Journal of Physical Education and Sport ® (JPES), Vol.20 (6), Art 475, pp. 3521 - 3527, 2020
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Dynamics of morphological and functional indicators of 10–12-year-old football players involved in the children and youth sports school program

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Published online: December 30, 2020
(Accepted for publication: December 15, 2020)
DOI:10.7752/jpes.2020.06475

Abstract.
Paper considers the dynamics of morphological and functional indicators of young football players 10-12 years old. *Objective* study was conducted among football players of the FC Arsenal. 24 football players of 10, 11 and 12 years old took part in it, who train according to the state program for children and youth sports schools of Ukraine. *Results*: Morphological indicators by age have an uneven tendency to change. Indicators of body weight, chest circumference and anaerobic anabolic (ANAME) and anaerobic metabolic capacity (AME) football players significantly increase every year (p>0,05). An analysis of heart rate data of football players showed that with age, indicators decrease. Arterial systolic pressure (BP syst.) and diastolic pressure (BP diast.) does not increase significantly with age. Conclusions: During the study, body length increased on average from 10 to 11 years (t = 2,10; p <0,05) and from 11 to 12 years (t = 2,01; p <0,05), body weight (t = 2,47; 2.96; p <0,05 - 0.01), chest circumference (from 11 to 12 years; t = 2,17; p <0,05), respectively. The indicators of the cardiovascular system significantly improved only in heart rate (from 10 to 11 years; t = 3.07; p <0.001), in BP, ANAME and AME no significant changes were identified. At the same time, indicators of the respiratory system significantly changed in VC (from 11 to 12 years; t = 2,20; p <0,05) and respiratory rate (from 10 to 11 years; t = 3.23; p <0.001). The obtained indicators indicate a moderate load of young football players who train according to the program of the children's and youth sports school, which is important during the formation of functions and systems of the children's body.
Key words: football players; girth of the chest and anaerobic anabolic (ANAME) and anaerobic metabolic capacity (AME) heart rate (HR), blood pressure (BP syst. and BP diast.).

Introduction

Relevance of the research

It is well known that the modern development of elite sports is entirely based on children and youth sports. At the same time, children and youth sports are characterized by high morbidity, traumatism and mass dropout of children from sports [9]. That is why an important task in modern children and youth sports is competent and modern selection at all stages of sports training [9,17,19]. The growth of sportsmanship largely depends on the degree of development of physical qualities and morphological and functional characteristics of a young athlete [8]. However, this topic has not been fully studied and there is an insufficient number of studies on the development of criteria that allow predicting athletic performance in young athletes [10, 11] and they mainly concern 13 year oldathletes and older. Anthropometric [12], morphometric [15,24] and pedagogical [14] characteristics are referred to predictive criteria in football.

Game and training activities have a comprehensive and versatile impact on the body of those involved, develop basic physical qualities - strength, speed, endurance, dexterity, increase the functionality of the body, form various motor skills [4,16].

In football, according to the cited literature data, the expediency of using a set of indicators in the selection is shown, where morphological and functional characteristics, more genetically determined, have a special informative value [18]. Among such indicators, the authors include the length of the body and individual limbs, as well as variable indicators of physical fitness, mainly genetically determined, which slightly change under the influence of the external environment. These include individual morphometric signs of body structure,

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coordination of movement and a predisposition to certain types of muscle activity[20,22,23]. In addition to stable characteristics that indicate the individual rate of development of the body, there are labile characteristics that change significantly under the influence of the environment, such as, for example, muscle strength, mobility in joints, the state of the respiratory and energy supply systems [21,24]. For example, heredity has the greatest effect on the longitudinal dimensions of the body (length of the trunk, upper and lower limbs, etc.), less - on latitudinal dimensions (width of the pelvis, hips, shoulders) and even less - on the girth dimensions (girth of the wrist, thigh, lower leg and etc.

The level of results in modern sports is so high that to achieve them, an athlete needs to have rare morphological data, a unique combination of a set of physical and mental abilities that are at an extremely high level of development [1,6,9]. Therefore, a football player, in addition to physical fitness, a high level of psycho-functional state, coordination abilities, technical and tactical skills, psychological stability and stress resistance, must have high morphofunctional indicators for full competition in the training and competition process.

Analysis of the latest publications.

In football, as in other sports, the level of achievement of sportsmanship is associated with certain morphofunctional changes, it should be noted that some morphofunctional indicators can be both hereditary and acquired [4,5,7]. Systematic football lessons, like other types of sports, helps to strengthen the body, increase its physical development and working capacity, this is accompanied by specific morphofunctional changes in the basic systems of the body, significantly expanded their functional capabilities, improved regulatory mechanisms, increased range of compensatory and adaptive reactions [8].

Thus, the relevance of the research topic is determined by the significant importance of information in the dynamics of the development of morphological and functional indicators of young football players, to improve the quality of educational work.

Purpose of the study was: to determine the dynamics of age-related development of morphofunctional indicators of young soccer players 10-12 years old under the influence of the state program of the children's and youth sports school of Ukraine.

Material & methods.

Participants.

The study was conducted among FC Arsenal football players. 24 football players of 10, 11 and 12 years old took part in it, who train according to the state program for children and youth sports schools of Ukraine.

Procedure.

Determination of anthropometric indicators: the length of the body in a standing position was measured using a height meter. Measuring the length of the body, the athlete becomes his back to the vertical stance, touching her heels, the plane table is lowered until it touches the head.

Accurate calibrated beam-type weights were used to measure body mass; weight was recorded with an accuracy of a tenth of a kilogram. Young athletes weighed in sports shorts.

Circumference of the chest (cm) was measured with a centimeter tape, at the same time it is necessary to circle a centimeter tape around the chest so that it passes from behind at the lower corners of the shoulder blades, and in front at the level of the 4th rib.

Assessment of physical performance was carried out using the submaximal load test PWC 170 [2, 11]. The content of this test is to determine the power of the work that the athlete is able to perform at a heart rate of 170 beats per minute. Physical activity was performed on a bicycle ergometer in a sitting position. The seat on the bicycle ergometer was set at such a level that in the lower position of the pedal the foot of the football player was completely straightened in the knee joint. Two loads of 5 minutes each were performed, the rest interval between loads was 3 minutes. The calculation of the power of the first and second load was carried out taking into account body weight. The first load was selected based on 1 W (6 kg × m min^{-1}) per 1 kg of body weight, the second - 2 W (12 kg × m min^{-1}) per 1 kg of body weight.

At the end of the first and second loads, heart rate was recorded. Heart rate at the end of the first load should be 100-120 beats min^{-1}, at the end of the second - 140-160 beats min^{-1}. The difference in heart rate between the first and second loads should be 40 beats · min^{-1}. If the heart rate difference of 40 beats min^{-1} was not reached, then after 3 minutes of rest, the third load was performed at the rate of 2.5-3 W (15-18 kg × m min^{-1}) per 1 kg of body weight. In this case, the first and third loads are taken into account. The calculation of indicators of physical performance was carried out according to the formula [6]:

$$PWC_{170} = N_1 + (N_2 - N_1)\frac{170 - f_1}{f_2 - f_1},$$

where: PWC_{170} – exercise power at HR 170 beats min^{-1}inWorkg· m ·min^{-1};

N_1 and N_2 – capacity of the first and second load in W or kg· m ·min^{-1};

f_1 and f_2 – HR at the end of the first and second load.

To determine the maximum oxygen consumption (MOC), lung vital capacity (VC), a dry spirometer (ml) is used. The person being examined takes the mouthpiece of the spirometer to his right hand, takes a deep breath and tightly holding the mouthpiece with his lips, exhales all the air into the tube.

Heart rate (HR) is one of the important physiological indicators characterizing the state of the cardiovascular system during physical exertion.

Heart rate was measured using a special sport watch POLAR RS 800, which consists of a sensor that is mounted on the chest of a football player and a registration watch placed on the hand.

To measure the values of systolic (upper), diastolic (lower) pressure and heart rate (pulse), an automatic UA-668 digital tonometer was used. This device operates on the oscillometric measurement method.

To assess the functional preparedness of athletes, the ECG complex CARDIOLAB was used. Athletes were determined indicators of systolic pressure, diastolic pressure, heart rate, MOC, AME, ANAME.

The CARDIOLAB electrocardiographic complex is designed to record human biological signals with electrocardiographic channels, analyze heart rate variability, conduct physical exercise tests, process the captured signals and display them on the screen and print them out. A complex of express diagnostics of athletes' functional preparedness was used according to the method of S. A. Dushanin[7].

Registration was carried out at rest; a preliminary assessment contained the automatic formation of a preliminary linguistic conclusion. In the absence of contraindications, the tester further performed the PWC170 test by cycle metering using the KETTLER complex, after the test was completed it was immediately proposed to re-register the parameters. To assess changes in heart rate, the state of its vegetovascular regulation (VVR) was recorded before and after exercise. According to BCC, 34 indicators were evaluated that characterize the activity and relationships of the autonomic nervous system at different levels of regulation [2, 11].

Statistical data processing. Methods of mathematical statistics are used in accordance with the known recommendations with the use of computer programs "EXCEL" and "SPSS" [1,25].

Results:

The study of the average team-wide morphofunctional indicators of football players aged 10-12 years showed the unevenness of their changes during the training sessions and competitive activity (Table 1).

Morphological indicators by age have an uneven tendency to change. So, the indicator of body length between 10-11 years old increased by 7 cm ($t = 2,10$; $p <0,05$), and at 11-12 years of age the difference was 7,5 cm ($t=2,01$; $p>0,05$) (Table2).

Table 1

Dynamics of changes in morphological and functional indicators of young football players of the studied group aged 10-12 years who were engaged in the program of children and youth sports school ($n_1=n_2= n_3=24$)

№ i/o	Indicators	Age, years		
		10	11	12
		$X_1±m_1$	$X_2±m_2$	$X_3±m_3$
Morphological indicators				
1	Body length, cm	141,3±2,12	148,3±2,57	155,81±2,73
2	Body weight, kg	38,3±1,02	42,1±1,15	47,1±1,23
3	Chest circumference, cm	70,2±1,11	72,1±1,08	75,6±1,19
Indicators of the cardiovascular system				
4	HR, beats·min^{-1}	80,3±0,65	77,2±0,77	75,6±0,72
5	BP syst., Mm Hg	103,3±3,5	107,4±3,04	115,5±3,43
6	BP diast., Mm Hg	60,2±2,31	62,4±2,54	65,4±2,71
7	ANAME, c. u.	70,2±1,52	73,3±1,25	76,2±1,49
8	AME, c. u.	205,4±3,11	212,3±3,2	217,5±3,12
Indicators of the respiratory system				
9	VC ml	2429,6±108,6	2543,2±105,2	2876,45±106,3
10	MOC, ml. min. kg	43,3±1,12	45,4±1,14	46,6±1,13
11	Respiratory rate in 1 min., times	19,7±0,33	18,3±0,28	17,8±0,53
12	Breath holding on exhalation, s	16,1±1,12	18,4±1,17	19,22±1,27

Table *2*

Matrix of statistical significance of length and body weight (cm) of football players of the studied group aged 10-12 years (n_1=n_2= n_3=24)

Age, years	10		11		12	
	t	p	t	p	t	p
10	*		**1-2,10 2-2,47**	**1-<0,05 2-<0,05**	**1-4,19 2-5,50**	**1-<0,001 2-<0,001**
11	-	-	*		**1-2,01 2-2,96**	**1->0,05 2-<0,01**
12	-	-	-	-	*	

Remark: 1 – body length 2 – body weight

The body mass indicators of football players are significantly increasing every year. So, between 10 and 11 years old, body weight increased by 3.8 kg (t = 2,47; p <0,05), from 11 to 12 years, this difference was 5 kg (t = 2,96; p <0,01) (Table 2).

The chest circumference of football players also increases with age. So, between 10 and 11 years, the difference was 1,9 cm (t = 1,22; p <0,05), from 11 and 12 years – 3,5 cm (t=2,17; p<0,05**)** (Table 3.)

Table *3*

Matrix of statistical significance of chest circumference (cm) of football players of the studied group aged 10-12 years (n_1=n_2= n_3=24)

Age, years	10		11		12	
	t	p	t	p	t	P
10	*		**1,22**	**>0,05**	**3,31**	**<0,01**
11	-	-	*		**2,17**	**<0,05**
12	-	-	-	-	*	

An analysis of the heart rate data of football players showed that with age, the indicators decrease, so a difference of 3,1 beats min^{-1} is determined between 10 and 11-year-old football players. (t = 3,07; p <0,001), and between 11 and 12-year-old players this difference was 1,6 beats min^{-1}(t=1,51; p>0,05**)** (Table 4).

Table 4

Matrix of statistical significance of heart rate (beats min^{-1}) of football players of the studied group aged 10-12 years (n_1=n_2= n_3=24)

Age, years	10		11		12	
	t	p	t	p	t	p
10	*		**3,07**	**<0,001**	**4,84**	**<0,001**
11	-	-	*		**1,51**	**>0,05**
12	-	-	-	-	*	

Systolic Blood Pressure (BP syst.) And diastolic blood pressure (BP diast.)does not increase significantly with age. The difference between 10 and 11-year-old footballers was a syst. - 4.1 Mm Hg (t = 0,88; p> 0,05), BPdiast. – 8,1 Mm Hg (t = 0,64, p> 0,05). During the period from 11 to 12 years, this difference between the players was 2,2 Mm Hg (t = 1,76; p <0,05) and 3 Mm Hg (t = 0,80; p <0,05, respectively) (Table 5).

Whereas in the period of 10-12 years, the rates of BP syst increased significantly. (t=2,48; p<0,01).

Table 5

The matrix of statistical reliability of BP syst., BP diast., football players of the study group aged 10-12 years (n_1=n_2= n_3=24)

Age, years	10		11		12	
	t	p	t	p	t	p
10	*		**1-0,88 2-0,64**	**1->0,05 2->0,05**	**1-2,48 2->1,46**	**1 - <0,05 2->0,05**
11	-	-	*		**1-1,76 2-0,80**	**1->0,05 2->0,05**
12	-	-	-	-	*	

Remark: 1– BP syst, 2 – BP diast.

The indicators of anaerobic anabolic (ANAME) and aerobic metabolic capacity (AME) of football players increase with age. So, if in 10 years the average group anaerobic metabolic capacity of the heart muscle was 70,2 c.u., then in 11 years it increased by 2,1 cu (t = 1,42; p <0,05), and at 12 years old reached 76,2 c.u. (t = 1,54, p>0,05). Anaerobic metabolic capacity in the first year of research increased by 2.9 cu (t=1,54; p>0,05), and later from 11 to 12 years the difference was 6.9 cu (t = 1,49; p> 0,05), AME – 5,2 c.u. (t = 1,16; p <0,05)

(Table 6). Whereas over the period from 10-12 years, changes in the indicators of ANAME and AME are significant ($p<0,05$) (Table 6).

Table 6

The matrix of statistical reliability ANAME and AME football players of the study group aged 10-12 years($n_1=n_2= n_3=24$)

Age, years	10		11		12	
	t	p	t	p	t	p
10	*		1-1,42 2-1,54	1->0,05 2->0,05	1-2,81 2->2,74	1 - <0,05 2-<0,05
11	-	-	*		1-1,49 2-1,16	1->0,05 2->0,05
12	-	-	-	-	*	

Remark: 1– ANAME; 2 – AME

Indicators of lung capacity from 10 to 11 years increased by 113,6 ml ($t = 0,75$; $p> 0,05$), and from 11 to 12 years old by 333,25 ml ($t=2,20$; $p<0,05$) (Table7).

Table*7*

The matrix of statistical reliability of VC and MOC of the studied group of football players aged 10-12 years ($n_1=n_2= n_3=24$)

Age, years	10		11		12	
	t	p	t	p	t	p
10	*		1-0,75 2-0,74	1->0,05 2->0,05	1-2,94 2-2,07	1- <0,01 2- <0,05
11	-	-	*		1-2,20 2-1,31	1- <0,05 2->0,05
12	-	-	-	-	*	

Remark: 1 – VC; 2 – MOC

The maximum oxygen consumption (MOC) with each year of research also increases, if in 10 years it amounted to 43,3 ml. min kg, then at 11 years old reached 45.4 ml. min kg ($t = 0,74$; $p <0,05$), and at the age of 12 the average MOC in football was 2,1 ml. min kg. ($t=1,31$; $p>0,05$) (Table 7).

At the same time, from 10 to 12 years, MOC has increased significantly ($t=2,07$; $p<0,05$).

It is also determined that the number of breaths is 1 min. decreases with age, so at 11 years old relative to the initial data by 1,4 ($t = 3,23$, $p> 0,001$), and at 12 years old decreased by 0,5 times relative to data at 11 years old ($t=0,83$; $p>0,05$) (Table8).

Table*8*

Matrix of statistical significance of the respiratory rate in 1 min (the number of times) of the football players of the studied group aged 10-12 years ($n_1=n_2= n_3=24$)

Age, years	10		11		12	
	t	p	t	p	t	p
10	*		3,23	<0,001	3,04	<0,001
11	-	-	*		0,83	>0,05
12	-	-	-	-	*	

We also note that the breath holding of young football players increases with age, but the difference between years of research is insignificant ($p>0,05$).

Discussions.

The results of our research continue a number of studies on the problem of morphological and functional indicators of professional and young football players (Dorokhov R.N. 2002; Koval S.S. 2010; Korzun D.L., Kaleby V.A., Pereverzev V.A. 2011).

Dorokhov R. N. in his work notes that the deviations of the growth process from the population curve have a normal distribution [3]. Having examined 3107 children, the author notes that the maximum increase in growth can reach 12 cm. The biomechanical characteristics of children associated with the location of the general and partial centers of gravity of the body are changing, and, therefore, the biodynamics of muscle work are changing. The second very significant indicator used in the selection and orientation in sport is body weight, which, like body growth, is controlled by hereditary and environmental factors.

Koval S.S. [6] in his thesis, notes that the training and competitive loads used in sports training under the program of the children's and youth sports school positively affect the formation of functional systems of young football players.

Research Korzun D.L., Caleby V.A., Pereverzev V.A. [5] examined the dynamics of indicators of physical development (body weight and its length, lung capacity and breath holding on inhalation and exhalation) and physical fitness (running time 30 meters from a high start, length of jump from a place) of football players 8-10 years old the period of employment in comparison with similar indicators in children, and not involved in sports. With an increase in the motor activity of young football players, first of all, functional indicators of breath holding increase, and then in parallel, in close relationship, increases: body weight (muscle mass), body length, lung capacity and physical fitness.

To summarize the above, we can confirm the importance of our research in determining the dynamics of morphological and functional indicators of young football players, since the tendency for selection in big football is traced in identifying talented players who are able to show highly competitive results.

Conclusions.

As a result of the analysis of anatomical and physiological features of 10-12 year old children and taking the min to account during the construction of the training process of young football players, it was found that body length increased on average from 10 to 11 years ($t = 2.10$; $p < 0.05$) and from 11 to 12 years ($t = 2.01$; $p < 0.05$), bodyweight ($t = 2.47$; 2.96; $p < 0.05$ - 0.01), chest circumference (from 11 to 12 years; $t = 2.17$; $p < 0.05$), respectively.

Morphological indicators with age have an uneven tendency to change. Thus, the body length between 10-11 years increased by 7 cm ($t = 2.10$; $p < 0.05$), and at 11-12 years of age the difference was 7.5 cm ($t = 2.01$; $p > 0.05$).

Maximum oxygen consumption (MOC) also increases with each year of the study, if at 10 years it was 43.3 ml. min. kg, then in 11 years reached 45.4 ml. min. kg ($t = 0.74$; $p > 0.05$), and at the age of 12 the average MOC of football players was 2.1 ml.min.kg. ($t = 1.31$; $p > 0.05$).

At the same time, the use of exercises recommended by the Children's and Youth Sports School program has significantly improved the performance of the cardiovascular system. Significantly improved only in heart rate (from 10 to 11 years; $t = 3.07$; $p < 0.001$), in BP, ANAME and AME significant changes were notidentified. Atthesametime, the indicators of the respiratory system indicate positive changes that have changed significantly in the VL (from 11 to 12 years; $t = 2.20$; $p < 0.05$) and respiratory rate (from 10 to 11 years; $t = 3.23$; $p < 0.001$). As a result, young football players due to training sessions had positive changes in the anatomical and physiological development and morphofunctional capabilities of the body of athletes.

Thus, the obtained indicators indicate a moderate load on young football players who train according to the CYSS program, which is important in the period of formation of functions and systems of the child's body.

Conflict of Interest. The authors declare that there is no conflict of interests.

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