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Original Article

Estimation of anthropometric parameters of track and field athletes at different stages of long-term preparation

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Abstract:
Purpose: estimation of anthropometric parameters in athletes on different stages of -term preparation.
Material: 53 sportsmen participated in the study. Absolute and relative anthropometric parameters were analyzed: body mass index, linear (longitudinal, transverse, anterior-posterior), thickness of the skin-adipose folds, proportional indices and component content of the body.
Results: in the conducted study an average body mass of young men was 69,9±8,4 kg, and in girls – 53,8±7,6 kg. An average parameter of the length of the lower limb in runners on the stage of a specialized basic training is 94,04±1,41 cm, while the parameter of the leg length in sportsmen on the stage of training to higher achievements is 3,47±5,1 cm, and on the stage of maximal realization of individual possibilities – 95,94±1,03 cm. We conclude that better competitive results are achieved by the sportsmen, running on middle distances, as they have less body mass. The athletes with longer limbs (the athletes on the stage of maximal realization of individual possibilities – 95,94±1,03 см) achieve higher sport results.
Conclusions: To achieve a high speed of running by distance those training means and methods should be used which promote increase of the step length with maintenance of high frequency values.
Key words: track and field athlete, physical development, anthropometry.

Introduction

Anthropology as a science has undergone rapid development for the late century. One of its branches is medical anthropology, which enables to characterize morphological-functional development of the organism of a modern man. An objective estimation of anthropometric parameters is not possible to perform without regular data updating obtained in case of massive measuring within the limits of every from generally accepted age, ethnic territorial groups. Similar measures are required to review the suggested standard tables and diagrams to detect the level of physical development (Korobeynikov & Korobeynikova, 2002; Kondravev, Chaplygina, Kharlamov, 2008). Such external factors as sex, age, condition of the internal body systems, heredity have an active effect on the parameters and indices of physical development (Syrova, 2008: Kozina, Sobko, Bazilyuk, Ryepko, Lachno & linitskaya, 2015; Ivashchenko, Khudolii, Yermakova, Iermakov, Nosko & Nosko, 2016).

Going in for professional kinds of sport also has its impact on the formation of level of physical development and figure type (Korobeynikov, Rossokha, Koniaeva, Medvedchuk & Kulinich, 2005). A considerable number of works deal with the study of anthropometric parameters in athletes going in for different kinds of sport, and track and field events in particular (Lezhniova, Kyrychenko & Stefanenko, 2012; Kemmler, Engelke, Baumann, Beeskow, von Stengel, Weineck, & Kalender, 2006; Lezhniova, Sarafyniuk & Stefanenko, 2011; Khimenes, Lynets, Yuriy, Maryan, & Galan, 2016; Knechtle, Wirth, Knechtle, 2010). Examination of anthropometric data will enable to make a qualitative selection of athletes on every stage of their training for many years. Athletes, who have higher anthropometric data, can be recognized as the most promising ones.

Purpose: estimation of anthropometric parameters in athletes on different stages of -term preparation.

Materials and methods

Participants.

Anthropometric parameters were estimated on the base of National University of Physical Education and Sport of Ukraine. The 53 athletes were participated in the study. All the examined sportsmen were divided into three groups: the first 15 athletes on the stage of specialized basic training; the second group 28 athletes on the stage of training to higher sport achievements and the third group 10 athletes on the stage of maximal realization of individual possibilities.

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Anthropometric examination included performing individual anthropometric measuring. Anthropometric parameters were detected by means of a standard set of anthropometric instruments undergone a metric control. Paired anthropometric sizes were detected on the right side of the body. Absolute and relative anthropometric parameters were analyzed: body mass index, linear (longitudinal, transverse, anterior-posterior), thickness of the skin-adipose folds, proportional indices and component content of the body. All the results of collecting anamnesis and anthropometric examination were written into the protocol of examination and processed by means of variation-statistical methods.

The following indices were calculated:

- Body mass index (Quetelet index);
- index indicating the ratio between the length of the lower limb and height:

$$I_1 = 100 \frac{\text{lower limb length}}{\text{height}};$$

- index indicating the ratio between the femoral length (or shin) and the length of the lower limb:

$$I_2 = 100 \frac{\text{femoral length (shin)}}{\text{lower limb length}};$$

To detect an absolute amount of muscular component the following formula was applied:

$$M = L * R^2 * K,$$

where L – body length, cm;

R^2 – the square of the mean of the circumferences of distal part of the shoulder, upper arm, femur and shin;

K – constant equal 6,5.

A relative amount of the muscular tissue was found in the following way: (M/P) *100, where P – body mass, kg. To detect an absolute amount of muscular component the following formula was applied:

$$M = L * R^2 * K,$$

where L – body length, cm;

R^2 – the square of the mean of the circumferences of distal part of the shoulder, upper arm, femur and shin;

K – constant equal 6,5.

To detect an absolute amount of the bone component in the body mass the following formula was used:

$$I = L * O^2 * K,$$

where I – absolute mass of the osseous tissue, kg;

L – bodylength, cm;

O^2 – the square of the mean of the circumferences of distal part of the shoulder, upper arm, femur and shin;

K – constant equal 1,2.

The interrelation of the detected morphological-functional signs was studied according to the sex and success of sport activity. The correlation analysis was conducted for this purpose. Close relation between the examined parameters and better results in running on 100 meters in the group of athletes sprinters and best result on 1000 meters in the group of athletes running on middle distance were estimated.

Statistical Analysis.

Statistical analysis was used by Statistica-6 programs. Experimental study was approved by the Ethics Committees for Biomedical Research of National University of Physical Education and Sport of Ukraine with accordance the ethical standards of the Helsinki Declaration.

Results

In the conducted study an average body mass of young men was 69,9±8,4 kg, and in girls – 53,8±7,6 kg. An average body mass of the young men was 24,2% reliably higher than that of the girls ($P < 0,01$). The young men also had higher values of linear anthropometric parameters ($P < 0,01$). In particular, average values of the body length in the examined sample of young men on the training stage to higher achievements(178,12±0,58 см) were 7,6 % more than the body length of the girls (164,52±0,46 см). At the same time, variability of the body length was not high: 3,9 % and 3,7 % for the boys and girls respectively. Having calculated Quetelet body mass index we can say that all the sportsmen had body mass within the norm (Table 1).

Table 1. Characteristics of body mass parameters of the examined groups of athletes

Groups	Body length, cm	Body mass, kg	Quetelet index
I	175,72±2,87	59,89±9,25	19,5
II	171,89±2,08	67,17±3,18	22,7
III	176,23±1,64	64,65±2,13	20,9

Athletes sprinters were characterized by a bigger body mass as compared with the athletes running on middle distances. The result of the correlation analysis has found that the less the body mass of an athlete is, the better his competitive result is. Therefore, we can conclude that anthropometric data (especially body mass) are of a great value in the development of speed at the start and its increase in the process of covering the distance. The sizes of the extremities also affect the technique and speed of running. Thus, the athletes with longer extremities, acting like levers, achieve higher sport results, which is proved by our studies: an average parameter of the length of the lower limb in runners on the stage of a specialized basic training is 94,04±1,41 cm, while the parameter of the leg length in sportsmen on the stage of training to higher achievements is 3,47±5,1 cm, and on the stage of maximal realization of individual possibilities – 95,94±1,03 cm (Table 2).

Table 2. Longitudinal sizes of the upper and lower limbs of athletes of various level of training

Parameters, cm	I group	II group	III group
the length of a free part of the upper limb	77,11±1,24	73,79±0,92*	77,48±0,69**
shoulder	29,87±0,54	31,45±0,38	33,29±0,51*
upper arm	25,96±0,78	24,66±0,49	24,35±0,31
hand	18,62±0,37	18,67±0,43	19,42±0,36
the length of a free part of the lower limb	94,04±1,41	93,47±1,59	95,94±1,03
femur	44,54±0,75	48,88±1,42	49,87±0,99*
shin	41,87±1,01	35,93±0,84**	40,63±1,31
legs from the head of the femur	85,5±1,59	85,99±1,38	88,65±1,34
general length of foot	24,74±0,39	25,44±0,40	26,77±0,36

Note: * – $p < 0.05$, comparing with the I group, ** – $p < 0.05$, comparing with the II group

The ratio between the length of the femur, shin and the length of the lower limb should be especially considered for athletes-runners. Long levers increase additional power to the ground and therefore, the speed of running and amplitude of the step.

According to the data obtained an average value of the lower limb index (I1) in sportsmen of a basic level is 53,9±1,9, which is indicative of the fact that a subject has a relatively short lower limb (I1 < 55). In the athletes from the III group – 55,4±1,8, that characterizes the lower limb as a long one. The index indicating the ratio of the femoral length to the length of the whole lower limb (I2) in the I group is 46,8, and the shin to the whole lower limb – 45,1; while in the III group – 49,7 and 47,3 respectively, which is indicative of a longer femur and shin in the group of athletes being on the stage of maximal realization of individual possibilities. The presented data are indicative of the fact that body sizes and their ratio promote achieving better port results.

A component content of the body is an important factor of the morphological status of athletes. The index of an absolute amount of muscular component in the I group of athletes is 31,5±1,3, and in the II group – 31,4±1,0, in the III group – 32,3±1,1. In the group of athletes on the stage of a specialized basic training the index of the muscular component was 49,2±0,7%, in the II group – 50,7%±1,3, in the III group – 51,9±0,9 from the body mass. The values of the muscular mass in girls were found to be close to those of the men, but sex differences in the in dices of adipose component were preserved. In girls of the I and III groups the absolute index of the adipose component is 16,5±0,9 and 14,7±0,8 (24,5±0,9% and 24,0±0,8% from the body mass), in young men the index of the adipose mass is 11,6±1,2 and 10,7±0,9 (14,4±0,9% and 13,1±0,2%) respectively. The amount of muscular mass in athletes running on middle distances was higher and it was 63,0 ± 5,3 (against 52,6 ± 3,03 in sprinters).

The amount of the adipose tissue was less (10,3 ± 0,9 and 12,4 ± 0,8 respectively). The ratio of the adipose and muscular component sin athletes is an important morphological sign influencing on the development of physical qualities. Statistically reliable differences between the indices of the skin-adipose folds thickness in sportsmen of all the examined groups were not found (Table 3), although, the phenomen on of rather large thickness of folds was found especially on the lower limbs. The above mentioned interrelation between the level of professional training with characteristics of the thickness of the skin and subcutaneous layer is also indicative of a positive influence of regular sport training on the condition of the skin and its slow age thinning. The results of the study showed that going in for running for many years have a positive influence on the condition of the skin of athletes, and the skin thickness is a marker of certain morphological peculiarities of athletes.

The osseous component in the body mass of athletes on the stage of a specialized basic training was found to be 13,7±0,4%, and in the group of athletes being on the stage of training to higher achievements – 12,4±0,33%; and in runners having achieved maximal realization of individual possibilities – 13,3±0,3% from the body mass, which is indicative of an average content of the osseous component in all the examined groups.

Table 3. Parameters of the skin-adipose folds of athletes of different levels of training

Parameters, cm	I group	II group	III group
Anterior surface of the houlder	0,68±0,11	0,50±0,05	0,66±0,07
Posterior surface of the shoulder	0,72±0,06	0,83±0,08*	0,81±0,06*
Upperarm	0,47±0,03	0,53±0,07	0,53±0,04
Hand	0,31±0,02	0,29±0,03	0,31±0,01
Abdomen	1,13±0,08	0,87±0,09**	1,16±0,09*
Inguinal	0,75±0,05	0,54±0,05*	0,68±0,04
Axillary	0,76±0,07	0,56±0,08*	0,71±0,08
Subscapular	1,04±0,09	0,94±0,07	1,10±0,08
Femur	1,16±0,11	1,19±0,09	1,34±0,09*
Shin	1,18±0,10	1,07±0,13	1,18±0,09

Note: * – $p < 0.05$, comparing with the I group, ** – $p < 0.05$, comparing with the II group

Discussion

The comprehensive characteristics of abilities of athletes-runners are based on their anthropometric features (height, weight, main body proportions), depends from degree of development of their most important physical qualities and from the main biodynamic peculiarities of running (Knechtle et al, 2009, 2010).

The priority of this study is in the estimation of anthropometric values of athletes at different stages of long-term preparation. It is extremely important considering the fact that body sizes and their proportions promote achieving better results in sport (Mooses et al, 2013). Having detected absolute and relative anthropometric parameters we have found that an average body weight of youngsters is reliably 24,2 % ($P < 0,01$) higher than that of girls. Among all the anthropometric parameters the body mass is of special importance in the process of passing the distance which contradicts the statement (Korobeynikov, Korobeynikovs, 2015) that body weight does not influence considerably upon the results of a runner for 100 meters, at the same time the parameters of power and speed are determinative in sprint. The size of extremities also influence on the technique and speed of running – on the stage of maximal realization of individual possibilities (95,94±1,03 cm) athletes get higher sport achievements that corresponds to the findings of the well-known studies (Gamble, 2006; Platonov, 2013). Note that the runners with different morphological qualities can achieve maximal speed in different ways. On the stage of maximal realization of individual possibilities is registered a long length of steps in athletes (due to longer length of the lower extremities) and less frequency of steps in athletes on the stages of specialized basic training and training to higher achievements. Our study has found that increase of running speed is in directly proportional to an average length of the step in running, and this dependence increases with the class of a sportsman. Therefore, to achieve a high speed of running by distance those training means and methods should be used which promote increase of the step length with maintenance of high frequency values.

Conclusions

1. Among all the anthropometric parameters the body weight was found to be of an especially importance for the development of the speed at the start and its increase in the process of covering the distance. An average body mass of young men was reliably 24.2 % higher of that of the girls ($P < 0,01$). Better competitive results are achieved by the sportsmen, running on middle distances, as they have less body mass.

2. The sizes of the limbs influence on the technique and speed of running. The athletes with longer limbs (the athletes on the stage of maximal realization of individual possibilities – 95,94±1,03 см) achieve higher sport results.

3. The analysis of the component content of the body has found that the biggest index of the muscular component amount (51,9±0,9) and the index of the absolute amount of the muscular component (32,3±1,1) is characteristic for the III group of sportsmen. An average content of the osseous component was found in all the examined groups. In girls-athletes sex differences are more pronounced in the indices of adipose component. In the girls from the I and III groups the absolute index of the adipose component mass is 16,5±0,9 and 14,7±0,8 (24,5±0,9% and 24,0±0,8% from the body mass), in young men the index of the adipose mass is 11,6±1,2 and 10,7±0,9 (14,4±0,9% and 13,1±0,2%).

4. Statistically reliable differences between the indices of the skin-adipose folds thickness in sports men of all the examined groups were not found.

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