of the body, as recommended by the International Biological Research Program (Weiner and Lourie, 1969). Measurements on both sides of the body, e.g., for assessing asymmetry in sports, are made according to the general procedure at points based on the mirror image.
- Measurements are recorded with the accuracy of the instrument.
- In sports, measurements are taken both as part of ongoing and periodic diagnostics (before the period of competitions, after it, before the preparatory period, and after breaks due to injury; this is especially true for body circumferences and skinfolds).

- Anthropometric posture: the person being measured should be in the correct position. They should remove their shoes, straighten the body, put their feet together, and place the upper limbs freely along the torso. The Frankfurt plane should be maintained in the alignment of the head (horizontal auricular-orbital plane) (figure 2).

The horizontal Frankfurt plane is the standard head or skull position used in physical anthropology. The examiner must position the subject's head so that the plane passing through the lowest point on the lower edge of the left orbital cavity (anthropometric point *orbitale*) and the highest point on the upper edge of the external auditory meatus (anthropometric point *tragion*) are parallel to the ground. Only when the head is correctly aligned in the horizontal Frankfurt plane will the highest point on top of the head, or *vertex*, be correctly determined.

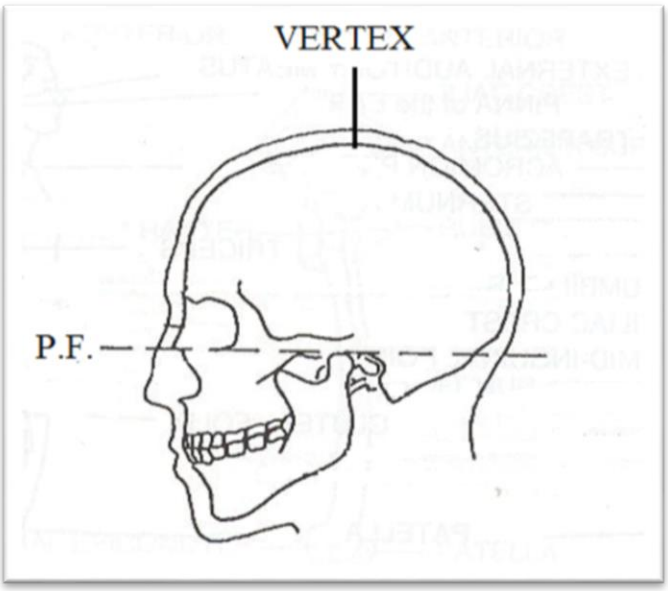

Figure 2. *The Frankfurt plane (FP) (Cameron, 2004).*

Taking correct somatic measurements requires a good knowledge of **the topography of anthropometric points** (figure 3) on the human body. Anthropometric points are precisely defined locations on the human skeleton or body. The distances between them or between them and the ground (base) are called anthropometric measurements.