Foot health: new approaches to prevention in young athletes

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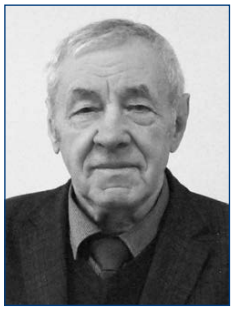

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Abstract

Objective of the study was to creation of a multifaceted approach to prevent and treat foot arch problems in young athletes engaged in team sports.

Methods and structure of the study. Plantography methods, Romberg test, and mathematical statistics method (Microsoft Office Excel and Stats Graphics) were used. The objects of the study were young football players aged 9-10 years old from the Junior football school and volleyball players aged 12-13 years from the Ekran school and Nevskie Zvezda school. There are 36 young athletes in total.

Results and conclusions. It has been confirmed that to effectively prevent and treat foot problems in young athletes engaged in sports, it is crucial to identify potential risk factors. The primary risk factor for foot arch disorders is the impact forces experienced when the foot contacts the ground during running and jumping, which exceed the adaptive capacity of the foot's connective tissues, muscles, and bones. Muscle weakness and compromised ligament and tendon elasticity can result in flat feet, leading to various types of lower limb overuse injuries in young athletes. To prevent the development of foot arch pathology, a comprehensive exercise program has been developed, which includes: 1) exercises without weight-bearing on the feet; 2) exercises with weight-bearing on the feet; 3) exercises for the feet using objects.. Through a comparative examination of the evolution of the degree of foot arch impairment following the implementation of the devised exercise regimen, it was determined that there was a positive trend: a reduction in the severity of flat feet was observed in 54.7% of football players and 97.5% of volleyball players.

Keywords: *young athletes, arches of the feet, flat feet, new methods of prevention, game sports*

Introduction. One of the most pressing issues in modern sports is the prevention and rehabilitation of injuries and diseases of the musculoskeletal system (MSS) in athletes. They are caused by a complex of risk factors, including external, internal and specific to a particular sport [4, 7, 8].

One of the types of chronic MSS overstrain in young athletes is foot arch pathology, which is observed in 55,9% of various team sports [6]. The main risk factor in young athletes is the biological patterns of connective tissue formation and force impact loads of the foot with support during running and jumping [5]. Such excessive impact loads lead to weakening of the foot muscles, joint instability and, as a consequence, to flat feet.

It should be noted that the motor homeostasis of a growing organism is characterized by ontogenetic patterns of formation of all physiological qualities that must be taken into account in the training process of children [6, 9]. The development of prevention and rehabilitation of diseases in athletes should be based on the achievements of modern theoretical and practical medicine, offering new approaches, methods and means.

One of such areas is integrative medicine [3], which provides for the synthesis of scientific, allopathic and holistic models of diagnosis and treatment. The main principle of integrative medicine is to increase the adaptive and compensatory capabilities of the patient's body, eliminating risk factors.

In addition to integrative medicine, the choice of means and methods for the prevention and rehabilitation of chronic overstrain of the musculoskeletal system in athletes is influenced by the basic provisions of connective tissue medicine [1]. This is due to the fact that connective tissue in the body unites all life support systems and implements the process of adaptation of the body to the environment.

The purpose of the adaptive role of connective tissue at different intensity of the training process in children and adolescents is indicated by the results of the study of V.I. Nechaev and T.M. Nikitin. Thus, with not "mature" arches of the foot, with a decrease in the reserve of elastic properties of arch-forming tissues, excessive training load leads to flattening of the arches of the foot. In their opinion, blind copying of the volume of training loads of adult athletes leads to flattening of the arches of the foot and the formation of functional weakness of the foot. As a result, the foundations of functional insufficiency of the feet of athletes are laid in childhood and adolescence, persist for life and require secondary prevention throughout the entire period of sports [2].

Objective of the study was to creation of a multifaceted approach to prevent and treat foot arch problems in young athletes engaged in team sports.

Methods and structure of the study. The study involved 20 young football players aged 9-10 years (10 boys made up the control group and 10 boys – the experimental group) at the Junior Football School, a branch of DSI Zenit, 16 female volleyball players aged 12-13 years, at the Ekran Sports School of the Vyborg District of St. Petersburg, and also at the Nevskie Zvezdy Sports School of the Olympic Reserve. Eight girls made up the control group and eight girls – the experimental group. The following methods were used: Romberg tests (placing the feet on one line, with the heel of one foot touching the toe of the other - 24-28 seconds (according to A.F. Sinyakov), assessment of the arches of the feet (plantograms were processed using the methods of V.A. Shtriter, I.M. Chizhin) [6], statistical data processing. At the first stage, the arches of the feet were assessed, Romberg tests were performed. Exercise sets were developed. At the second stage, exercises were carried out in training sessions and it was recommended to perform the exercises at home (3-4 times a week). Three exercise sets were developed including: 1) exercises without axial load on the feet; 2) exercises with axial load on the feet; 3) exercises for the feet with objects. At the third stage, the arches of the feet, Romberg tests were re-evaluated and the results obtained were analyzed (Student's t-criterion).

Results of the study and discussion. In order to achieve the set goal, a dynamic study of the arches of the feet, the Romberg test in young athletes of team sports was conducted. The results of plantography (the norm is 43-50 units) showed that most young football players have deviations in the development of the arches of the foot 55,92 ± 3,7% at the beginning of the study. In addition, various violations are determined on the right and left legs 15% (Figure 1), 25% have longitudinal flat feet of both feet, 40% have transverse flat feet, 30% have hollow feet, 25% have no deviations.

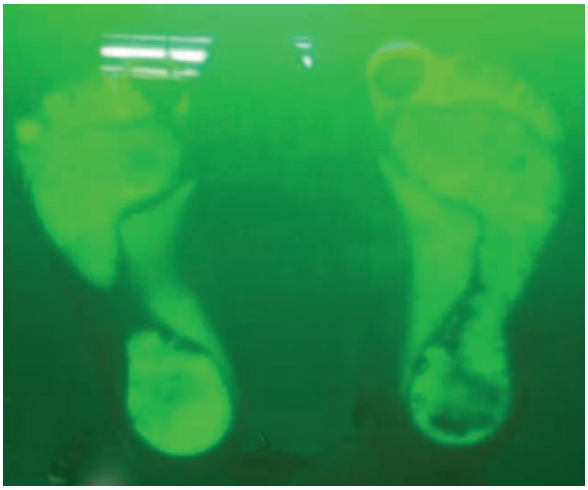

Figure 1. Different heights of the longitudinal arch and transverse flat feet

After using the proposed complex, at the end of the observations, improvements of 54,69±3,39 (p≥0,05) were revealed. The results of the Romberg test indicate poor static coordination of young football players (8,55±4,68 s). After repeating the Romberg test, the results improved (11,65±4,16 with p≥0,05) (Figure 2).

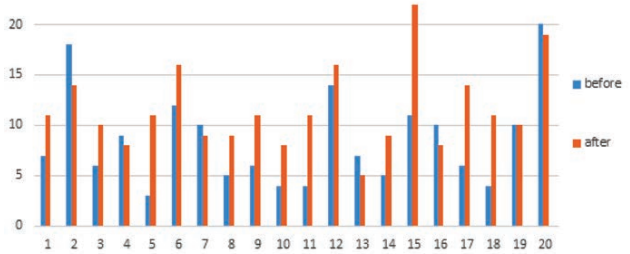

Figure 2. Comparison of Romberg test results in young football players

Table 1. Indicators of the Plantogram test in the experimental group (%)

Research stage		N	$\bar{x} \pm S\bar{x}$	Meaning p-value	p
Left leg	Before the experiment	8	1,7125±0,173	0,000480734	<0,05
	After the experiment	8	1,173±0,199		
Right leg	Before the experiment	8	1,7125±0,212	0,00010255	<0,05
	After the experiment	8	1,172±0,201		

Table 2. Indicators of the Plantogram test in the control group (%)

Research stage		N	$\bar{x} \pm S\bar{x}$	Meaning p-value	p
Left leg	Before the experiment	8	1,8±0,7143	04497	>0,05
	After the experiment	8	1,7125±0,173		
Right leg	Before the experiment	8	1,825±0,175	04788	>0,05
	After the experiment	8	1,75±0,233		

Table 3. Indicators of the test «Heel pronation angle» (o)

Research stage		N	$\bar{x} \pm S\bar{x}$	Meaning p-value	p
Left leg	Before the experiment	8	12,0±2,0	0,000225759	<0,05
	After the experiment	8	5,375±1,408		
Right leg	Before the experiment	8	11,75±1,669	0,000121812	<0,05
	After the experiment	8	5,5±1,414		

Table 4. Indicators of test No. 2 «Heel pronation angle» (o)

Research stage		N	$\bar{x} \pm S\bar{x}$	Meaning p-value	p
Left leg	Before the experiment	8	14,25±1,98	0,6217	>0,05
	After the experiment	8	13,75±1,98		
Right leg	Before the experiment	8	13,875±1,885	0,145	>0,05
	After the experiment	8	12,63±1,3		

The results of Romberg tests are affected by the asymmetrical state of the feet. If one of the feet is significantly flattened compared to the other, this noticeably affects the ability to maintain balance in the complicated Romberg test. The inability to stand in a narrow stance indicates a significant imbalance due to flat feet. If the load is distributed incorrectly, valgus/varus tilt in the ankle joint, both in one foot and between the feet, discomfort occurs, which disrupts static coordination. The test results of volleyball players after the experiment on the Plantogram test in the experimental group are presented in Table 1.

The test results of volleyball players after the experiment on the Plantogram test in the control group are presented in Table 2.

According to the analysis of the results of Tables 1 and 2, it can be concluded that statistically significant changes in the Plantogram test occurred in the experimental group of volleyball players after the experiment. No statistically significant changes occurred in the control group. The results of the Heel Pronation Angle test in volleyball players were also subjected to mathematical and statistical processing. The results of the mathematical processing of the outcome of the experiment in the experimental group are presented in Table 3.

The results after the experiment on the “Heel Pronation Angle” test for volleyball players in the control group are presented in Table 4.

According to the analysis of the results of tables 3 and 4, it can be concluded that statistically significant changes in the «Heel Pronation Angle» test occurred in the experimental group of volleyball players after the pedagogical experiment. No sta-

tistically significant changes occurred in the control group.

Flat feet as an internal factor leads to a violation of the biomechanics of the lower limbs, and as a consequence, to pathological problems of the free lower limb and the lower limb girdle. The applied complex performs a preventive purpose, it brings the ankle joint to a physiological position, and thereby removes excess dynamic and static load from it, contributing to the improvement of the tone of the ligaments and muscles of the feet.

Analysis of the obtained results showed that the compiled training program is effective. Thus, the strength of the calf muscles increased, many of those involved improved balance and a sense of equilibrium, which indicates an improvement in the tone of the muscles and ligaments of the foot, ligaments of the calf. Of course, this complex should be performed on a regular basis or at least over a longer period of time, especially when it comes to exercises for the correct formation of the arches of the foot. Ligaments and tendons are bradytrophic tissues, and to improve their functional state and restore the physiological position of the feet, it is necessary to use preventive measures over a long period.

Conclusions. It has been established that flat feet are detected in young athletes of team sports. It is caused by excessive impact loads when the foot contacts the support when running and jumping. Such loads exceed the functional reserve of elastic properties of the arch-forming connective tissues of the foot, and as a result, lead to flattening of the feet. A program of secondary prevention of flat feet in young athletes has been developed. The means and methods of secondary prevention contributed to the reduction of flat feet in 57% of football players and 97,5% of volleyball players. Prevention of flat feet in young athletes should be considered as a system for preventing chronic syndromes of overexertion of the lower extremities and is carried out constantly during sports.

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