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ASSESSMENT OF PHYSICAL DEVELOPMENT OF PRIMARY SCHOOL AGE CHILDREN ENGAGED IN KYOKUSHIN KARATE

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Annotation. To date, there are contradictions in science and practice between the demands of modern sports in the intensification of sports loads for successful performance at competitions and the preservation of health and harmonious development of young athletes. The search for a balance between these two issues lies in the plane of studying the physiological features of adaptation of the athlete's body to specific muscle loads, which served as the basis for this study. The aim of the study was to examine the morphotypological features of primary school age children engaged in Kyokushin karate. With the help of anthropometric methods and caliperometry, to determine the characteristics of the physical development of primary school age children engaged in Kyokushin karate and to identify morphological selection criteria at the stage of sports improvement, the indicators of 58 primary school age children were studied (8 boys aged 7 years, 5 at the age of 8 and 9 years, 20 at the age of 10 and 11 years). The length and mass of the body, total and partial body dimensions, as well as the thickness of subcutaneous fat folds were determined with the identification of body types. The proportions of the body were established according to the classification of P.N. Bashkirov based on the percentage ratio of the longitudinal and transverse dimensions of the body to its length. The assessment of physical development showed that as young athletes grow and develop, there is a harmonious development of the physique with a predominance of dolichomorphic and dolichomesomorphic body proportions, a change in the component composition of the body towards an increase in the muscle component, which indicates adaptive changes in the body composition to systematic physical exertion. The degree of physical development of the examined young athletes corresponds to the morphophysiological norms of the development of children of these age groups. In the studied contingent, physical development is quite active, which allows them to implement complex psychomotor acts necessary for success in their chosen sport, i.e. Kyokushin karate.

Introduction. Physical development (PD) is one of the criteria for children's health [1-2]. In a broad biological understanding, physical development is the growth and formation of an organism, including the tempo, stages and critical periods of its maturation, adherence to genetically determined species programs, individual variability, maturity and connection with external and internal environmental factors [3-4]. Physical development depends not only on the genetic predisposition, but also on a number of external factors: the environmental situation, climatic and geographical, socio-economic, sanitary and hygienic living conditions, as well as nutrition and physical activity [5-8].

The leading parameters reflecting the state of physical development of children and adolescents are rightfully considered to be the length and mass of the body. Body length characterizes the growth processes of the child's body, mass indicates the development of the musculoskeletal system, subcutaneous fat and internal organs [3]. Physical development is an external integral manifestation of the adequacy of the processes of growth and development, especially with intense physical loads during sports. Any manifestations of significant deviations from the norm in physical development indicate a relative disadvantage in the state of health of the individual.

Currently, as an additional assessment of the PD of children, the index method is widely used, which is the ratio of individual anthropometric features expressed in mathematical formulas [3, 8, 9, 10, 11, 12]. They are used to characterize the group and age ratios of individual body dimensions during growth [13]. Being additional criteria of physical development, they allow us to compare the studied groups and take into account the relationships between the characteristics.

The use of data on physical development and systematic observations of children engaged in Kyokushin karate, in combination with data from other studies, will allow us to more accurately assess the impact of a given training load, the dynamics of recovery processes, the degree of physical performance, as well as the functional state of the child as a whole.

Methods and organization. All studies were conducted in compliance with the bioethical requirements for conducting research, based on the recommendations of the Helsinki Declaration of 1964. The study involved 58 children of primary school age engaged in Kyokushin karate. Of these, 8 boys aged 7 years, 10 – at the age of 8 and 9 years, 40 – at the age of 10 and 11 years. The examined children were characterized by the middle social status of the family, approximately the same type and balance of nutrition, the number and duration of the training process, the absence of chronic diseases. To obtain data on the

morphotypological status of the studied categories of children, the parents' informed consent for the examination was obtained.

The anthropometric and caliperometric methods were used in the work [2]. The study consisted in determining the length and weight of the body, total, partial body size, as well as the thickness of subcutaneous fat folds. To assess body types, the indices recommended by WHO (1997) were used: "Weight/Age" (WAI), "Height/Age" (HAI), body mass index (BMI), Rohrer index, Vervek-Vorontsov index [2, 10]. The proportions of the body were determined according to the classification of P.N. Bashkirov based on the percentage ratio of the longitudinal and transverse dimensions of the body to its length [2]. Statistical data processing was carried out using the Statistica 10.0 program, the reliability of the differences was discussed at a 5% significance level.

Results and discussion. Using an anthropometric approach to the study of the physical development of primary school age children engaged in Kyokushin karate, data on the component and overall composition of the body of this age group were obtained. The evaluation of all the studied parameters revealed a positive dynamics of their increase as children grow older.

It was found that the average body length in 7-year old boys was $122,1 \pm 5,9$ cm, in the age group of 8-9 years, this indicator varied in the range of $134,6-137 \pm 3,32$ cm. In 10-year old athletes, the average body length was in the range of $142,8 \pm 3,54$ cm, and in the 11-year old group – $149,7 \pm 7,97$ cm. At the same time, the coefficients of variation were different for different ages (fig. 1). Thus, the minimum coefficient of variation in young athletes was noted at 9 years ($V=1,53\%$), and the maximum – at 11 years ($5,19\%$). The studied indicator for young karatekas (7 years old) did not differ statistically from the data of 11-year-old children, but it was 3 times higher than in children at the age of 9. There were also no statistical differences in 8- and 9-year old karatekas, while the coefficient of variation in 8-year olds was 2,7 times lower than in 11-year olds. The coefficient of variation among young athletes at the age of 10 was $2,48\%$, which is 1,6 times higher than the data of 7-year old karatekas and 2,1 times lower than the indicators of 11-year-old athletes.

It was revealed that the dynamics of body mass gain has a smooth increasing trend with a maximum absolute value at 11 years (fig. 1). The level of intragroup variation of body mass has higher indicators.

The range of body mass values in the group of 9-year old boys was 29,0-33,0 kg with a minimum coefficient of variation ($V=3,35\%$). Whereas in 11-year old boys this indicator ranged from 29,0 to 65,0 kg, and the coefficient of variation was equal to $V=22,07\%$. A high coefficient of variation in body mass was also characterized by 10-year-old athletes ($V=21,6\%$). Eight-year-old boys had an

average body mass of $25,8 \pm 1,7$ kg, and the coefficient under consideration was 2 times greater than the minimum value. The body mass in the group of 7-year old boys ranged from 16,0 to 22,0 kg with a coefficient of variation $V=9,85\%$, which is 3 times higher than in 9-year old children.

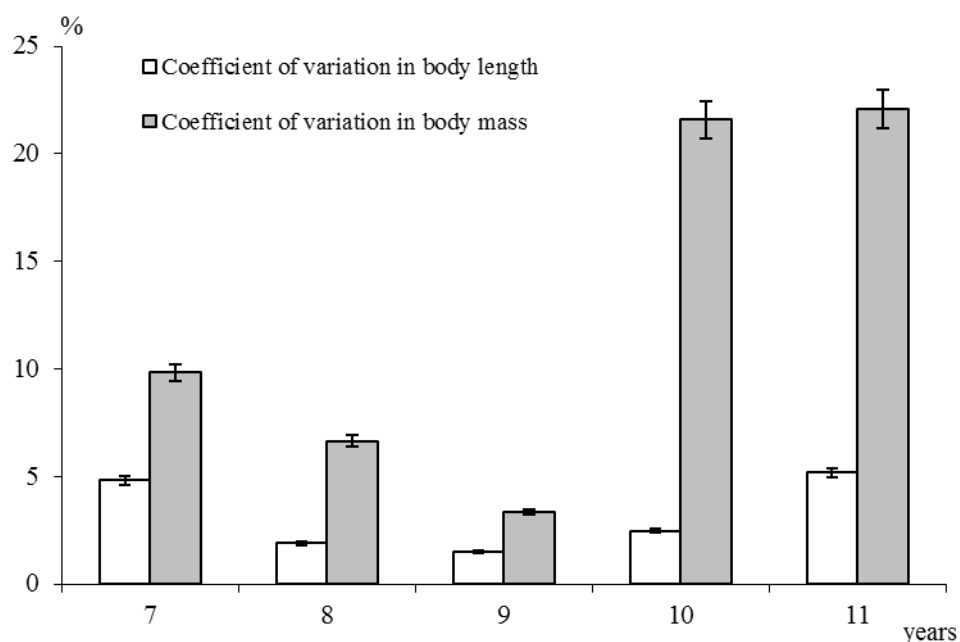


Fig. 1 Coefficients of variation in body length and mass of primary school age children engaged in Kyokushin karate

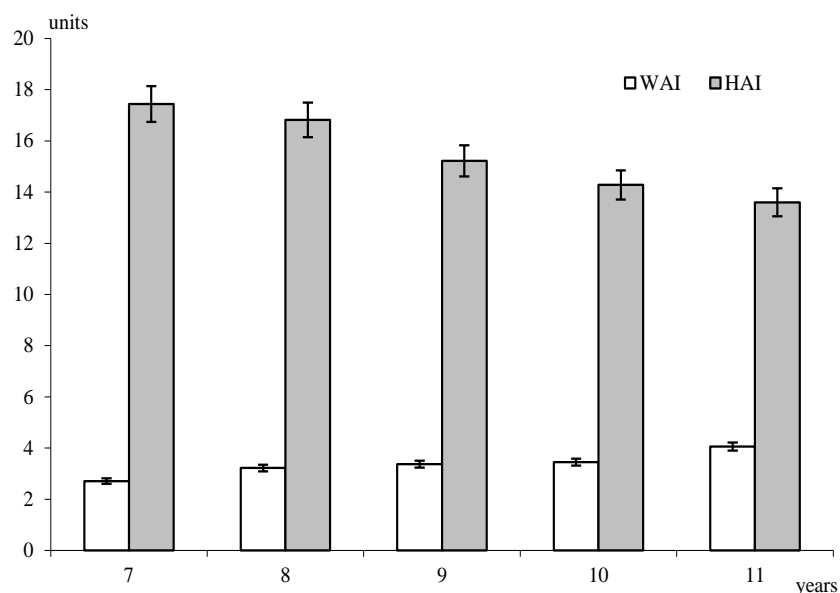


Fig. 2. Weight-age (WAI) and height-age (HAI) indices of primary school age children engaged in Kyokushin karate

Consequently, as children grow older, there is a linear increase in body length and mass, which corresponds to physiological processes. Whereas the maximum values of the coefficient of variation in body length and mass were characterized by children aged 10-11 years, and the minimum values were in 9-year old athletes, i.e. the coefficients of variation in body length and mass decreased from 7 to 9 years of age, followed by an increase by 11 years of age.

When considering the weight-age index, it was found that this indicator increases with age from $2,7 \pm 0,01$ (7 years) to $4,06 \pm 0,02$ (11 years) (fig. 2), which indicates a normal increase in body mass with age. While the height-age index shows the opposite trend – a decrease in the index as you get older. The maximum rate of HAI was observed in 7-year old children and was $17,4 \pm 0,81$, and the minimum in 11-year old athletes was $13,6 \pm 0,51$ (fig. 2). These data indicate a delay in growth with age.

The body mass index (Quetelet index II) is used to assess the nutritional status of older children and adolescents. This index determines the relationship between body mass and length better than other indices. The Quetelet II index has long been used in therapy, since its value is relatively constant, has little variability and does not depend on age [1, 10, 14]. There is a wave-like change in the Quetelet II index. From the first year of life, the value of the index decreases, reaching the minimum figures at the age of 5-7 years, and later, from 7-8 years, there is an increase in the value of the body mass index with age. This can be explained by intensive growth rates, a change in the direction of growth and an acceleration of linear growth at the age of 5-7 years (a "half-growth spurt") and, hence, a physiological decrease in "fatness", which, according to the laws of growth, reflects an asymmetric ratio of body mass to height depending on age. In this regard, the use of the index before the age of 7 is not very informative. With age, constitutional features become of great importance in changing body mass, and the asymmetry of mass gain relative to growth becomes less pronounced. Therefore, it is legitimate to use the body mass index to assess the nutritional status of older children [10].

With the growth and development of children engaged in Kyokushin karate, a change in body mass index (BMI) was observed (fig. 3). The lowest indicator was characterized by children at 7 years old. For them, the value of this indicator was $12,8 \pm 0,9$ kg/m². Whereas at the age of 11, the BMI was 1,5 times higher compared to 7-year olds. The BMI index at the age of 8 was also higher than that of 7-year old athletes, but there were no statistical differences.

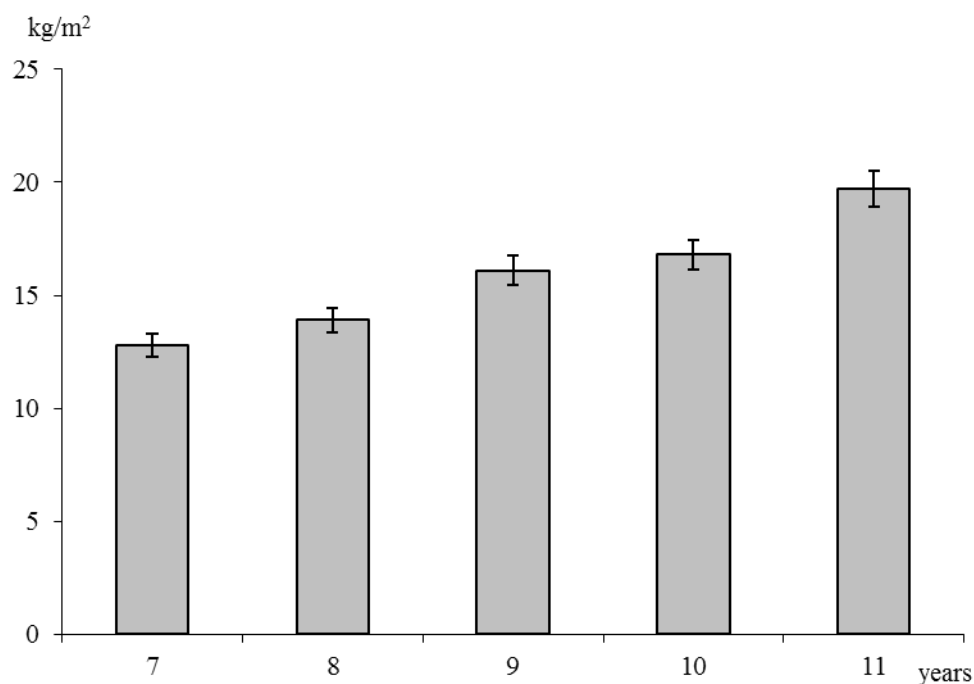


Fig. 3. Average body mass index (BMI) of primary school age children engaged in Kyokushin karate

Athletes of 9 and 10 years old had an average body mass index in the range of $16,1-16,8 \pm 1,2 \text{ kg/m}^2$ (fig. 3), which is higher than the values of young athletes by 3,3-4 units, but lower than the values of older karatekas by 2,9-3,6 kg/m^2 .

According to the formalized assessment of the Quetelet index for school age children, 50% of young karatekas of seven years of age have a harmoniously developed physique (fig. 4), of which 12% have a height and body mass correspondence within the limits of the norm of their age, and 38% have a small body mass shortage. Fifty percent of the studied children of this age are characterized by a deficit of body mass.

Among 8-year old karatekas, 80% of children had a harmonious development (fig. 4). At the same time, 20% of the subjects had their indicators at the border of the norm. The share of children with a body mass deficit also accounted for 20%.

All 9-year old athletes had a harmonious development of their physique (fig. 4). Among them, the correspondence of body mass and length was within the normal range in 20%, the share of children in the lower limits of the norm accounted for 60%, and in the upper limit – 20%.

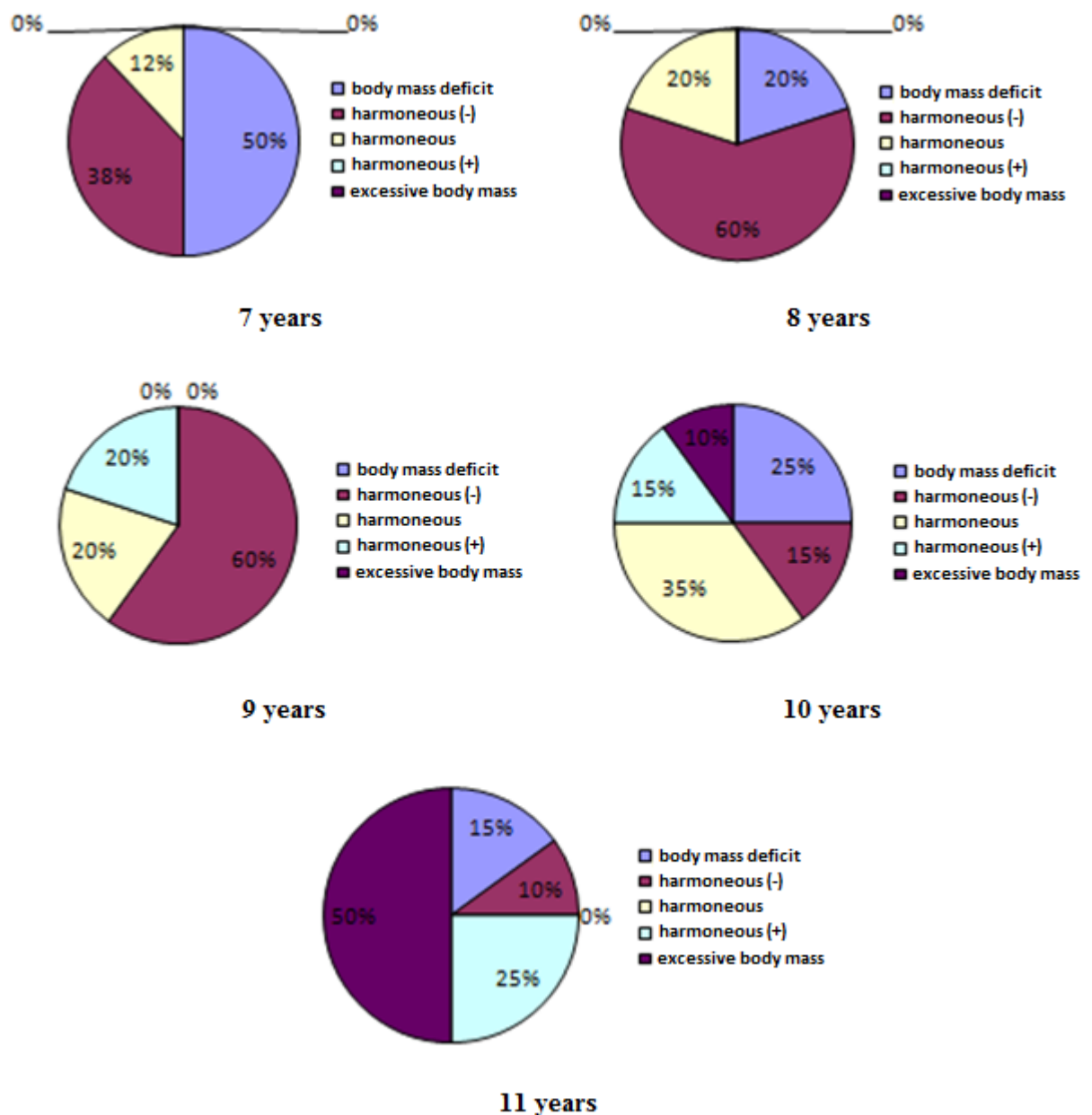


Fig. 4. Percentage ratio of BMI indicators of primary school age children engaged in Kyokushin karate

In the course of the study, it was revealed that 65% of 10-year old karatekas had a harmonious physique (fig. 4). The proportion of children with a body mass deficit was 15%, and with excessive body mass – 10%. In 11-year old karatekas, the share of overweight children accounted for 50%, while the subjects with a body mass deficit accounted for 15%, the rest had a harmonious development, of which 10% were at the lower limit, 25% – at the upper limit.

When assessing excessive body mass, focusing only on weight and height indicators does not always give a real idea of the amount of adipose tissue. In particular, this indicator may give an inaccurate idea of the body mass of children who are professionally engaged in sports. The high value of the index in

this case is explained by the developed musculature. Therefore, excess body mass in 10-11-year old athletes cannot be attributed to the problem of obesity, since previously obtained data on the component composition of the body and the Rohrer and Vervek-Vorontsov indices (fig. 5-6) show that children in these age groups have a predominance of the muscle component in the body composition [3]. This correspondence between the parameters of height and body mass is associated with an earlier start of accelerated growth of muscle mass.

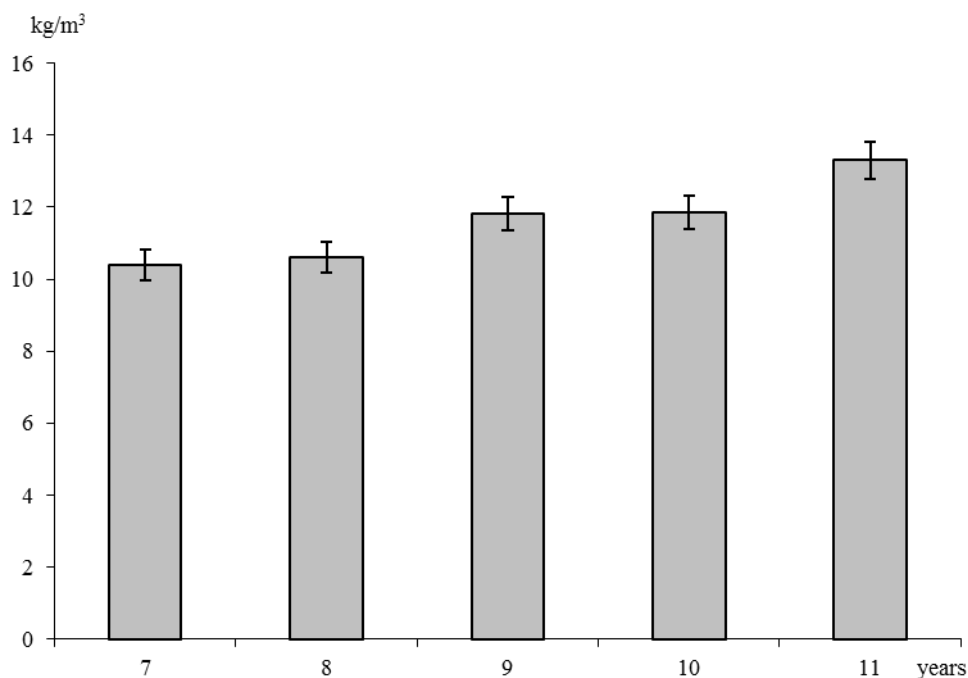


Fig. 5. Average values of the Rohrer index of primary school age children engaged in Kyokushin karate

The Rohrer index characterizes the relative density of the body, which can be used to assess a person's physical development. The method of assessing the degree of physical development in child athletes, based on the calculation of the Rohrer index, is very simple, does not require special centile tables, which must be updated every 5 years and may be different in different regions. It does not depend on the gender, age and height of children and can be widely used for screening, preventive examinations of children, when only the body mass and height of the child are measured. In addition, it allows us to identify borderline states, which often, when using only centile tables of the correspondence of body weight to length, fall into normal physical development [10].

In 7-8-year old children, the Rohrer index was $10.4-10.6 \pm 1.2$ kg/m³ (fig. 5). These values correspond to low physical development. In the remaining age groups, this indicator was in the range of $11.8-13.3 \pm 1.1$ kg/m³, which diagnoses harmonious physical development.

The Rohrer index is proposed for determining the somatotype according to the classification of V.G. Shtefko and A.D. Ostrovskij (1929). It is an integral feature that reflects the content of various tissues in the body, including fat and muscle [4].

Based on the values of the indices, it can be concluded that children of 7-8 years old engaged in Kyokushin karate have an asthenic body type, which is characterized by a narrow chest, weak development of the bone component, predominant development of the lower extremities, a poorly developed abdomen. Karatekas of 9-10 years old according to the indicators of the Rohrer index belong to the muscle type. Children of this type have an evenly developed trunk, wide straight shoulders, a developed chest. The contours of the muscles in children of the muscle type are clearly expressed.

To characterize the direction of growth processes and body type, the Vervek-Vorontsov “sthenia” index was also used. The determination of the prevailing direction of body length using the Vervek-Vorontsov index revealed a harmonious ratio of linear and transverse growth processes in athletes aged 9-11 years, which corresponds to mesomorphy (fig. 6). The predominance of linear growth processes (dolichomorphy) was noted in 7-8-year old boys. Consequently, with age, the ratio of morphotypes changes in the direction of mesomorphy.

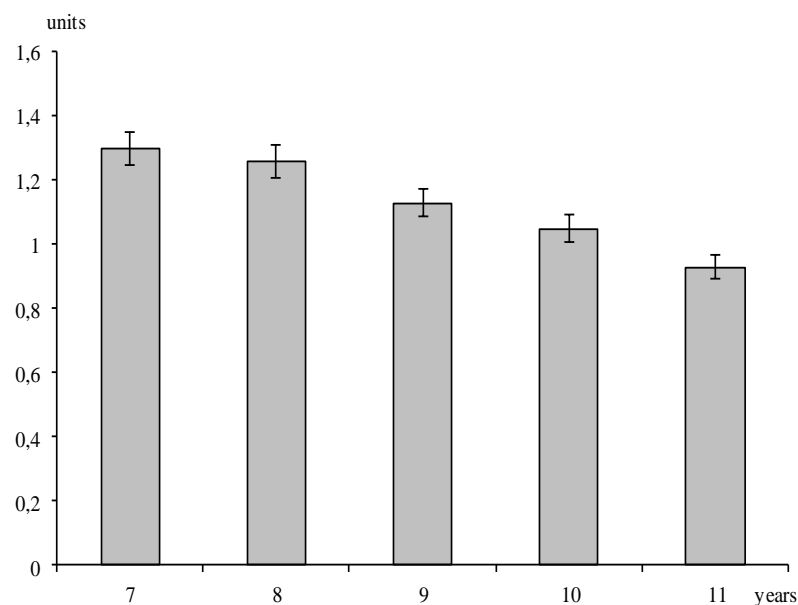


Fig. 6. Average values of the Vervek-Vorontsov index of primary school age children engaged in Kyokushin karate

The analysis of the proportionality of the body according to the classification of N.P. Bashkirov showed that most of the examined young karatekas aged 9-10 years had a dolichomorphic type of body structure (fig. 7), i.e. they were characterized by a narrow elongated body, long limbs and a short trunk.

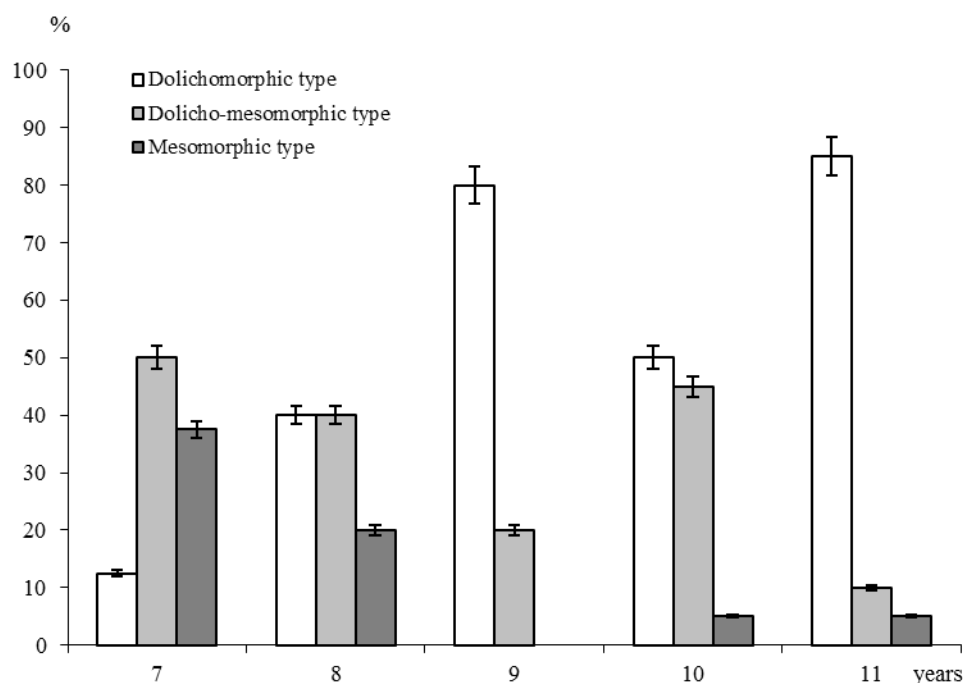


Fig. 7. Types of body proportions of primary school-age children engaged in Kyokushin karate

A small part (5%) of children aged 10-11 years is represented by the test subjects of mesomorphic type, for which the average values of anatomical features of the body structure are typical. No children with mesomorphic body type were identified among 9-year old karatekas. A fairly large group (45%) of athletes at the age of ten had a transitional type – dolicho-mesomorphic, whereas in 9 and 11-year old subjects, this type was found in 20 and 10%, respectively.

It was revealed that the dolicho-mesomorphic type of body structure prevails in the group of young karatekas aged 7 years, these representatives account for 50% (fig. 7). The rest is distributed between dolichomorphs (12,5%) and mesomorphs (37,5%).

Among 8-year old karatekas, a large percentage (80%) were children with dolichomorphic and dolicho-mesomorphic body proportions, 40% for each type respectively. The share of mesomorphs accounted for 20%, which is twice as less than in the group of children of seven years of age.

The data obtained during the calculations correspond to the previously considered indicators. Consequently, as children who practice Kyokushin karate grow and develop, their physical development increases.

Systematic monitoring of the growth and development of children is an important link in the system of monitoring the condition of the child and the development of measures for their recovery.

The conducted study of morphotypological indicators of primary school-age children engaged in Kyokushin karate using the anthropometric method allowed us to obtain data that characterized the features of physical development taking into account age and during this sport. The physical development of the examined young athletes corresponds to the morphophysiological norms of children of these age groups. In karate students of primary school age, physical development is quite active, which allows them to implement complex psychomotor acts.

As children grow older, there is a linear increase in body length and mass. Whereas the maximum values of the coefficient of variation of body length and mass were characterized by young karatekas aged 10-11 years, and the minimum values were 9-year old athletes, i.e. the coefficients of variation of body mass and length decreased from 7 to 9 years of age, followed by an increase by 11 years of age.

Young athletes aged 9-11 years, compared with 7-8-year old children, were characterized by higher indicators of skeletal massiveness, which is also confirmed by high values of bone and muscle tissue. The predominance of the muscle component in young athletes of this specialization is explained by adaptation to training loads, while the fat component remains within the normal range.

Conclusion. The assessment of the physical development of primary school age children engaged in Kyokushin karate using the index method showed that as young athletes grow and develop, there is a harmonious development of the physique with the predominance of dolichomorphic and dolicho-mesomorphic body proportions, a change in the component composition of the body towards an increase in the muscle component, which indicates adaptive changes in body composition to systematic physical loads.

Thus, the index assessment of body proportions, body shapes, fatness, strength and harmony of development of primary school age children engaged in Kyokushin karate expanded the information content of the factual evidence.

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