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Study of respiratory and circulatory system, locomotor and mechanical characteristics in first-class male football players aged 15-19 years

For a doctoral (Ph.D.) thesis

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Introduction

My thesis was inspired by the poor sporting results of Hungarian football in the past decades and the reasons for this, especially considering that during the 1920s and 1930s there were numerous football schools in Hungary that had a significant impact on the history of football, and it can almost be said that the impact - as the sport was still in its infancy at that time - was greater than the Barcelona School of the 1990s. The combination of rigour and soaring imagination was unique, with countless brilliant players and coaches who have gone on to achieve great renown. Known as the 'Golden Team' in the 1950s, the national team achieved the distinction of being considered unbeatable by beating the world, and its legendary captain Ferenc Puskás became one of the first global stars in football history.

In the course of our research, we came across legendary coaches with Hungarian roots, such as Dori Kruschner and Imre Hirschl. Kruschner's name is associated with Brazil, as contemporary records show that the revolutionary changes he introduced led to Brazil's success in the 1958 World Cup, while Hirschl made his mark as coach of Argentina's River Plate in the 1930s. We might as well ask where French football would be without Joseph Eisenhoffer. In conclusion, the sport was introduced to the world by the British - shipbuilders, sailors, industrialists, teachers and bankers - in the late 19th and early 20th centuries, but it was the Hungarian diaspora between the two world wars that helped the sport to develop.

Football is still the most popular sport in the world today, moving millions of people from week to week thanks to its uncertain outcome. As a consequence of globalisation, huge sums of money are moved around, just think of the transfer fees, merchandising revenue or even match-day ticket sales. Sports science, as a multidisciplinary science, has undergone rapid and extensive development in recent decades, which has also reached the sport of football. It is now possible to predict from an early age what height one can expect to reach in adulthood, to determine who is capable of performing rapid movements or who can perform activities requiring endurance over long periods of time. These characteristics are now objectively measurable and are extremely important for selection. However, it is also a fact that each sport has its own specific technique, not only in terms of the elements that are specific to the sport, but also in terms of the general elements of movement that complement it, such as running, distance covered, acceleration, deceleration and jumping. There is a wealth of objective data available following a match, the processing of which provides a wealth of information on the situation at the time.

In my thesis, I focus mainly on motor skills, as innovation has allowed us to analyse objective data. Of course, as I wrote before, since technique and tactics are closely related to physical endurance, the data recorded by the performance tracking systems helped me to draw conclusions. My personal goal with this thesis is to contribute to the further development of Hungarian football through the knowledge and research acquired and applied in my field, and to present directions for further reflection for the domestic players of the sport.

Goals

The objectives of the study are as complex as the nature of the problem outlined. Considerable research has been conducted on the anthropometric and physiological profile of adult football players (Gravina, L, et al., 2008; Mensah, T.K, et al., 2020), but fewer studies have focused on the anthropometric and physiological characteristics of young football players representing different age groups and playing positions. In addition, these characteristics have not been studied in the context of competitive football in Hungary, and the literature on anthropometric and physical performance characteristics of Hungarian football players in general is also scarce. The concept of creating anthropometric and physiological profiles using multi-aspect tests with a critical approach is very topical, as talented football players are difficult to identify. This is because the development of young players is determined by a number of factors, including anthropometric, physiological, technical, tactical and psychological characteristics, as well as environmental and sociological influences. (Unnithan, V, et al., 2012; Larkin, P. et al., 2017). From this perspective, I believe that research on these perspectives of Hungarian football players can provide valuable insights for football coaches, strength and conditioning professionals.

The basic aim of our research was therefore to: **(a)** identify the anthropometric and physiological profiles of Hungarian boys' football players of different age groups (14-, 15-, 16- and 17-18-year-olds) playing in different positions, and **(b)** to present and explain the similarities and differences between the analysed groups of athletes. Since running performance in matches is age-dependent, existing knowledge gaps need to be filled to assist professionals in determining at which age(s) additional training is needed to improve running performance in the most physically demanding positions.

The following question was formulated: *are there differences in anthropometric, physiological and motor characteristics of junior football players by age group and post?*

A further aim was to focus on the cardiovascular locomotor and mechanical performance of children in the U16 age group (and later in other age groups of the academy) in the laboratory and in terms of outcome, based on different outcomes, match situations and positions on the field.

We also aimed to examine the match performance of the U19 team in comparison with Bayern Munich U19 team, based on the same considerations.

Hypotheses

1) It was thought that the characteristics of the sample by age group would be reflected in both height and weight averages.

(2) We are talking about a relatively homogeneous pattern in terms of subtype, perhaps with a predominance of the "mesomorphic-ectomorphic" constitution that is advantageous for competitive sport. The analysis of anthropometric characteristics, including fat mass, muscle mass, and subtype, may differ in some playing positions.

(3) For circulatory, respiratory and metabolic characteristics, it was assumed that aerobic performance improves with age. This is coupled with an increase in the anaerobic threshold as a proportion of power.

(4) We also hypothesized that there would be real differences in aerobic capacity and anaerobic breakpoint pulses based on playing positions.

(5) We thought that the final result of the match (winner, loser, draw) is fundamentally influenced by the running performance, and that we should treat the differences between the posts as an important criterion, if they exist at all.

(6a) For the development of Hungarian football, it was assumed that the failure of the last decade and the outcome of matches could be related to the running performance in the match.

(6b) The available performance diagnostic tools provide insight into the distance covered by players in a match and the speed range at which the movement is performed. We therefore felt that a greater emphasis should be placed on finding players who are not only capable of performing a particular movement or movement form at high speed, but who are also capable of achieving a speed range above >25.2 km/h during their running movement.

(7) We may think that running performance can have a decisive influence on the final outcome of a match, but since the speed of the game is determined by the speed of the ball, perfect technical knowledge and a high level of tactical awareness are essential. We wanted to compare the application and effectiveness of the in-match technical elements of players from a top Hungarian academy with the performance of direct junior players from a TOP5 club.

(8) It was assumed that a high level of technical elements and the resulting individual qualities would play a greater role in the final outcome of matches than running performance.

METHODS, SUBJECTS

The study was conducted at the ETO FC Győr football club (Győr, Hungary) during an off-season period (January-early February 2022). Eighty-one boys' football players aged 14-18 were included in the study. All players are certified players of the Fehér Miklós Elite Football Academy and play in the Hungarian elite youth league. The age categories defined by the MLSZ were used as subgroup classification criteria. Four subgroups were created: 14 year olds ($n=20$), 15 year olds ($n=16$), 16 year olds ($n=22$) and 17-18 year olds ($n=23$). In each group, a given player position was represented by the following number of players: strikers ($n=23$), central defenders ($n=15$), wing-backs ($n=12$), central midfielders ($n=12$), wing midfielders ($n=10$) and goalkeepers (n=7). The analysed subgroups (14-, 15-, 16- and 17-18-year-olds) were 4.2 ± 0.6, 5.4 ± 0.9 years, 6.1 ± 0.8 years and 7.8 ± 1.5 years of training age, respectively. The two youngest subgroups (14 and 15 year olds) trained three times a week for 90 min (Monday, Wednesday, Friday) and had a (>70) min per game (alternating Saturday or Sunday) on weekends. The two older sub-groups trained four times a week (Monday, Tuesday, Thursday, Friday) for 90-120 minutes and had a (>70) minute match load on the weekend (Sunday). All players, regardless of age group, participated in an average of ~12 hours of combined football-specific training, strength, coordination and conditioning. Players were excluded from the study in the following cases: (1) acute injury or condition limiting physical function; (2) lower limb injury in the last six months.

In the academic work, we highlighted the (U16) age group (age: 15.63±0.27; height: 176.66±7.04 cm; weight: 61.51±7.59 kg) and examined 11 matches of the 2021 autumn semester, which represented 92 game performances. Players' match results were grouped by post and final result (win=4; loss=5; draw=2). In turn, we grouped children by post into attackers (n=56), defenders (n=78) and midfielders (n=45). Players' time on the pitch per match was defined as >70 minutes.

Participants and their parents or legal guardians gave written consent to participate in the study and to publish the players' pictures in accordance with the ethical guidelines of the Helsinki Declaration and subsequent updates. The study was approved by the National Centre for Public Health Ethics Committee (17990-7/2022/ECIG).

The anthropometric, physiological and performance characteristics of youth football players from the flagship academies are measured on an ongoing basis, as instructed by the Ministry of Human Resources. The tests are always carried out by the same qualified professionals. The data are stored in a central database, which is a cloud-based platform for athletes (TalentX). Thus, these data have been analysed in this study. In the first phase of the study, demographic and anthropometric data of the participants were collected. Biological age was estimated based on morphological age (MA) using the method described by Mészáros and Mohácsi. Briefly, the average of chronological age (CA) and three age values of height (BH), body mass (BM) and plasticity index (PLX), each defined to the nearest 0.25 years, was calculated according to the formula MA = 0.25 - (BH age + BM age + PLX age + CA). Afterwards, a standard warm-up of 8 min was performed (running, joint mobility exercises and neuromuscular activation exercises) and the results of the following assessments were recorded: isometric strength of the hip abductor (ABD) and adductor (AD) muscles and the results of the Y balance test (YBT). All tests were explained verbally and participants were given a trial to familiarise themselves with the task (these results were not recorded).

All anthropometric characteristics were assessed by a trained, ISAK-accredited (Level 1) examiner according to the standardized procedures of the International Society of Kinanthropometry (ISAK). Body height (TM) was measured to an accuracy of 0.1 cm (Seca 217, Hamburg, Germany) using an ultrasonic height meter. Body mass (BM) was measured to the nearest 0.1 kg after removal of shoes and heavy clothing. Body composition variables (percentage of fat mass and muscle mass) were measured in the standing position using the InBody 720 tetrapolar 8-point tactile electrode system (Biospace Co., Ltd., Seoul, Korea). Body composition measurements were performed according to the relevant measurement guidelines. Three body measurements (shoulder width, forearm circumference and hand circumference) were measured using a special anthropometric device (Martin Anthropometer, GBM, SiberHegner, Zurych, Switzerland, 2003) and a metal tape measure (Holtain, Crymych, UK).

Sprint performance Linear sprint (5, 10 and 20 m)

All tests were carried out indoors on PVC tread. Four pairs of wireless single-beam timing gates (TAG Heuer, La-Chaux-de-Fonds, Switzerland) were placed 5 m apart. The gates were set at a height of 1 m, which was approximately the same as the participants' hip height. A high-speed camera (Weinberger Deutschland GmbH, Erlangen, Germany; 100 frames per second) was placed behind the initial timing gate, aligned with the timing beam. The subject and the timing beam were in the field of view of the camera. A reflective marker was placed on the participant's left hip to indicate the height of the centre of gravity. Subjects performed a 10-minute general warm-up consisting of light jogging, short accelerations and dynamic stretching exercises. The order of starting distances was randomized to eliminate possible effects of fatigue.

Measuring the ability to agility

(IAGT) tests the ability to accelerate and change direction during linear sprinting. The CODAT consists of a straight 5 m sprint followed by three 3 m sprints. These 3 m sprints are performed at 45° and 90° angles. The third 3 m sprint is followed by a 10 m straight sprint to the finish line. The 5 m and 10 m linear sprints are included because speed over these distances differentiates between faster and slower athletes (Lockie et al,
2011) and is important for the overall linear acceleration (Sporis et al., 2010).

Fitness test with a track record

The Yo-Yo IR1 study was performed according to the method described by Krustrup et al. (2003). Twenty m shuttle runs at increasing speeds were performed until fatigue, with a 10 s active recovery period between each run (2 × 5 m jogging). The test ended when the objective criteria (two failures to reach the first line on time) or subjective criteria (participant was unable to continue at the prescribed speed) were met. The total distance covered during the test was used in the statistical analysis.

Isometric strength testing of the hamstrings and hip

The current status of the hamstring muscles was measured using the *"NordBord®"* Hamstring Testing System Device (VALD Performance Pty Ltd., Brisbane, Australia). Hip isometric strength was measured using the *"ForceFrame®"* Strength Testing System (VALD Performance Pty Ltd., Brisbane, Australia) device following a tension protocol (Impellizzeri, F.M. et al., 2007, Kadlec, D.; et al., 2021).

Examination of the circulatory and respiratory systems

The load tests are carried out at the Academy's Load Laboratory, using the instrument "Piston" Ltd. European VAT code: HU 10465905. The spiroergometric tests were performed before the start of the autumn season, following a progressive intensity protocol until complete fatigue on a treadmill. All players underwent the test after two light football adaptation training sessions in order to minimize injuries. Before starting the workload, players performed an individual warm-up consisting of 5 minutes of self-paced cycling and 3 minutes of dynamic stretching. The test protocol began with a 5 km/h walk for one minute and continued at 8 km/h. The speed increased by 2 km/h every two minutes with a continuous inclination of 2°. Players were instructed to run to exhaustion and were given strong verbal encouragement to perform at their best during the test.

Match-performance analysis

Data from the "*Catapult Vector S7."* (Catapult Sports, Melbourne, Australia) were collected using electronic performance tracking systems. This device contains inertial sensors (four 3D accelerometers, three 3D gyroscopes, a 3D magnetometer and a barometer) that collected data at 100 Hz. The validity and reliability of this device has been analysed for the collection of time and motion variables and is considered a suitable device for this purpose in football (Wundersitz DW., et al., 2015). Six characteristics considered informative by the literature were recorded during the matches *(Table 1)* (Rampinini, E.,2007).

Match performance analysis with "InStat" system

The "*InStat"* experts register all actions: goals, passes, duels won... An algorithm calculates all the actions and produces the player's InStat index, which varies from match to match. Each number is interactive, you can play a video or create a playlist with a click. Statistics, videos, custom reports and profiles help players to objectively evaluate their own performance. Numerous analytical systems are used around the world for tactical analysis of football matches. In Hungary, the Instat analysis system is the preferred analysis system adopted in Europe. Many studies have been carried out on the pure playing time of a match

RESULTS

Results I. Anthropometric and physiological characteristics of male football players of different ages (14-19): a multidimensional assessment using a critical approach

Differences in anthropometric characteristics between age groups

The chronological age of players in all age groups was very similar to their biological age. Differences in anthropometric characteristics between age groups were consistent with the chronological and biological age of the participants. In the vast majority of cases, the highest values of somatic characteristics, including height, body mass, BMI and fat mass, were observed in the oldest group. In general, anthropometric parameters were significantly higher ($p<0.001$) in the 17-18 year old group than in the 14-15 year old group, while no significant differences were found between the 16 year old and 17-18 year old groups ($p>0.05$). Percentage muscle mass (%M) was the only exception and this parameter was highest in 15 and 16 year olds, but differences between age groups were not significant ($p>0.05$). The maximum body mass was relatively high for football players in all age groups (range: 80.25-91.80 kg). Analysis based on Heath-Carter body type classification showed no significant differences ($p>0.05$) in the percentage of endomorphic, mesomorphic and ectomorphic somatotypes between groups. However, ectomorphs were predominant in all age groups.

Differences in physiological characteristics between age groups

In the vast majority of the motor tests *(Tables 1a and 1b),* (17-18) year olds achieved the best results, significantly higher ($p<0.001$) than (14-15) year olds. In addition, the oldest players also performed significantly better ($p<0.001$) than the 16-year-olds [s] in the 505 COD test for the dominant leg and the Illinois test with and without ball [s]. However, the results of the NB-IBM [%], FF ADD limb [%], and 5 and 10 m speed [s] tests did not differ significantly ($p>0.05$) between age groups. HR_{rest} values were highest in the 16 year old and (17-18) year old groups (76.3 and 77.5 strokes×min^{-1}) and were significantly higher than in the 15 year old group. However, the mean HR_{rest} values for 15-year-olds (63.5 strokes×min^{-1}) were significantly lower ($p<0.001$) than for the other age groups. The HR_{max} values of ergospirometric tests and ATP values did not differ significantly between 16-year-olds and 17-18-year-olds (range: 194.2-196.7 and 180.6-183.2 bpm, respectively). The mean values of $rVO2_{max}$ and rVO2/AT were highest in 14-year-olds (57.6 and 51.2 ml×kg^{-1} ×min^{-1}) and significantly higher than in 16-year-olds (52.6 and 46.8 ml×kg^{-1} ×min^{-1})

Results II. Cardiovascular characteristics and performance indicators in football, U16 academy boys

Significant differences were found between the height averages, with the highest for defenders (179.89± 5.20) and midfielders (175.3±9.79), who are taller than their attacking counterparts. As for the differences in aerobic capacity between the positions, the midfielders have the best results (58.33± 4.10), significantly higher than their counterparts in the other two positions. Comparing the six performance characteristics tested by half-time, significant differences were found between the first and second half distance covered, MT_1 -MT_2 =(5069.9±689.8-4603.6±825.1); $p<0.001$ means and total player workload TJT_1 -TJT_2 =(534.6±161.0-461.3±99.8); $p<0.001$ means.

Results III. Match analysis by locomotor and mechanical characteristics compared by age group

In total, 337 academics' data were analysed. Data were measured in the first and second half of the game for U15 (n=88), U16 (n=92), U17 (n=85), and U19 (n=72) players per age group.
The measured variables were statistically significantly higher in the first half than in the second half, regardless of age. There were six variables for which there was no statistical difference between the measured variables of the two halves, the mean values of which also showed a relatively higher value in the first half compared to the second half All of the measured variables in the first half showed statistically significant differences between the age groups studied. In the second half, with the exception of one variable - deceleration B23 minutes - there was also a statistically significant difference between the age groups tested. Overall, in both the first and second half, the U15 age group showed a lower value compared to the U19 age group. The U16 and U17 results were generally in between. In the second half, for explosive efforts, the U17 age group showed a lower score compared to the U19 age group, and the other two age groups showed an intermediate score.

3.4 Results IV Examination of U19 team matches with different outcomes, accurate or inaccurate execution of tactical and technical elements - based on the frequency of *"InStat"* results

The average playing time of the matches included in the study was 96 minutes and 14 seconds. In the TOP leagues, "extra minutes" ranged from 7 minutes and 26 seconds to 6 minutes and 22 seconds. The average playing time for NB1 matches was 95 minutes and 11 seconds. In the light of the above, we wanted to investigate whether the measured match performances of the home U19 team show any difference compared to the performances of Bayern Munich, an international elite team of the same age group. The Bayern team was chosen because, on the one hand, it is in the TOP5 league and, on the other hand, it uses the same analysis system Instat as Hungarian football, so we can compare objective data.

SUMMARY

Studies evaluating the relationship between young football players' match performance and anthropometric parameters (height and weight, skinfolds) have shown that excessive body weight and fat mass are associated with weak to moderate scapular and abdominal fat folds, which is undesirable (Sporis, G, et al, 2011; Buchheit, M.; Mendez-Villanueva, A. 2014). For this reason, the maximum body mass values of 16, 17 and 18 year old Hungarian football players (in some cases exceeded 91 kg) are a serious concern. Thus, ***our first hypothesis is partly valid*** and may also be a warning for the professional team in charge of development. However, the mean values of BMI and %BF were within normal limits in all age groups.

The lack of significant differences in muscle mass between age groups is also a concern. Muscle mass should be highest in the oldest group (17-18 years old), but the highest values of this parameter were observed in the 15-year-olds (>1.4 kg difference compared to 14-year-olds; >0.5 kg difference compared to 16-year-olds; >0.8 kg difference compared to 17-18-year-olds). Thus, our hypothesis that relative muscle mass (M%) increases with age does not hold in this sample, and is ***therefore not valid.***

In general, the analysis of the different playing positions (strikers, defenders, midfielders and goalkeepers) showed that anthropometric (biological age, body weight, height, BMI and PLX) and physiological parameters were higher in goalkeepers in most cases. In terms of anthropometric characteristics (height, body mass, PLX, BMI and endomorphic somatotype), goalkeepers differed significantly from midfielders (6 cases), defenders (4 cases) and strikers (3 cases). As regards the subtype characteristics of the whole sample, we can speak predominantly of mesomorphic-ectomorphic, which is a basically favourable constellation. ***Our hypothesis is entirely valid.***

The analysis of $rVO2_{max}$ and rVO2/AT values, considered to be the most important components of endurance performance (Hoff, J.; Helgerud, J, 2004), revealed some training gaps (no training load progression due to age and training experience). Surprisingly, the mean values of $rVO2_{max}$ and rVO2/AT were highest in the youngest group (57.6 and 51.2 and mL/kg/min, respectively), and $VO2_{max}$ values were significantly higher than those of the 16-year-old group (46.8 and 46.8 $mL \times kg^{-1} \times min^{-1}$). The 14-year-olds also had the largest maximum $rVO2_{max}$ and rVO2/AT values (68.3 and 60.8 and ($mL \times kg^{-1} \times min^{-1}$), respectively), and the largest differences between minimum and maximum values (24.5 and 21.9 ($mL \times kg^{-1} \times min^{-1}$), respectively), suggesting significant differences in aerobic thresholds in this age group. ***Thus the assumption that relative aerobic capacity increases with age does not hold. However, it should be stressed that the averages of absolute values across age groups are indeed larger, but the increase in body weight is larger than the increase in absolute values of aerobic capacity. The*** average $VO2_{max}$ of elite football players generally ranges between 55 and 68 ($ml \times kg^{-1} \times min^{-1}$) and is influenced by the player's position (McMillan, K, et al., 2005).

However, it is still not known whether Hungarian goalkeepers perform significantly better than other players in terms of lower limb strength. The lack of significant differences between HR_{rest} , HR_{max} and ATP values is also surprising because goalkeepers tend to cover shorter distances than other players.

Therefore, the lack of differences between $rVO2_{max}$ and rVO2/AT values should also be interpreted with caution, as these parameters should be significantly lower for goalkeepers than for field players. Strøyer et al. observed higher $VO2_{max}$ values for midfielders/attackers than for defenders 65 vs. 58 ($ml \times kg^{-1} \times min^{-1}$) for young elite football players at the end of puberty (i.e. at age 14 years). In our study, ***we found a real difference in $VO2_{max}$ averages by*** playing position in the U16 age group, with ***midfielders performing best (58.33±4.10) $ml \times kg^{-1} \times perc^{-1}$, followed by defenders (56.47±3.80) $ml \times kg^{-1} \times perc^{-1}$, and forwards (54.56±6.53) $ml \times kg^{-1} \times perc^{-1}$. This assumption is indeed true.***

The results show that the basic somatic parameters of the football players studied increased with age, which is consistent with natural biological developmental processes. In all age groups of Hungarian football players, the mesomorphic-ectomorphic constitution was predominant. Mean values of anthropometric, body composition, physiological and performance variables were within normal limits in all age groups, indicating an appropriate selection process. Surprisingly, among the age groups, the mean values of $rVO2_{max}$ and rVO2/AT were highest in the youngest players aged 14 years (57.6 and 51.2 ($ml \times kg^{-1} \times min^{-1}$), respectively; smallest range of values). This study also confirmed the significant differences in anthropometric and physiological characteristics of the different playing positions; the highest values of these parameters were observed in goalkeepers. Goalkeepers scored higher values in lower limb strength (NB max dominant and non-dominant leg, NB average non-dominant leg, FF max dominant and non-dominant adductors, FF max right and left abductors), sprint performance at 5 and 10 m, and agility tests (Illinois test with and without ball). Goalkeepers scored significantly lower than other players (forwards, defenders and midfielders) only in the Yo-Yo test.

Taking into account practical applications, the current results suggest that national grading standards based on anthropometric and physiological characteristics of players studying at eleven football academies in Hungary should be developed. These standards would support the rapid analysis and comparison of football players within age groups based on selected strength and endurance parameters and the general profile of football players (GPSP).

Finally, an in-depth understanding of the anthropometric and physiological parameters of football players in relation to age group, level of competition and playing situation would help professionals in individualised training to try to assess and develop football-specific skills in relation to these factors and optimise player performance.

The present study has not demonstrated a direct relationship between performance per post and the final outcome of the match. This is probably because the data recorded by the Catapult is mainly influenced by the effectiveness of technical-tactical elements in a football game. In other words, players may have excellent circulatory characteristics, but a lack of technical and tactical skills can significantly affect the team's performance. Of course, this can also happen in the opposite way. However, we have found characteristics based on the positions that players take that can help team coaches shape tactics.

The present study has shown that the distance covered by Hungarian youth players, i.e. the net running performance, reaches the level of international TOP football, but there is a significant gap in terms of the speed zones required to effectively perform football. In the future, emphasis should be placed on selection and suitably qualified professionals should be involved in the process. In other words, it is not enough to take into account childhood skills, but the involvement of highly qualified professionals with knowledge of developmental biology is essential to move forward. Without this, the success of the game will remain limited.

It is clear that the proper execution and application of technical elements at a high level of speed has an impact on the final outcome of matches, which can be used to improve the tactical repertoire. In order to make progress in this area, it is necessary to introduce the teaching of technical elements at an early age, taking into account the specificities of the age of the child, at the most sensitive stages of development, and to introduce them into the methodological training of teachers, with the help of qualified professionals. Without this, no lasting progress can be expected.

Publication list

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