Original Article

Measures to prevent functional muscular disorders in sports training of 7-9-year-old football players

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Abstract.
The study was aimed at evaluating the effectiveness of the measures to prevent postural disorders of young football players at initial stages of sports training. In this study, the following methods were used: pedagogical experiment; pedagogical testing; anthropometrics, video recording and biomechanical analysis of biogeometrical profile of the individual's posture (using the Torso software), methods of mathematical statistics. The study included two stages: the first stage involved 179 football players aged 7-9 years, and the second stage of pedagogical experiment involved young athletes aged 8 years old with diagnosed disorder 'round back posture': the control group (CG) involved 12 football players and the experimental group (EG) involved 11 football players. Results: It was found that in the 9 year old age group the percentage of athletes with postural disorders is twice as great as that in the 8 year old age group and almost three times as much as that in the 7 year old group of athletes. There was developed a training program that included corrective exercises divided into blocks: Correctional, Prophylactic, Dynamic Posture, Vertical Body Stability, Physical Games and Relays, and Stretching. The duration of the experiment was 1 year. The conducted pedagogical experiment confirmed the effectiveness of the program for correction of postural disorders in young football players. There have been positive changes in the indicators of biogeometric profile of the posture and physical fitness of young football players.
Keywords: locomotor system, football players, sports training, young athletes, correction, prevention, posture.

Introduction

The standards of children's health are steadily deteriorating (Andrieieva, Kashuba, 2018; Tanaka, C., Tanaka, M. & Tanaka, S., 2018; Galan et al., 2018). Increased physical and emotional stress against the background of the processes of growth and formation of organs and systems place increasing demands on the body of young athletes and can lead to a number of physical health disorders (Galan, et al., 2019). According to scientists, a significant part of young athletes (more than 75%) have various health disorders (Liugailo, 2016). This is the main reason for an early end of sporting activities.

The problem of functional disorders of locomotor system in children is urgent all over the world. The diseases of locomotor system are recognized by the World Health Organization as the main area of preventive research for the period 2010-2020. The prevalence of postural disorders among young athletes is steadily increasing. The number of primary school children with postural disorders in the frontal and sagittal planes ranges from 66 to 71.2%, with scoliotic disease – from 5.7% to 11.5%, and with platypodia – from 25% to 33.9% (Melentyeva, 2007). Similar data were obtained by the authors in the study of postural disorders of children aged 9–12 and young women (Kashuba, Andrieieva, Goncharova, 2018).

The analysis of scientific literature showed the presence of a large amount of theoretical and experimental materials on the training of young football players (Nikolaychuk V., 2012). Nevertheless, the problems of prevention and correction of functional disorders of locomotor system of young football players do not have a proper solution. Experimental studies of scientists indicate that 42% of 9-14 years old football players have reported functional disorders of locomotor system (Melentyeva, 2007). This indicates the need for preventive and corrective measures focused on reducing the risk of development of functional disorders of the locomotor system to implement in sports training of young football players.

The objective was to evaluate the effectiveness of the measures to prevent postural disorders in the process of sports training of young football players.

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Material & methods

The first stage of the study involved 179 football players aged 7–9 years old of the Children and Youth Sports School No. 10 of Kyiv, FC 'Dinaz' in Vyshgorod. Anthropometric indicators, posture status, and the physical fitness of young football players were assessed.

Anthropometric assessment was performed with the standard measuring devices and using the standard procedures (Stewart, Arthur, et al, 2011). Anthropometric points having rather specific localization with respect to certain skeletal bone formations were used as landmarks in the measurements. Therewith in order to make the measurement of the human body more accurate there was used somatic reference axis. The location of an anthropometric point was determined by palpation and painless pressing, followed by its drawing with a marking pen (Kashuba, 2016).

A digital video camera connected to a personal computer using Torso program was used to record the quantitative characteristics of the state of the young players' posture (Kashuba, 2016). The filming was done taking into account the basic biomechanical requirements: the centers of joints and the anatomical marking of the foot were marked with contrast markers; a scale bar was placed in the plane of the subject (when shooting the foot, the bar was divided into two-centimeter colored sections; a meter long scale was fixed when filming the walk and the posture); the camera was fixed on a tripod motionlessly 3 meters away from the subject for static positions (Kashuba, 2016). Videograms of posture biogeometric profile were processed using the Torso program, determining 3 angular characteristics of posture biogeometric indices: α_1 is the forward head angle formed by the vertical and the line connecting the C_7 spinous process to the center of mass of the head; α_2 is the gaze angle formed by the horizontal and the line connecting the frontal eminence to the mental eminence; α_3 is the trunk angle formed by the vertical and the line connecting the C_7 spinous process, the most protruding part of the spine at the junction of the cervical and thoracic sections, and the spinous process of the fifth lumbar vertebra (L_5), the most depressed point of transverse lordosis (center of the somatic system of reference) (Kashuba, 2016).

Pedagogical testing was used to determine the indicators of physical fitness. Static endurance of the muscles of anterior trunk and leg was determined as follows: start position was lying supine on a couch, hands behind the head, legs fixed, only lumbar region touching the couch; the hold of the body was measured not lower than horizontal (Alyoshina, 2015). The static endurance of the muscles of the posterior trunk and leg was determined as follows: start position was lying prone on a couch, hands behind the head, legs fixed, only abdomen touching the couch; the hold of the body is recorded not lower than horizontal (Alyoshina, 2015). Standing balance (open eyes test) was determined in the following way: star position was standing on the tips of the toes, hands up, not moving, the time of balance kept was measured (Alyoshina, 2015). Coordination skills of young football players was evaluated by the results of the test 'Shuttle run 3x10 m'.

In the second stage, a pedagogical experiment was applied to evaluate the effectiveness of preventive measures in the correction of musculoskeletal disorders. The pedagogical experiment involved young athletes aged 8 years old with the diagnosed disorder 'rounded back posture': a control group (CG) of 12 football players and an experimental group (EG) of 11 football players. The athletes were divided according to the sampling method, the groups did not have statistically significant differences in the studied indicators (p> 0.05).

The frequency and duration of weekly sessions for the control and experimental group participants were the same. The football players of the CG were trained in accordance with the program 'Football: a training program for children and youth sports schools, specialized children and youth Olympic Reserve Schools, schools of high sports mastery and specialized educational institutions of sports profile, 2009' (Program, 2009) based at FC 'Dinaz' of Vyshgorod. The duration of the pedagogical experiment was nine months. The football players of the EG were trained in accordance with the traditional program, which additionally included corrective and preventive exercises. The exercises were divided into blocks: Correctional, Prophylactic, Dynamic Posture, Vertical Body Stability, Physical Games and Relays, and Stretching. The Correctional Block was aimed at correcting the posture of young football players (correction of the deformation that is just emerging, stabilization of already formed ones, and creating conditions to compensate the musculoskeletal disorders), the formation of the core, as well as the improvement of their fitness. The Prophylactic Block was aimed at strengthening the arch of the foot that prevents platypodia in young football players. Dynamic Posture Block was aimed at forming the correct body posture while performing various physical exercises. The Vertical Body Stability Block was aimed at the development and improvement of vertical body stability of young athletes. The Block of Physical Games and Relays was aimed at increasing the level of physical fitness of young football players and forming a dynamic posture. The basis of the Stretching Block was the flexibility exercises that were performed in a specially defined sequence. These blocks were used in variations according to the goals and objectives of the training sessions.

The experimental data were processed using standard methods of mathematical statistics with mean ($\bar{x}$); standard deviations (SD); non-sampling error (m). Non-parametric tests were used to determine the statistical validity of the differences between the sample parameters, the distribution of which did not meet the normal law: the Mann-Whitney U test was used for the independent samples and the Wilcoxon test was used for the dependent ones.

The study was organized as follows: assessment of the morpho-functional state of young footballers, which allows to determine the initial levels of the state of locomotor system and physical fitness of athletes;

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determining the guidelines for planning training sessions at the stage of initial training of football players based on the results of the assessment; development of the content of training sessions, including the selection of means, methods, methodological techniques aimed at correction of postural disorders, maintenance of spring-like function of the foot, load and rest parameters that ensures the achievement of the planned results; carrying out training sessions (using the sets of corrective exercises); monitoring and evaluation of the effectiveness of the developed program.

Results

It was found that, in the 7 year old group of athletes, 86,11% had a normal posture, and 13,89% had functional postural disorders. Among the 8 year old football players, 77.05% had a normal posture and 22.95% had postural disorders. According to the data obtained, 58.70% of 9 year old football players had normal posture and 41.30% of them had postural disorders. The most common types of postural disorders at the age of 7 are round back (12.50%), scoliotic posture (8.33%), and round-concave back (6.94%). Among the 8 year old children, the greatest number of athletes with impaired posture were the footballers with round back and scoliotic posture: 18.03% and 14.75% respectively, at the age of 9 years old, the most common types of postural impairment were round back and scoliotic posture.

It should be noted that in the age period from 8 to 9 years old, the percentage of athletes who had postural disorders has doubled and almost tripled compared to the number of 7 year old athletes. Our further research was aimed at considering the specificity of postural disorders of football players at the 7-9 years age of old using the results of videometry confirmed by the evidence of an orthopedist.

As a result of the study, the peculiarities of the spatial organization of the body of 7-9 years old football players with different types of posture were studied, in particular, the body length and girth measurements, and the state of the biogeometric profile of the posture were determined.

Among the 7 year old football players, the angle formed by the vertical and the line connecting the C7 spinous process to the center of mass of the head (α_1) had the greatest values among the athletes with a flat-concave round back 44.30° (SD = 0.20°) and 38.28° (SD = 1.40°), respectively. Among the football players with a flat back, the average values of this indicator were on the average 36.42° (SD = 0.50°), with a scoliotic posture - 32.48° (SD = 1.80°), with a normal posture - 32.14° (SD = 0.61°) and with a round-concave back - 31.44 ° (SD = 1.54 °). Among the 8 year old football players, the highest values of α_1 angle were found among the athletes with posture-type of flat-concave back 44.65° (SD = 0.09°), flat back 37.22° (SD = 0.91°) and rounded back 37.03° (SD = 0.61°). Among the football players with posture type of round-concave back, the average values of the angle were 34.49° (SD = 0.56°), with normal posture - 32.12° (SD = 0.40°), with scoliotic posture – 31.23° (SD = 0.70°). Among the football players aged 9 years old the highest average values of the angle α_1 are among the athletes with posture type of flat-concave back 44,3 ° (SD = 1,18 °), rounded back 37,20° (SD = 0,30°) and flat back 36.55° (SD = 0.72°). At the same time, among the football players with a round-concave back the average values of the angle α_1 were 34.26° (SD = 1.17°), with a normal posture - 32.06° (SD = 0.22°), with a scoliotic posture - 31.50° (SD = 0.75°). The conducted researches allowed to determine the indicators of static endurance of muscles of anterior and posterior trunk and leg and standing balance of the body, coordination abilities of young football players with different types of posture. It should be noted that young football players with round back and flat back had the low level of the aforementioned physical qualities. The results provided became the basis for finding new approaches and methods aimed at correcting posture of football players at the initial training stage. Upon the completion of the experiment, there was determined the presence of positive dynamics of changes in the average values of all three angular characteristics of the biogeometric profile of the posture among the football players of the EG when comparing their data before and after the experiment (fig. 1).

Table 1. Comparative analysis of static endurance and static balance in young football players during the formative experiment (n = 23)

Before the experiment						After the experiment					
CG (n = 12)			EG (n = 11)			CG (n = 12)			EG (n = 11)		
$\bar{x}$	SD	m	$\bar{x}$	SD	m	$\bar{x}$	SD	m	$\bar{x}$	SD	m
Static endurance of the muscles of anterior trunk and leg, s											
103,00	5,04	0,14	102,00	4,68	0,19	111,00*	6,13	0,08	118,00*	2,65	0,12
Static endurance of the muscles of posterior trunk and leg, s											
109,00	4,59	0,21	109,00	3,75	0,08	115,00*	5,16	0,17	122,00*	2,93	0,06
Static balance with eyes open, s											
11,00	1,61	0,04	11,00	1,45	0,05	13,00	1,38	0,03	14,00*	1,08	0,02
Static balance with eyes closed, s											
2,00	0,38	0,03	2,00	0,22	0,02	4,00	0,36	0,04	7,00*	0,57	0,02

Notes: * – the change is statistically significant (p < 0,05); cells shaded gray indicate that the difference between the groups is statistically significant (p < 0,05).

The analysis of the indicators of the level of manifestation of the standing balance of the body of young footballers made it possible to conclude that only in the EG during the implementation of the formative experiment there appeared significant changes in the time of the test task to determine this indicator with eyes open and eyes closed. In the EG the test, run time with both the eyes open (before the experiment -11.00 ± 1.45 s, after the experiment -14.00 ± 1.08 s) and with the eyes closed (before the experiment -2.00 ± 0.22 s, after the experiment -7.00 ± 0.57 s) statistically significantly improved ($p < 0.05$).
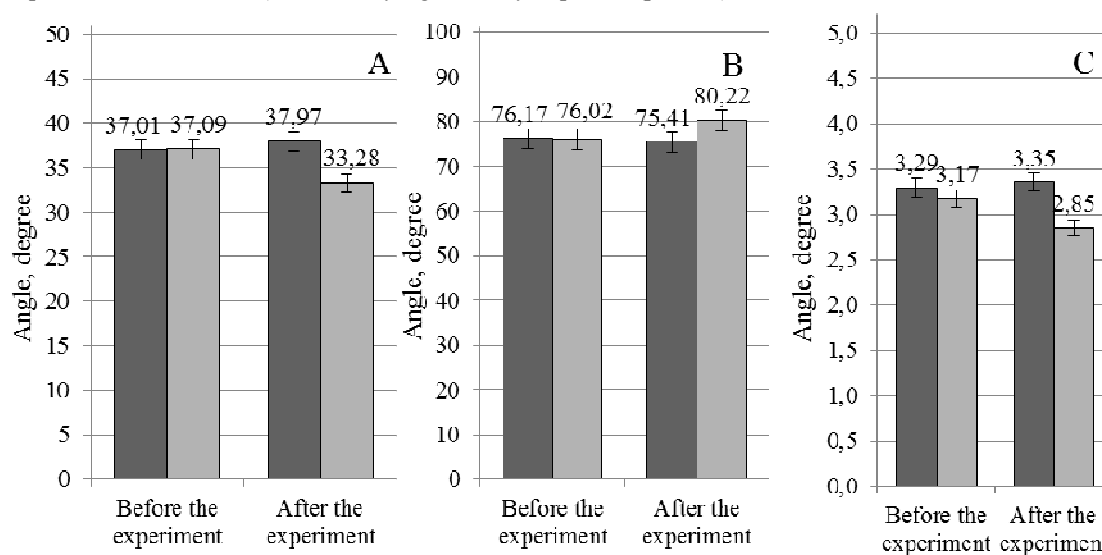

Fig. 1. Indicators of goniometry of the biogeometric profile of the posture of young football players: A – the angle formed by the vertical and the line connecting the C7 spinous process to the center of mass of the head; B – the angle formed by the horizontal and the line connecting the frontal eminence to the mental eminence; C – the angle formed by the vertical and the line connecting the spinous processes of the C7 and L5 vertebrae; (* – statistically significant difference compared to the beginning of the experiment at the level $p < 0.05$).

The comparative analysis of the data of the CG and the EG recorded at the end of the formative experiment confirmed the presence of statistically significant differences in the level of static endurance of the muscles of anterior trunk and leg, which demonstrates the positive influence of the developed program on the functional state of posture of the 8 year old football players ($p < 0.05$). The data of the formative experiment confirmed the viability of the developed program of correction of postural disorders of young football players at the stage of initial training.

Discussion

Today, the experts are actively discussing the problems of improving the theory and practice of sports training of children, adolescents, and young people (Platonov, 2013; Liugailo, 2016). The scientific publications show the basic provisions of children's and youth sports and characterize the effective means, methods and organizational forms of sports training of children and adolescents. The preparation of sport reserves in football is one of the most difficult problems caused by biological factors of organism development, physical qualities and changes in social factors (Riutiva, 2008). It was found that researchers and experts had paid insufficient attention to the prevention and correction of functional disorders of locomotor system of athletes during the initial training stage. Early sports specialization may have a negative influence on the harmonious development of certain muscles and muscle groups, which is the fundamental factor of the prophylactic effects of increased motor activity. Planning a training session at the stage of initial training should take into account morphological characteristics of young athletes, since during this period intense growth of the child's body, an increase in oxidation processes, and an increase in functional reserve of the body occur.

The training process should be focused on the gradual development of individual physical abilities and skills, and preparing a creative football player. According to the scientist (Nikolaienko, 2014), the unreasonable regime of training and competitive activity, imperfect criteria for evaluating the effectiveness of the sports organization and the coaching staff, and a number of other reasons do not allow to build a rational system of long-term preparation of sports reserve for professional football. At the stage of initial training (6-9 years) it is necessary to create the conditions for harmonious development of a child, and full mastering of the training program. The tasks at this stage of training should be aimed at promoting health, versatile physical training, elimination of problems in the level of physical development, teaching techniques with the wide use of material of various sports, physical games and game method in forming a diverse base of joint and special motor skills (Nikolaienko, 2014). The data we obtained allowed us to reveal a negative trend of deterioration of the state of posture of young football players in the corresponding age dynamics.

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For children of primary school age it is more appropriate to use a model of composing an annual cycle of training in sports and recreation groups in accordance with the type of modular (block) system (Kryuchkov, Astakhov, 2010). According to A. S. Kryuchkov and D. B. Astakhov (Kryuchkov, Astakhov, 2010) a training module is a structurally integral and relatively independent part of the training process. Its content, organization and duration provide the formation of relatively stable morpho-functional changes in the body and the transition to a higher level of functioning on this basis without signs of reduction of immune resistance, psycho-emotional overload of those who study, and minimization of the decrease of their mental and physical capacity during a school year.

Our study is a continuation of the approach recommended by the aforementioned specialists in the direction of using the necessary training facilities in the training process of young footballers and their rational structural organization with various corrective exercises. The correction block was completed with physical exercises aimed at forming the "core", the vertical stability of the body of young football players.

Our studies confirm the research of the scientists V. O. Kashuba (Kashuba, 2016, 2019), according to which functional disorders of locomotor system of children affect the goniometry of their bodies. The data characterizing the age dynamics of the formation of the biogeometric profile of posture of primary schoolers, and those characterizing the peculiarities of disorders of posture of young athletes are added.

Conclusions

The negative dynamics of the posture of football players was revealed. Thus, among the 7 year old football players a normal posture was observed in 66.67% of the examined, while among the 8 year old athletes this number decreased to 60.66%, and among the 9 year old footballers the number of athletes with a normal posture was 45.65% only.

Postural disorders were found to affect the goniometric parameters of the body of young football players. Functional muscle status of young athletes with a normal posture is higher than of those having postural disorders. Thus, the static endurance of the muscles of the front of the body and legs of 7 year old football players with a normal posture (104.00 ± 2.04 s) is significantly higher than of children with a flat back (89.0 ± 2.07 s) and a scoliotic posture (88.00 ± 3.61 s) (p <0.05). Moreover, the level of static endurance of the muscles of posterior trunk and leg of 7 year old football players with a normal posture (113.00 ± 4.22 s) was significantly greater than that of football players with other types of posture, especially with round-concave back (99.00 ± 3.48 s) and scoliotic posture (97.00 ± 5.97 s) (p <0.05). The same trend was clearly evident for 8 and 9 year old groups of football players.

The results obtained suggest that, among the football players with postural disorders, the studied indicators of development of static endurance of the muscles of anterior trunk and leg and standing balance of the body are lower than among children with a normal posture, and in our opinion, they are caused by lop-sided development of the locomotor system, namely the muscular system.

There has been explained and developed the program of correction of postural disorders of young footballers taking into account functional disorders of locomotor system, features of goniometry of the body and physical fitness, including such structural elements as the following: the objective, tasks, principles, means and methods, models of trainings, modules of its implementation, as well as the multimedia information and methodological system "Torso". The program of correction of posture of football players at the initial stage of training consists of three modules - theory, correction, and control. The selected corrective exercises were divided into the following blocks: Correctional, Prophylactic, Dynamic Posture, Vertical Body Stability, Physical Games and Relays, and Stretching.

The effectiveness of the offered program for the correction of posture of football players at the stage of initial training is evidenced by the quantitative changes of the studied indicators among the persons of the experimental and control groups. Thus, during the program implementation, the improvement of all three indicators of the biogeometric profile of the posture of young football players of the EG was found. The positive impact of implemented means and methods on the fitness of young athletes revealed during the formative experiment in this study allowed us to recommend the use of the program to prevent postural disorders in football players at the initial stage of training.

Conflict of Interest

All the authors declare to have no conflict of interest.

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