AGE-RELATED FEATURES OF THE PHYSICAL DEVELOPMENT OF YOUNG FOOTBALL PLAYERS

ВІКОВІ ОСОБЛИВОСТІ ФІЗИЧНОГО РОЗВИТКУ ЮНИХ ФУТБОЛІСТІВ

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DOI https://doi.org/10.32782/2522-1795.2025.19.4.8

Abstracts

One of the main conditions for the high efficiency of the athlete training system is strict consideration of age and individual anatomical and physiological characteristics. Such an approach contributes not only to the effective formation of a technical and tactical arsenal, but also lays a solid foundation for the further qualitative growth of specific functional reserves of the body, in accordance with the requirements of football specialization. **Research objective** – to establish the features of the physical development of young football players and compare the obtained data with the criteria. **Material and methods.** The study involved 32 young football players – 13 (n=18) and 14 years old (n=14). To achieve the stated goal, the following methods of scientific research were used: theoretical analysis and generalization of data from scientific and methodological literature, content from the Internet and documentary materials; pedagogical observation of the training and competitive activities of athletes; to determine physical development: age determination, method of indices (body mass index), anthropometry, dynamometry, method of centile standards and standard deviations. Statistical methods were used to collect, process and analyze the obtained data, in particular descriptive and analytical statistics using non-parametric methods. **Results.** Analysis of variables related to body length and weight, chest circumference, and strength of the flexor muscles of the right and left arms provided data for understanding the physical characteristics of this category of athletes and developing future specific models of preparation for the training process. The average values of the testing indicators are most characteristic of this age and gender. However, in 13-year-old athletes, a deficit in body mass index was recorded in four (22.22%) football players; in 14-year-olds – in three (21.43%). The average body mass index was 17.33 kg/m² in 13-year-old football players, 17.29 kg/m² in 14-year-olds; by median: in 13-year-olds – 17.20 kg/m², in 14-year-olds – 17.25 kg/m², which corresponds to the normal value. Despite the spread of the range of values of length and body weight, the general profile corresponds to the level of physical development and weight control. The average values of chest excursion and hand dynamometry correspond to age norms. However, within one age group there is a large difference between the indicators according to these tests. The fluctuation of the measurement results depending on the value of the coefficient of variation is more than 20%, which indicates the heterochrony of the indicators of physical development of boys. **Conclusions.** The results of the study are recommended to be used for the development of personalized training programs and game specialization of young athletes, emphasizing the importance of physical development according to age norms and adequate physical training. Future studies can supplement the assessment of physical development by the index method, determination of body composition (in particular, the percentage of muscle and fat mass), somatotype, level of physical fitness.

Key words: football, athletes, reserve of sports of higher achievements, physical development, anthropometric indicators.

Одна з основних умов високої ефективності системи підготовки спортсменів полягає у строгому врахуванні вікових та індивідуальних анатомо-фізіологічних особливостей. Такий підхід сприяє не лише ефективному формуванню техніко-тактичного арсеналу, а й закладає міцний фундамент для подальшого якісного зростання специфічних функціональних резервів організму відповідно до вимог футбольної спеціалізації. **Мета** – встановити особливості фізичного розвитку юних футболістів та зіставити отримані дані з критеріями. **Матеріал і методи дослідження.** У дослідженні взяли участь 32 юних футболісти 13 (n=18) та 14 років (n=14). Для досягнення зазначеної мети було використано такі методи наукового дослідження: теоретичний аналіз та узагальнення даних наукової та методичної літератури, контенту мережі Інтернет і документальних матеріалів; педагогічне спостереження за тренувальною та змагальною діяльністю спортсменів. Для визначення фізичного розвитку: встановлення віку, метод індексів (індекс маси тіла), антропометрії, динамометрії, метод центильних стандартів та стандартних відхилень. Для збору, обробки та аналізу отриманих даних використовувалися статистичні методи, зокрема, описову та аналітичну статистику з використанням непараметричних методів. **Результати.** Аналіз змінних, пов'язаних з довжиною та масою тіла, обхватом грудної клітки, силою м'язів-згиначів правої та лівої рук, дав дані для розуміння фізичних особливостей цієї категорії спортсменів та розробки майбутніх специфічних моделей підготовки до тренувального процесу. Середні значення показників тестування найбільш характерні для такої вікової і статевої належності. Однак у 13-річних спортсменів був зафіксований дефіцит маси тіла за показником індексу маси тіла у чотирьох (22,22%) футболістів; у 14-річних – у трьох (21,43%). Середній показник індексу маси тіла становив у 13-річних футболістів – 17,33 кг/м², у 14-річних – 17,29 кг/м²; за медіаною: у 13-річних – 17,20 кг/м², у 14-річних – 17,25 кг/м², що відповідає нормальному значенню. Незважаючи на розкид діапазону значень довжини і маси тіла, загальний профіль відповідає рівню фізичного розвитку та контролю ваги. Середні значення екскурсії грудної клітки та кистьової динамометрії відповідають віковим нормам. Проте в межах однієї вікової групи є велика різниця між показниками за цими тестами. Коливання результатів вимірювань залежно від величини коефіцієнта варіації більше 20%, що свідчить про гетерохронність показників фізичного розвитку хлопців. **Висновки.** Результати дослідження рекомендовано використовувати для розробки персоналізованих тренувальних програм та ігрової спеціалізації молодих спортсменів, підкреслюючи важливість фізичного розвитку за віковими нормами та адекватної фізичної підготовки. Майбутні дослідження можуть доповнити оцінку фізичного розвитку методом індексів, визначенням складу тіла (зокрема, відсотка м'язової та жирової маси), соматотипу, рівнем фізичної підготовленості.

Ключові слова: футбол, спортсмени, резерв спорту вищих досягнень, фізичний розвиток, антропометричні показники.

Introduction. One of the main conditions for the high efficiency of the system of training athletes is strict consideration of age and individual anatomical and physiological characteristics. This allows us to correctly solve the issues of sports selection and orientation, the choice of means and methods of training, the standardization of training and competitive loads, and the prediction of possible achievements. Each age period has its own characteristics in the structure and functions of individual systems that change in the process of sports activity [13]. Experts argue that in the process of training young football players it is necessary to take into account their physical development, functional, psychological state, physical fitness, age, qualification, role of the player, and the training period [11, p. 16; 12; 21]. At the stage of initial specialization in football, means are widely used that allow increasing the functional potential of the athlete's body without using a large amount of work close to competitive [1, p. 14]. Planning at this stage should be approached taking into account the individual abilities of the football player [1, p. 15; 3; 12, etc.]. Moreover, teenagers attend training sessions within the same group with a difference of several months, which significantly complicates the work of the coach, since at 13–14 years old they have significant differences in both motor fitness and physical development [5; 13; 21].

Thus, in adolescence, when there is active biological development, the priority in the training of young football players should not be the achievement of maximum results, but comprehensive and harmonious physical development. Such an approach contributes not only to the effective formation of the technical and tactical arsenal, but also lays a solid foundation for the further qualitative growth of

the specific functional reserves of the body, in accordance with the requirements of football specialization [2; 3; 12]. Therefore, the training of comprehensively developed young football players is a priority of sports schools that prepare the replenishment of the Olympic reserve groups [1]. With the increase in sports skills, the training process becomes more specialized [11, p. 16]. Since the level of physical readiness can only be confirmed in relation to physical development, we needed to study the physical development of young football players.

In scientific and methodological literature, physical development is considered as a process of gradual changes in its quantitative characteristics during ontogenesis, as well as a result of this process, objectively determined at a certain point in time. Physical development of a person is a complex of morpho-functional properties of the organism, which determines the reserve of its physical strength and biological age at the time of examination [4, p. 6; 14, p. 196].

Thus, the problem of assessing the physical development of adolescents aged 13–14 is relevant and determined the direction and purpose of the study.

Research objective – to establish the features of the physical development of young football players and compare the obtained data with the criteria.

Material and methods. The study involved 32 young football players – 13 (n=18 people) and 14 (n=14 people) years old. All of them live in the city of Rivne and, according to the medical examination, were enrolled in the main medical group. To achieve the outlined goal, the following scientific research methods were used: theoretical analysis and generalization of data from scientific and methodological literature, Internet content, and documentary materials; comparison – to compare different views of scientists on the problem under study; pedagogical observation of the training and competitive activities of athletes, which was carried out throughout the entire research period: to determine physical development, widely known in research practice methods were used [4; 9], which allowed obtaining an objective characteristic of the development of young football players aged 13–14 years: age determination, index method (body mass index), anthropometry, dynamometry, centile standards and standard deviations method. For this purpose, testing was conducted, the results of which were used to make a comparative analysis of individual indicators of young football players with criteria and establish age-related features of physical development. Since the physical development of a person is characterized by somatometric values and physiometric indicators, during the testing process, data on total body dimensions (body length, body weight, chest circumference) and hand dynamometry (strength of the flexor muscles of the right and left hands) were recorded.

Statistical methods, including descriptive and analytical statistics using nonparametric methods, were used to collect, process, and analyze the obtained data.

Organization of the study. The algorithm for measuring the length and body weight of young football players was carried out in accordance with Annexes 2, 3 of the Criteria for assessing the physical development of children under 18 years of age [7]. The assessment of the body length of athletes was carried out in accordance with the graphs (growth charts) of height standards in cm according to Table 2 of Annex 2 [7, p. 2] in standard deviations (SD). The calculation of normal or deviant height was carried out with the definition of SD according to the formula [7, p. 14]:

$$SDheight = \frac{height\ (cm) - median\,(cm)}{SD}$$

As noted in the Criteria, body length indicators within the range from 1SD to 2SD and from minus 1SD to minus 2SD are not considered pathological deviations, but such a teenager requires monitoring of the dynamics (rate) of growth [7, p. 2, Section III, item 4].

When measuring body weight with an accuracy of 0.1 kg, the weighing algorithm given in clause 1 of Appendix 3 to the Criteria [7, p. 1–2] was followed. Body weight was assessed using the body mass index (BMI) [7, p. 2], which was calculated using the formula [7, p. 3]:

$$BMI(kg/m^2) = \frac{bodyweight(kg)}{height(m)^2}.$$

Body weight for age was assessed according to the indicators given in paragraph 2 of Appendix 3 to the Criteria [7, p. 3–5], as:

1) normal body weight – the determined indicator is within the limits of > 15th and < 85th percentile;

2) overweight – the determined indicator is within the limits of ≥ 85th and < 97th percentile;

3) underweight – the determined indicator is within the limits of > 3rd and ≤ 15th percentile.

The interpretation of the results of the above studies was carried out in accordance with the recommendations set out in sections III–IV of the Order [7].

The normal BMI for 13-year-old boys is between 16.3 and 21.0 kg/m²; for 14-year-olds, it is between 16.7 and 21.9 kg/m². If a teenager's BMI is within this range, their weight is considered normal.

Measurements of the chest circumference were performed with a rubberized centimeter tape at rest. The centimeter tape passed along the mid-sternal point in front, and under the lower edges of the shoulder blades in the back. Measurements were performed in a standing position, with arms lowered along the torso. First, the main anthropometric indicator was measured – chest circumference during calm breathing. Then the measurements continued at maximum inhalation and then at maximum exhalation. All measurements were performed with one application of the tape. To assess the degree of chest mobility, its excursion was determined – this is the difference between measurements during inhalation and exhalation. The indicator was evaluated based on sigmal deviations.

Hand dynamometry (measurement of the strength of the flexor muscles of the right and left hands) using a hand dynamometer was carried out in the following sequence. The football player rubbed his hands with magnesia and took the dynamometer in his hand; it should be in line with the forearm at the hips. Then he took his hand to the side and squeezed the device vigorously, exerting maximum effort. The force was recorded in kilograms. Two attempts were allowed. It was not allowed to make sharp swings or other sharp movements with the hands that could artificially improve the result.

Next, for each variable (body height and weight, BMI, chest circumference, right and left arm flexor muscle strength) in each age group, descriptive parameters were calculated, including the mean value ($\overline{X}$), mode (Mo), median (Me), standard deviation (σ), value ranges (min; max), coefficient of variation (V, %). These values provided insight into the distribution and variability of participants' anthropometric characteristics.

The Student *t*-test was used to compare the mean values. This test allowed us to determine whether there were statistically significant differences between 13- and 14-year-old soccer players with respect to each of the measured variables. The null hypothesis (H_0) indicated that there were no differences between the age groups, while the alternative hypothesis (H_1) stated that there were statistically significant differences. After calculating the data for all participants, the mean values were compared using the *t*-test for independent samples. For each indicator, the results obtained were interpreted according to the level of significance (*p*-value). A p value < 0.05 was considered statistically significant, indicating that the differences between the age groups were not random.

Correlation analysis was performed using Spearman's rank correlation coefficient ($r_{x\gamma}$). The relationship was considered statistically significant at $p<0.05$. The strength of the correlation was assessed using the following scale (V.M. Kostyukevich, 2001): strong statistical relationship – $0.7 \le r_{x\gamma} < 0.99$; medium – $0.5 \le r_{x\gamma} < 0.69$; weak – $0.2 \le r_{x\gamma} < 0.49$; very weak – $0.09 \le r_{x\gamma} < 0.19$.

All data were analyzed using the software package "Statistica 10" and using the spreadsheet editor "MS Excel 2010" (Fig. 1) for descriptive data management and diagram construction.

The research findings. In the process of processing the obtained data, certain age patterns were revealed, which are inherent in this period.

Surname, name	Year of birth	age, years/months	Body weight	Body mass index	Body weight assessment criteria	Body length	Sigma deviation SD	Body length assessment criteria	chest circumference: Inhale	Exhale	Pause	Evaluation criteria	Chest tour	Evaluation criteria	Dynamometry: Left hand	Right hand	Systolic
Guz-ch	21.05.2011	13 years 6 m	48,2	18,3	normal	162	Average	normal	78	70	74	normal	8	normal	20	22	119
Vorosh-n	10.11.2011	13 years	41	17,7	normal	152	Average	normal	82	75	78	normal	7	normal	20	20	117
V-g	14.08.2011	13 years 3 m	44,1	17,2	normal	160	Average	normal	87	78	81	normal	9	increased	20	25	120
Lab-v	30.07.2011	13 years 3,5 m	51,1	17,4	normal	171	2SD	high	88	78	79	normal	10	increased	30	30	119
Kokh-vich	22.06.2011	13 years 5 m	31	16,3	normal	138	-3SD	low	70	65	67	reduced	5	reduced	15	15	107
Pre-k	27.07.2011	13 years 3,5 m	45,9	18.43	normal	158	1SD	normal	78	70	73	normal	8	normal	10	10	101
Kir-tch	13.07.2011	13 years 4 m	51	18,9	normal	164	1SD	normal	81	75	77	normal	6	normal	18	20	117
R-n	22.08.2011	13 years 3 m	54	19,2	normal	167	1SD	normal	93	86	88	increased	7	normal	25	30	131
Yak-ts	04.07.2011	13 years 4 m	46	18,3	normal	158	Average	normal	87	82	84	normal	5	reduced	38	40	115
Khu-ko	30.08.2011	13 years 3 m	44	18,1	normal	156	Average	normal	75	69	71	normal	6	normal	15	15	111
Kry-ch	20.05.2011	13 years 6 m	36,1	15,6	shortage	152	-1SD	normal	66	61	64	reduced	5	reduced	20	22	121
Gon-vych	06.08.2011	13 years 3 m	48	19,5	normal	157	Average	normal	82	74	77	normal	8	normal	22	29	138
Kir-ch	02.11.2011	13 years	41	15,1	shortage	165	1SD	normal	70	64	67	reduced	6	normal	20	20	116
M-sik	05.08.2011	13 years 3 m	44,4	17,19	normal	160	Average	normal	76	69	71	normal	7	normal	23	25	119
Kor-g	12.11.2011	13 years	46,1	15,7	shortage	171	2SD	high	72	68	72	normal	4	reduced	20	25	118
Pav-ko	18.05.2011	13 years 6 m	51,2	17,2	normal	172	2SD	high	76	68	72	normal	8	normal	25	28	119
Vab-ch	20.07.2011	13 years 3,5	42	15,2	shortage	166	1SD	normal	71	64	66	reduced	7	normal	16	16	119
Myz-ko	18.07.2011	13 years 3,5	45	16,5	normal	165	1SD	normal	87	77	78	normal	10	increased	35	40	114
$\overline{X}$ =			45.01	17.33		160,78			78,83	71,83	74,38		7		21,78	24	117,83
Mo			41	18,3		152			87	70	78		8		20	20	
Me			45,45	17,2		161			78	70	73,5		7		20	23,5	
σ			5,600889869	1,3730087		8,31409544			7,5556757	6,7322752	6,445599401		1,7149859		6,9667746	8,065905	
min			31	15,1		138			66	61	64		4		10	10	101
max			54	19,5		172			93	86	88		10		38	40	138
V			12,44	7,91		5,17			9,59	9,37	8,67		24,43		32	33,63	
Kry-ch	14.08.2010	14 years 3 m	46	17,1	normal	171	1 SD	normal	77	72	74	normal	5	reduced	30	29	110
Syts-ch	30.05.2010	14 years 5,5 m	51,7	17,6	normal	170	1SD	normal	80	74	76	normal	6	normal	25	28	114
Shep-ich	07.06.2010	14 years 5 m	44,2	16,56	shortage	163	Average	normal	78	71	74	normal	7	normal	24	25	122
Celiu	06.08.2010	14 years 3 m	43,4	17,4	normal	157	-1SD	normal	77	69	70	reduced	8	normal	20	20	128
Ut-ko	08.08.2010	14 years 3 m	41,8	17	normal	157	-1SD	normal	80	73	76	normal	7	normal	20	20	119

Fig. 1. Screenshot of a fragment of the spreadsheet of the physical development of young football players (Sheet 1)

The analysis concerned the main anthropometric variables of young football players, which allowed to draw a general conclusion about their health status and physical development at the time of the study. The distribution of 13–14-year-old young football players by height (body length) in percentages is shown in Fig. 2.

The largest proportion of athletes at both 13 and 14 years of age have a body length in accordance with age norms. At the age of 14, there is an increase in the proportion of football players whose body length corresponds to the normal value (from 77.78% to 100%). In 13-year-old athletes, low body length was recorded in only one (5.56%) football player, high – in three (16.67%); in 14-year-olds, such was not observed. This may indicate natural growth rates at this age and selection for sports sections.

Due to pubertal processes in the body of adolescents, individual advances or lags behind average values occur. As for height, the average body length indicator was 160.78 cm and 162.82 cm, respectively; the median was 161.00 cm in 13-year-old and 163.50 cm in 14-year-old athletes (Table 1), which indicates compliance with the physiological norms of this age group. The scatter of the range of values – the determination of the range between the minimum

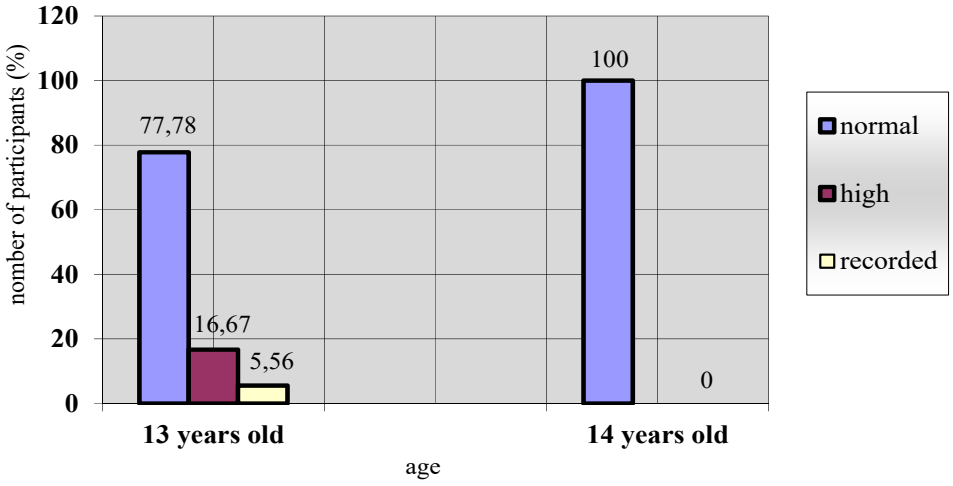

Fig. 2. Distribution of 13–14-year-old football players by body length (n=32; in %)

Table 1

Statistical indicators of physical development of young athletes

Researched indicators	Statistical characteristics						
	$\overline{X}$	σ	Mo	Me	min	max	V,%
13 years old							
Body length, cm	160.78**	8.31	152.10	161.00	138.00	172.00	5.17
Body weight, kg	45.01	5.60	41.00	45.45	31.00	54.00	12.44
BMI, kg/m²	17.33	1.37	18.30	17.20	15.10	19.50	7.91
Chest circumference, cm	74.38	6.45	78.00	73.50	64.00	88.00	8.67
Chest circumference during inspiration, cm	78.83	7.56	87.00	78.00	66.00	93.00	9.59
Chest circumference on exhalation, cm	71.83	6.73	70.00	70.00	61.00	86.00	9.37
Chest excursion, cm	7.00	1.71	8.00	7.00	4.00	10.00	24.43
Left arm flexor muscle strength, kg	21.78	6.97	20.00	20.00	10.00	38.00	32.00
Right arm flexor muscle strength, kg	24.00	8.07	20.00	23.50	10.00	40.00	33.63
14 years old							
Body length, cm	162.85**	5.52	170.00	163.50	154.00	171.00	3.39
Body weight, kg	46.22	3.94	46.00	46.00	38.00	52.00	8.55
BMI, kg/m²	17.29	0.74	not installed*	17.25	15.80	18.59	4.28
Chest circumference, cm	76.36	5.40	74.00	76.00	65.00	84.00	7.07
Chest circumference during inspiration, cm	81.14	5.64	77.00	80.00	68.00	90.00	6.95
Chest circumference on exhalation, cm	73.93	4.81	77.00	73.50	63.00	81.00	6.51
Chest excursion, cm	7.14	1.44	7.00	7.00	4.00	9.00	20.23
Left arm flexor muscle strength, kg	23.57	5.59	20.00	22.00	17.00	35.00	23.76
Right arm flexor muscle strength, kg	25.29	5.47	20.00	25.00	17.00	45.00	21.63

*– The result that occurs most frequently in this sample according to the specified statistical characteristic of measurements has not been established.

**– The threshold values of the Student t-test (reliability of the calculation: P = 0.95 (α = 0.05)) are 2.04. Statistically significant differences between the anthropometric indicators of 13- and 14-year-old athletes have not been established, p>0.05.

and maximum values in the data set – was made using the MIN and MAX functions. The range of values ranged from 138–172 cm in 13-year-old athletes, 154–171 cm in 14-year-old athletes. Within one age group, the degree of data dispersion around the mean value (V) for 13-year-olds is 5.17%, for 14-year-olds – 3.39%, so the averages are considered representative.

The next stage of our study was the analysis of body mass. Body mass was assessed, as indicated above, by BMI [7, Appendix 3, p. 2]. BMI was calculated for each participant according to the indicated formula and interpreted according to the Criteria for adolescents aged 13–14 years, referring to Fig. 6 "BMI (kg/m²) of boys aged 5–18 years (percentiles)" [7, Appendix 3, p. 5]. The results obtained are presented in Fig. 3.

The largest proportion of athletes at both 13 (77.78%) and 14 (78.57%) years have a body weight in accordance with age norms. At the age of 14, there is an increase in the proportion of football players whose body weight corresponds to the normal value (78.57%), that is, the value in the interval from the 25th to the 75th centile. Among 13-year-old athletes, a deficit of body weight according to the BMI indicator was recorded in four (22.22%) football players; in 14-year-olds – in three (21.43%). The obtained

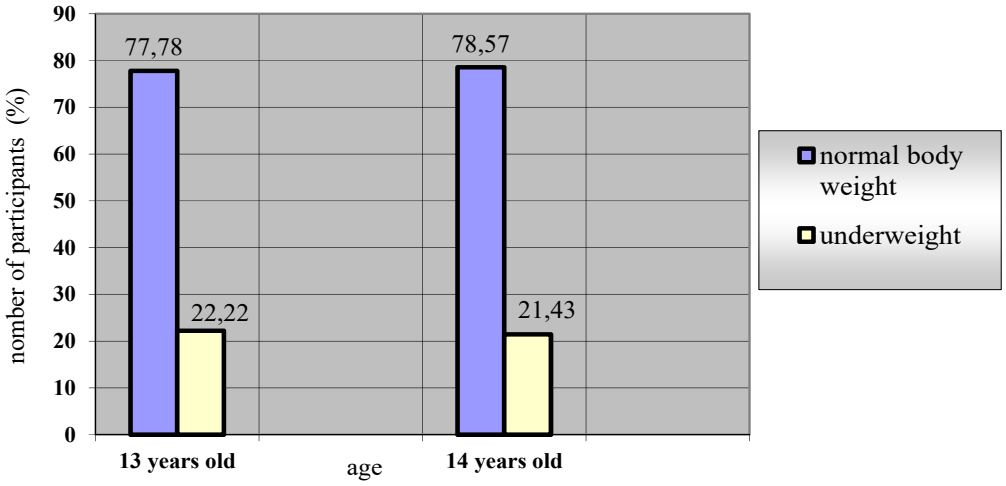

Fig. 3. Distribution of young football players by BMI (n=32; in %)

results are confirmed by scientific studies and data indicating the prevalence of the problem of body weight deficiency among adolescents and its consequences [14]. At the same time, it was found that the average BMI indicator was 17.33 kg/m² in 13-year-old football players, 17.29 kg/m² in 14-year-olds; by median: in 13-year-olds – 17.20 kg/m², in 14-year-olds – 17.25 kg/m², which corresponds to the normal value in the interval from the 25th to the 75th centile. The minimum value in the group of 13-year-old athletes – 15.10 kg/m², in 14-year-olds – 15.80 kg/m² indicates a deficit of body weight relative to length. However, the maximum result corresponds to the age norm (19.50 kg/m² in 13-year-olds and 18.59 kg/m² in 14-year-olds). In the study of BMI of adolescents, the fluctuation of the measurement results around the mean value by the coefficient of variation is considered small – 7.91% in 13-year-olds and 4.28% in 14-year-old football players, which indicates the homogeneity of the group.

The results of length and BMI indicate that, on average, young athletes demonstrate anthropometric characteristics closer to the reference model. Despite the range of values, the overall profile appears to be consistent with the level of physical fitness and weight control.

Chest girth and body length in adolescence can be an important indicator of physical development, as they depend on muscle mass. Deviations in chest girth indicators can be both in the direction of decrease and increase. The causes of such violations are anomalies of the development of the chest and lungs, the degree of physical training and muscle development, constitutional features, etc. The scientific literature indicates the average value of chest girth for boys 13–14 years old, which is 74–84 cm. According to the formula [4, p. 13], we determine the appropriate chest girth for children 13–14 years old – 72 cm and 75 cm, respectively, by age. We evaluate the indicator based on sigmal approaches. The classification of athletes according to the results of chest girth in our testing is presented in Fig. 4.

The largest proportion of athletes at both 13 and 14 years of age have chest girth dimensions that correspond to age norms. At the age of 14, there is an increase in the proportion of football players whose body girth corresponds to the normal value (from 72.22% to 78.57%). In 13-year-old athletes, chest girth increased by age norms was recorded in only one (5.56%) football player, decreased – in four (22.22%); in 14-year-olds, increased data from the norm were not observed, decreased – in three (21.43%).

The results for the mean values were 74.38 cm and 76.36 cm, respectively; for the median – 73.50 cm in 13-year-old and 76.00 cm in 14-year-old athletes. The range of values varied within 64–88 cm in 13-year-old athletes, 65–84 cm in 14-year-olds. The age groups of adolescents who participated in this testing are quite homogeneous,

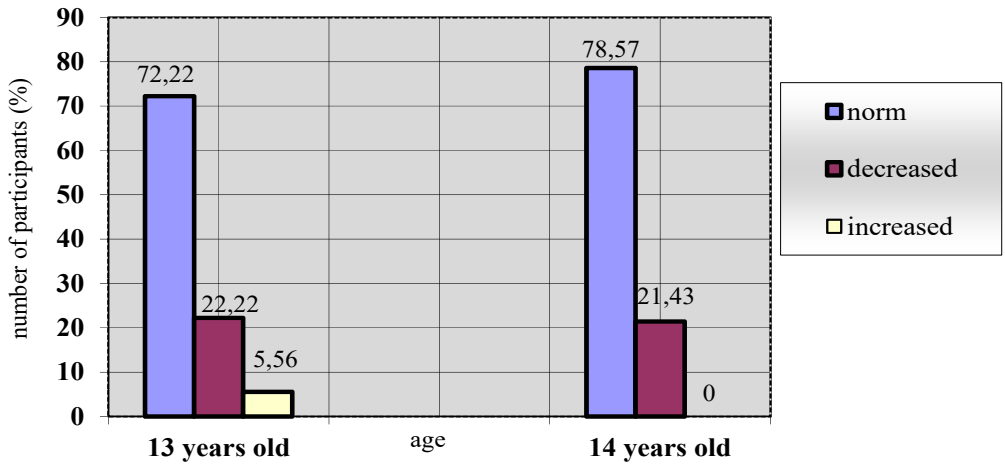

Fig. 4. Classification of athletes according to the results of chest circumference (n=32; in %)

since the coefficient of variation does not exceed 10% (V.M. Kostyukevich, 2001), namely: in 13-year-olds – 8.67%, in 14-year-olds – 7.07%.

According to age norms, the average chest excursion for boys 13–14 years old is 6–8 cm. In the majority of 13-year-old boys – 11 people (61.11%) and 14-year-olds – 10 people (71.44%) it coincides with the norms. According to the average values – 7.00 cm in 13-year-olds and 7.14 cm in 14-year-old athletes; according to the median in both groups – 7.00 cm. The data range ranged from 4.00–10.00 cm in 13-year-old athletes, 4.00–9.00 cm in 14-year-olds. Within the same age group, there is a large difference between the indicators of chest excursion, so the coefficient of variation in 13-year-olds is 24.43%, in 14-year-olds it is 20.23%, which indicates the heterochrony of the indicators of physical development of boys.

Research by scientists (M.I. Mayevsky, 2018) has shown that the maximum hand strength increases unevenly with age. Moreover, the increase in muscle strength of the upper extremities occurs faster than that of the lower extremities. The sensitive period for the development of hand strength in adolescents falls on the age of 10–14 years, when there is a significant increase in muscle strength, in particular of the hand and back. At this time, adolescents are especially sensitive to the influence of exercises that develop strength, and can achieve significant success in improving it [13].

Considering the importance of strength qualities in the physical development of adolescents aged 13–14 and the possibility of obtaining new data, testing of the strength of the flexor muscles of the right and left hands was carried out. According to research, the strength of the flexor muscles in 13-year-old boys is on average 24.00 kg for the right hand and 21.78 kg for the left hand, in 14-year-olds – 25.29 kg for the right hand and 23.57 kg for the left hand; the median is 13 years (23.50 kg right, 20.00 kg left), 14 years (25.00 kg right, 22.00 kg left). The range of values varied within 10.00–40.00 kg right hand, 10.00–38.00 kg left hand in 13-year-old athletes, 17.00–45.00 kg right, 17.00–35.00 kg left hand in 14-year-olds. Within the same age group, there is a large difference between the obtained data, so the coefficient of variation in 13-year-olds is 33.63% right hand, 32.00% left hand; in 14-year-olds – 21.63% right hand, 23.76% left hand, which indicates heterochrony of indicators of physical development of boys. The results are consistent with data from studies and literary sources on sensitive periods of development of strength qualities in athletes 13–14 years old [13].

Thus, anthropometric measurements confirmed that with age, the indicators of the total body dimensions of young athletes increase, which is associated with age-related characteristics of physical development.

The t-test for equality of means for independent samples did not reveal statistically significant

differences between 13- and 14-year-old football players in body length (t = 0.85), body weight (t = 0.38), BMI (t = 0.13), chest circumference (t = 0.576), chest circumference on inspiration (t = 0.636), chest circumference on expiration (t = 0.619), chest excursion (t = 0.039), left arm flexor muscle strength (t = 0.969), right arm flexor muscle strength (t = 0.351).

In order to assess the nature, quantity, and level of statistically significant relationships between somatometric and physiometric indicators, a correlation analysis was performed, which was determined using the Spearman correlation coefficient (Table 2).

In 13-year-old football players, very weak correlations were established in 2 dimensions. A weak statistically significant relationship was established in 6 indicators. The relationships of the results of the strength of the flexor muscles of the left/right arm at the average level were found between 6 results – chest circumference (r=0.557; r=0.600); chest circumference on inspiration (r=0.575; r=0.612); chest circumference on expiration (r=0.579; r=0.616). A strong statistical relationship between the anthropometric data of 13-year-old football players was not recorded.

Correlation analysis of anthropometric characteristics of 14-year-old football players revealed almost the same number of statistically significant relationships as 13-year-olds, but established an existing difference in their tightness. Weak statistically significant correlation interdependence was established in 6 indicators (Table 2). Relationships at the average level were recorded between 4 results – body weight and strength of the flexor muscles of the left hand (r=0.652); strength of the flexor muscles of the right hand and the following data: chest circumference (r=0.609); chest circumference on inspiration (r=0.559); chest circumference on expiration (r=0.606). High-level relationships were established between 3 indicators: left/right arm flexor muscle strength and body length (r=0.788; r=0.837); right arm flexor muscle strength and body weight (r=0.816).

Discussion. Adolescence is a period of complex anatomical and physiological changes in the human body. The physical development of adolescents is characterized by a high intensity of growth of all body sizes, unevenness and complications associated with puberty. The authors note that body length and weight increase significantly. The growth of body length exceeds the growth of body weight (Rybalko, 2013). Signs of uneven growth of body parts are clearly evident, the growth of limbs prevails over the growth of the trunk [13].

Scientists emphasize that determining physical development is an integral part of a comprehensive examination. In this regard, information about the features of the physical development of young athletes aged 13–14 has both theoretical significance and the ability to use the obtained data in the process of practical work [12; 19; 20].

L.Ya.-G. Shakhlina and co-authors indicate that the socio-pedagogical effectiveness of the

Table 2

Correlation coefficients of anthropometric data of young athletes

Researched indicators	Body length	Body weight	BMI	Chest circumference	Chest circumference during inspiration	Chest circumference on exhalation	Chest excursion
13 years old							
Left arm flexor muscle strength	0.336	0.339	0.101*	0.557	0.575	0.579	0.261
Right arm flexor muscle strength	0.370	0.406	0.168*	0.600	0.612	0.616	0.276
14 years old							
Left arm flexor muscle strength	0.788	0.652	0.211	0.392	0.329	0.410	0.019*
Right arm flexor muscle strength	0.837	0.816	0.495	0.609	0.559	0.606	0.248

* There is no statistically significant relationship; p>0.05

training process, ensuring the normal physical development of young athletes, the formation of their somatic and psychological health directly depends on the degree of consideration of the anatomical and physiological features of the child's body, which substantiate the medical and biological foundations of the system of training young athletes [23, p. 185]. In the practice of sports training of adolescents, the effectiveness of the training process in sensitive periods is the highest, the development of physical qualities is more pronounced, the processes of adaptation to physical exertion are characterized by the optimal capabilities of the body, which leads to an increase in the functional reserves of the body [6; 23, p. 186]. Scientists emphasize that the inconsistency of physical exertion with the functional capabilities of the child's body, the adolescent-young man are the main reasons for the development of chronic physical overstrain of the functions of the body's systems and sports injuries, in particular [20; 23].

The works of scientists [6; 12; 18; 20, etc.] substantiate the logic and appropriateness of using modern scientific views on the individualization of the training process in the educational and training process of young football players. In particular, they analyze and compare research in children's and youth sports, the possibilities of interpreting them in relation to the specifics of children's football based on diagnostics of individual characteristics of the ontogenesis of the child's organism, correcting the structure and content of the training process, and normalizing the volume, intensity and direction of training influences both for young football players with similar physical characteristics and for athletes with different intensities of development [20]. The authors prove that the stage of specialized basic training coincides with a period of significant growth in body length and weight, which will inevitably be accompanied by a breakdown of established skills and abilities. In this case, the versatile motor base laid at the stages of initial training will contribute to the further harmonious adaptation of young football players to genetically determined changes in their body [12, p. 105–106].

Again, in the works of V.V. Nikolayenko and co-authors [12, p. 108] it is emphasized that morphological features, the integral representative of which is the body length, are only an indicator of the potential fitness of an athlete. Current performance is largely and mainly determined by the level of preparedness. In some children, the same processes (stages of development) proceed faster, in others – slower, some recover faster after physical or emotional stress, others – slower; for some, two-time (sometimes three-time) training is acceptable, for others – this is the path to overtraining, under-recovery, etc. [12].

In addition to the above, experts argue that the unreasonable regime of training and competitive activities, imperfect criteria for assessing the effectiveness of the work of the sports organization and coaching staff, and a number of other reasons do not allow rationally building a system of long-term training of the sports reserve for professional football [2; 3; 16].

It has been proven that success in football is associated with specific anthropometric and physical characteristics of athletes of different playing roles (forwards, midfielders, defenders and goalkeepers) [5; 10; 11; 15; 22]. Studies describing professional football players have shown that each playing specialization in professional football is characterized by a representative profile [15]. Goalkeepers and central defenders were reported to be the tallest and heaviest players, while the average height and body mass of defenders, midfielders, and forwards were found to be similar, approximately 177±0.15 m and 74.0±1.6 kg, respectively [15].

The relationship between playing positions and anthropometric and physical performance characteristics has also been studied in young football players [3; 5; 17]. As in adult players, studies have shown that goalkeepers and defenders are usually the tallest and heaviest players [17]. The scientific research of coaches is consistent with the works of S.G. Lysenchuk and co-authors [10]. As experts note, studies of the level of physical development (length and body weight) of young football players of different playing roles indicate the presence of differences

in morphological indicators. If these differences are less pronounced in field players, then the advantage of goalkeepers in terms of body length is fully confirmed ($p<0.05$). Even greater differences are observed in terms of body weight. The greatest weight is noted in goalkeepers ($p<0.05$) [10, p. 69].

The results of our own research complement the scientific developments of scientists on the use of information and communication and fitness technologies in the process of training sessions, which allows for the differentiation and individualization of personally-oriented training based on the design features of innovative implementation of means and methods of physical training, control, record and monitor the dynamics of the physical and functional state, the level of their physical fitness [8].

Conclusions. Analysis of sources has shown that physical development control serves as the basis for determining physical activity, intensity of training and competition processes. Control allows you to manage physical culture and sports activities so that they do not harm health, but contribute to its strengthening, help to intelligently build the training process and determine the need for physical and mental rest of adolescents.

The results obtained allow us to draw a general conclusion about the physical development of young football players at the time of the study. The average values are most characteristic for this age and gender. The body length indicator by the average value was 160.78 cm in 13-year-old and 162.85 cm in 14-year-old athletes; by the median – 161.00 cm and 163.50 cm, which indicates compliance with the physiological norms of this age group. The largest proportion of athletes at both 13 (77.78%) and 14 (78.57%) years have a body weight in accordance with age norms. At 14 years, there is an increase in the proportion of football players whose body weight corresponds to the normal value (78.57%) in the interval from the 25th to the 75th centile. In 13-year-old athletes, a deficit of body weight by BMI was recorded in four (22.22%) football players; in 14-year-olds – in three (21.43%). The average BMI was in 13-year-old football players – 17.33 kg/m², in 14-year-olds – 17.29 kg/m²; by median: in 13-year-olds – 17.20 kg/m², in 14-year-olds – 17.25 kg/m², which corresponds to the normal value. Despite the spread of the range of values of height and body weight, the general profile corresponds to the level of physical fitness and weight control.

The average values of chest excursion and hand dynamometry correspond to age norms. However, within the same age group there is a large difference between the indicators according to these tests. The fluctuation of the measurement results depending on the value of the coefficient of variation is more than 20%, which indicates heterochrony of the indicators of physical development of boys.

The practical significance of the study is determined in addition to the existing data on the results of the physical development of young football players for the development of personalized training trajectories and optimization of adolescent development strategies. In addition, sports schools and coaches themselves will be able to have more objective tools for assessing the suitability of athletes at the selection stage, as well as for monitoring progress in the future and targeted intervention in physical training. Future studies may be aimed at assessing physical development using the index method, determining body composition (in particular, the percentage of muscle and fat mass), somatotype, and the level of physical fitness.

Information on conflict of interest. There is no conflict of interest.

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Прийнято до публікації: 21.11.2025
Опубліковано: 31.12.2025
Accepted for publication on: 21.11.2025
Published on: 31.12.2025