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Dynamics of Functional Indicators of Adolescents Against the Background of Regular Volleyball Trainings

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ABSTRACT

139 adolescent male volleyball players were examined. The impact of systematic volleyball training on the somatotype of adolescents was assessed. We found out the somatic parameters of volleyball players, taking into account their chronological age. Regular volleyball training lasting at least 1 year strengthened the body of athletes, increasing the prevalence of strong and medium build among them. This was accompanied by an increase in the proportionality of their physique. As the experience of volleyball training increased, an increase in endurance and functional reserves of the body was noted. Obviously, systematic volleyball practice in adolescents leads to an increase in strength capabilities and an increase in the tolerance of long-term cyclic loads.

KEY WORDS: ADOLESCENTS, VOLLEYBALL, PHYSIOLOGY, PHYSICAL TRAINING, STRENGTH TRAINING, MUSCLE ACTIVITY.

INTRODUCTION

Regular moderate muscle loads create conditions for the activation of most functions of the human body, form a consistently high level of resistance and increase the margin of safety of its functional systems. Long-term observations indicate a great functional benefit from physical training in people of any age and especially among young people (Zhvavy et al, 2001, Ereshko and Makhov, 2018; Makhov and Zakharov, 2018 Karpov et al., 2020).

This effect is promising to use for the widespread health improvement of young people, building up their labor potential and increasing the resistance of their body. For the most pronounced health-improving result from physical activity, obviously, young people should be more widely involved in the system of regular physical training, taking into account the existing preferences and biological characteristics. At the same time, it is the general physical status that should be considered as the basis for rational planning and dosage of muscle activity in the chosen sport (Galkina, 2008, Grechishkina, 2009; Kotova et al., 2017,Vorobyeva et al., 2018). Researchers recognize the presence of morphological and functional relationships that determine the physical individuality of a person, regardless of his attitude to sports. In this regard, the physical capabilities of a person should be strictly taken into account during the planning of muscular loads (Makurina et al, 2020; Kulikov et al, 2020).

At the same time, the process of individualization of training in any kind of sport should not be determined only by age, gender and the current general functional state (Skoryatina and Zavalishina, 2017). Modern researchers recommend that beginners take into account the peculiarities of constitutional characteristics, adaptive properties and typological status (Usha et al., 2019). Obviously, taking these indicators into account helps to establish the general level of viability and the severity of the adaptive potential of the organism (Vorobyeva et al., 2020).

The relationship between somatic parameters and physique features with the effectiveness of muscular loads of a different nature and achievements against their background of a certain degree of harmonization of the physical status of a person is known. Apparently, the athlete's somatotype strongly reflects the biological foundations of the body, which are significant for overcoming physical exertion. The presence of a number of morphofunctional differences inherent for

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certain constitutional types and associated different motor capabilities, adaptive and functional properties during systematic muscle training is recognized (Fayzullina et al., 2020).

It is believed that the type-specific method is very effective in helping to achieve a high individualization of sports training. This point of view is supported by the possibility of this method to optimize the functional state in the process of physical education. Positive somatic changes are based on physiologically beneficial changes in metabolic processes that ensure the functionality of the whole organism. Differences in somatotype are associated with differences in metabolic rate, motor skills, strength and speed abilities, and, ultimately, with the level of general performance (Zavalishina, 2020a). Regular physical activity, including in a playful way, is a proven way to correct the somatotype. An effective option for improving the level of physical fitness in adolescents is to regularly play volleyball. These trainings, carried out taking into account the current level of their physical development, are able to provide its correction. Purpose of the present work was to consider the changes in the morphological and functional characteristics of adolescents involved in volleyball for different periods of time.

MATERIAL AND METHODS

The performed studies were evaluated and approved by the local ethics committee established at the Russian State Social University on March 10, 2017 (Protocol No. 3). The work was carried out on the basis of the Russian State Social University, Moscow, Russia. 72 adolescent male volleyball players were examined. The volleyball players recruited underwent at least four workouts per week, with each workout lasting about 100 minutes. All surveyed volleyball players were 12-14 years old. According to the amount of volleyball training experience, all athletes were divided into 3 groups. The first group was considered the control group. It was formed by volleyball players with up to one year of sports experience (22 people). The second group of volleyball players consisted of athletes with sports experience from 1 to 2 years (26 people). The third group of athletes included volleyball players who have been training for 3 years and over three years (24 people).

In the course of the study, a number of indices were recorded to assess the somatic status of a person. The state of physical development of volleyball players was assessed taking into account the value of their body weight, the value of the size of the chest girth and the value of the linear body size. A method for assessing the strength of the physique was applied, which determines the somatic status, that is, the state of individual, functional and morphological characteristics with the registration of the value of the Pignet index. For this purpose, the following formula was used:

Pignet index = body length (cm) – [body weight (kg) + chest circumference at the moment of exhalation (cm)]

In thin asthenics, the value of the Pignet index > 30, with a dense physique (hypersthenics) the value of the Pignet index is <10, with a normal physique (normostenics) the Pigne index is 10-30. The state of harmony of the somatic development of adolescents was determined by the ratio of the shape of the chest and the linear size of the body. For this, the Erisman index was used, which was calculated using the following formula:

Erisman index = the size of the chest circumference in the pause of breathing (cm) -1/2 body length (cm)

If the value of the index was below +3.3 cm, it was said that a person had a narrow chest, in the case of an index value over +5.8, a wide chest was recorded.

Body mass index (Ketle index) was calculated using the formula:

Body mass index = body weight (kg) / linear body size (m^2)

Four levels of this index were recorded: with a body mass index <18.5, it was considered that there was energy deficiency (malnutrition) in the body, with a value of 19-25 it was considered that there was normotrophy, with a value of 26-31, the state was estimated as the presence of excess body weight (in other words, hypertrophy), in the case of its value over 31, obesity was revealed.In the examined subjects, the harmony of the somatic status was determined using the Rorera index, which makes it possible to determine the correspondence between the linear size of the human body and the value of his body weight. It was calculated according to the following formula:

Rorera index = body weight (kg) / body length (m^3)

In the case of a value of this index <10.3, it was said about the disharmony of development due to the small value of body weight. With an index value in the range of 10.4-13.7, they talked about the harmony of the physical status, in the case of the index value> 13.7, there was a disharmony of the somatic status due to the overweight of a person. The features of development were clarified taking into account the Pirke-Beduzi index, which made it possible to take into account the proportionality of standing height in relation to height in a sitting position. The following formula was applied:

Pirke-Beduzi index = [standing height (cm) – sitting height (cm)] / sitting height (cm) x 100%

The values obtained during the calculation of the Pirke-Beduzi index determined the relative size of the legs: values below 87% indicated a short leg length in relation to the height of a person, in the case of 87-92% they spoke of proportional physical development, in the case of a value of the indicator more than 92% the length of

the legs was considered large in relation to the height. The working properties of the respiratory system were determined by the level of the vital index, calculated as the ratio of the vital capacity of the lungs and body weight:

Vital index = vital capacity, lightness (ml) / body weight (kg)

The higher the level of the vital index, the more optimal the degree of development of the subject's chest breathing ability was considered. The average value of the vital index in adolescents is normally 55-60 ml / kg. The value of the strength index of the hand was determined. This indicator was considered as the ratio between body weight and the level of muscle strength in the main hand:

Arm strength index = [hand strength (kg) / body weight (kg)] x 100%

Low arm strength was noted in the case of the arm strength index <30%, the strength capabilities less than average were considered in the case of the index value from 31 to 41%, the average arm strength level was determined at the level from 42 to 64%, the strength capabilities above the average were found at the value from 65 up to 74%, high level of strength> 75%. The index of the back strength index allows to reveal the relationship between the size of the body weight and the level of strength capabilities of the back muscles:

Back Strength Index = [back dynamometry (kg) / body weight (kg)] x 100%

Low back strength was determined when the back strength index was below 101%, strength was assessed as less than average in the range from 102% to 119%, the average strength was indicated by the indicator in the range from 120% to 156%, the strength above the average level was from 157% to 174%, the strength that was in the range of more than 175% was considered a great strength. The type of biological reaction of the neuromuscular system of the surveyed was identified for their classification into "sprinters", "mixed" and "stayers" by calculating the Kaznacheev index using the formula below:

Kaznacheev index = maximum muscle strength / maximum muscle endurance

The value of the Kaznacheev index in the case of less than 1.0 was considered a sign of pronounced endurance (a person belongs to the "stayer" type), with a value above 2.0, it was considered a sign of prevalence strength characteristics (a person belongs to the "sprinter" type), with an index level between 1.0 and 2.0, there was a development of endurance and developed strength capabilities and the type was considered intermediate (a person belonged to the "mixed" type). Obtained in the course of the study, the indicators were statistically processed using the Microsoft Excel program with the subsequent calculation of the Student's criterion.

RESULTS AND DISCUSSION

The registration of the strength of the physique using the Pignet index showed the prevalence of this indicator in the athletes of the 2nd and 3rd groups in comparison with the individuals who formed the first group (Table 1). The surveyed volleyball players, included in the control group, had mostly weak physique (in about a third of cases they had a very weak physique). There were more athletes with an average physique in the 2nd group. In this group, there were fewer adolescents with a very weak physique compared to the control group. In the third group of athletes with a period of sports training for more than 3 years, the number of those with a weak and very weak physique was minimal. In this group, the bulk of the athletes had an average physique. In this regard, we can say that as the duration of the experience of sports training increases, the general physical status is strengthened, which indicates a beneficial effect on the physical development of regular volleyball loads.

The values of the Pignet index obtained in the study in the examined volleyball players of the first group said that they were mainly of hyposthenic body type. They rarely had a normosthenic type and rarely had a strong physique, assessed as a hypersthenic type. Regular volleyball training has shown the ability to strengthen adolescents' physique to medium to robust status. With regular exercise, chest size and mobility increased to meet the growing need for oxygen throughout the body. The value of the Erisman index among volleyball players turned out to be higher in the second and third groups in relation to the first group by 31.7% and 68.7%, respectively. A negative value of this index indicated the narrowness of the chest. The data obtained indicate that as the duration of volleyball sessions increased, the number of athletes of asthenic constitution decreased and therefore in the third group it turned out to be minimal.

The assessment of the state of physical development and adequacy of nutrition was allowed to carry out the body mass index. The value of this index was comparable for all observed volleyball players. Evaluation of individual indices of body mass index among volleyball players made it possible to find out that in the first observation group the main number of adolescents had normal body weight for their age and height. Disharmony of physical development as a result of weight loss in this group was rare. In the second group of volleyball players, even more athletes had a normal body mass index, and less than 10% had body mass deficit or excess. In the third group of volleyball players, almost all athletes had a normal body mass index and only in about 5% of cases there was some excess body weight. Apparently, this is due to the fact that athletes have a pronounced appetite against the background of frequent physical exertion, leading to significant energy consumption.

The mean value of the Rorera index was the highest in the first group (13.5±0.22 kg/m³), in the second and third groups they were lower and were comparable. Assessment of the harmony of the physique by the value of the Rorera index revealed some phenomena of disharmony in the first group in no more than 20% of cases due to low body weight. In the second observation group, this was noted in about 10.0% of cases. In the third group, developmental disharmony was present only in 5.0% of the surveyed. Basically, the volleyball players registered average, that is, quite harmonious development. In the third group, the number of athletes with a harmonious development of the somatic status was the largest in comparison with the rest of the observation groups.

Table 1. Values of somatic indices in the surveyed

No	Indicator	Examined groups, M±m		
		first group, n=22	second group, n=26	third group, n=24
1.	Pignet index, point	36.7±0.67	29.1±0.75 p<0.01	20.6±0.46 p1<0.01
2.	Erisman index, cm	-5.4±0.70	-4.1±0.62 p<0.01	-3.2±0.53p1<0.01
3.	Body mass index, kg/m²	17.9±0.32	18.7±0.16	19.6±0.31
4.	IndexRorera, kg/m³	13.5±0.22	11.5±0.18 p<0.05	11.0±0.25 p1<0.01
5.	Pirke-Beduzi index, %	93.0±0.83	95.9±0.72	93.8±0.96
6.	Life index, ml / kg	40.8±0.61	47.2±0.43 p<0.05	49.6±0.37 p1<0.01
7.	Kaznacheev index, point	0.4±0.06	0.6±0.07p<0.01	0.8±0.05 p1<0.01
8.	Leading hand strength index,%	36.2±0.68	41.7±0.75 p<0.01	53.4±0.61 p1<0.01
9.	Back strength index,%	59.7±0.73	85.2±0.60 p<0.01	89.8±0.83 p1<0.01

Note: p – is the significance of the differences between the first and second groups; p1– is the statistical difference between the first and third groups.

In the course of the study, the proportionality of the physique of volleyball players was determined using the Pirke-Beduzi index, which assesses the ratio of the linear dimensions of the legs and trunk, taking into account the ratio of growth in a standing position to the value of growth in a sitting position. The calculated values of the Pirke-Beduzi index allowed us to say that its average values in all observation groups did not differ significantly: in the first group, the index was 93.0 ± 0.83%, in the second group – 95.9 ± 0.72%, in the third it was 93.8 ± 0.96% in the group. Judging by the Pirke-Beduzi index, in the first group there were about 20% of people with short legs in relation to body length, in the second group there were less than 11.0% of such people, and in the third group it was less than 7.0%. Significant length of the lower extremities (Pirke-Beduzi index -> 90%) was more often observed among volleyball players who train for a long time: in the second group (over 70.0%) and in the third group (over 65.0%). In the control group with such parameters, it was about 60.0%.

The vital index assessment reflected the value of the vital capacity of the lungs in terms of per kilogram of body weight in all athletes. Its increase indicated a greater severity of general physical development (Zavalishina, 2020b). It was possible to trace the increase in this index with increasing experience of physical training. In the second group this indicator was 15.7% more than the control, and in the third group by 21.6%. It can be assumed that in the second and third groups of volleyball players, the respiratory characteristics of the chest prevail over those in the first group.

Monitoring of the type of functional characteristics of the neuromuscular system in volleyball players taken under observation revealed that in the first group the value of the Kaznacheev index was in the range from 0.3% to 0.6% (0.4±0.06%), in the second group it was in the range from 0.4% to 0.7% (0.6±0.07%) and in the third group it was in the range from 0.6% to 0.9% (0.8±0.05%). Apparently, all the volleyball players observed were "stayers", that is, they were able to withstand prolonged cyclic physical activity.

The examined volleyball players of the control group had low values of the strength of the leading hand. Volleyball players in group 3 (53.4±0.61%) showed great strength capabilities of the hand. This value was inferior to the values of the second group of athletes (41.7±0.75%), but exceeding the indicators of the first group by 15.2%. Differences between the values of the strength indices of the leading hand among volleyball players, when comparing groups 2 and 3, reached 28.0%. Registration of the back stance index made it possible to establish low strength characteristics of the back in all groups of athletes. The maximum value of this index was found among volleyball players who made up the third group (89.8 ± 0.83%). This value was inferior to the indicator of the second group by 5.4%, and the control group was inferior to 50.4%. In this regard, it can be assumed that as the duration of volleyball practice increases, the back muscles are trained.

CONCLUSION

In the course of increasing the length of service in

volleyball among adolescents, the morphofunctional status is strengthened. Regular volleyball training for more than one year leads to an increase in the prevalence of medium and strong physique among them and to a decrease in the incidence of a weak body type. At the same time, adolescent volleyball players experience an increase in the harmony of development and increase their endurance in relation to cyclic physical activity.

Conflict of interest: No conflict of interest is declared.

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