PECULIARITIES OF SOMATOMETRIC INDICES OF YOUNG BASKETBALL PLAYERS WITH DIFFERENT TYPES OF POSTURE

ОСОБЛИВОСТІ СОМАТОМЕТРИЧНИХ ПОКАЗНИКІВ ЮНИХ БАСКЕТБОЛІСТІВ З РІЗНИМИ ТИПАМИ ПОСТАВИ

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DOI https://doi.org/10.32782/2522-1795.2024.18.20

Abstracts

The aim is to define the peculiarities of somatometric indices of young basketball players with different types of posture. Experimental studies were conducted at the Department of Theory and Methods of Physical Education of Vasyl Stefanyk Precarpathian National University from September 2022 to August 2023. 66 basketball players aged 9–10 years from the children's and youth sports school in Ivano-Frankivsk were involved in the experiment, after obtaining their parents' consent to analyze data from medical records. The research was conducted in compliance with the requirements of the World Medical Association's Declaration of Helsinki "Ethical Principles for Medical Research Involving Human Subjects". **Research methods:** theoretical methods – for studying and substantiating the fundamental provisions of the research, outlining its problematic field; empirical methods – pedagogical observation as a method of the empirical level of research for familiarization with the process of educational and training classes organization; pedagogical experiment; statistical methods. **Results.** The present study was designed to determine the type of posture of young basketball players in the age range of 9–10 years. The analysis of data from basketball players' medical records revealed the presence of posture disorders in some of them. It was established that among 9-year-old children 18.18% (n = 12) had normal posture, stoop back, and scoliotic posture, whereas among basketball players aged 10 years old, 15.15% (n = 10) had normal posture, stoop back, or scoliotic posture. **Conclusions.** Most children aged 9 and 10 are taller than average for their age and generally of normal weight. As for the young athletes' chest circumference it generally corresponds to the general norms. However, there are individual variations, especially among 9-year-olds, who require increased attention and correction to reach the normative values. The type of posture is not a determining factor for the physical development of basketball players, since children with any type of posture have similar somatometric characteristics, and small variations are rather due to individual peculiarities of physical development. Significant differences were found between children aged 9 and 10 years, indicating higher height, weight, and chest circumference of athletes of the older group. The results of measuring somatometric indices obtained in these groups were analyzed in the following ways: a) assessment of the expression level of each index by comparing with the data on norms according to age; b) comparison of data in groups of young basketball players with different types of posture within a certain age category; c) determination of differences between athletes of different ages with the same type of posture.

Key words: young athletes, basketball players, posture, disorders, somatometric indices, sports training.

Мета – визначити особливості соматометричних показників юних баскетболістів з різними типами постави. Експериментальні дослідження проводилися на кафедри теорії і методики фізичного виховання Прикарпатського національного університету імені Василя Стефаника в період з вересня 2022 по серпень 2023 рр. До експерименту було залучено 66 баскетболістів віком 9–10 років дитячо-юнацької спортивної школи м. Івано-Франківська, попередньо одержавши згоду

їхніх батьків на аналіз даних з медичних карток. Дослідження проведені з дотриманням вимог Гельсінської декларації Всесвітньої медичної асоціації «Етичні принципи медичних досліджень за участю людини як об'єкта дослідження». **Методи дослідження:** теоретичні методи – для вивчення й обґрунтування засадничих положень дослідження, окреслення його проблемного поля; емпіричні методи: педагогічне спостереження як метод емпіричного рівня досліджень – для ознайомлення із процесом організації навчально-тренувальних занять; педагогічний експеримент; статистичні методи. **Результати.** Передбачений пропонованим дослідженням констатувальний експеримент був спроєктований для визначення типу постави у юних баскетболістів у віковому діапазоні 9–10 років. Аналіз даних з медичних карток баскетболістів виявив наявність порушень постави у окремих із них. Встановлено, що серед 9-річних дітей 18,18% (n = 12) осіб мали нормальну поставу, сутулу спину та сколіотичну поставу, серед баскетболістів 10 років 15,15% (n = 10) осіб відповідно виявляли нормальний тип постави, сутулу спину або сколіотичну поставу. **Висновки.** Більшість дітей 9 та 10 років мають зріст, який перевищує середню норму для свого віку, і загалом нормальну вагу. Щодо окружності грудної клітини юних спортсменів, вона загалом відповідає загальним нормам. Проте спостерігаються індивідуальні варіації, особливо серед 9-річних дітей, які потребують підвищеної уваги та корекцій для досягнення нормативних значень. Тип постави не є визначальним чинником для фізичного розвитку баскетболістів, оскільки діти з будь-яким типом постави мали схожі соматометричні характеристики, а невеликі варіації радше зумовлені індивідуальними особливостями фізичного розвитку. Між дітьми 9 і 10 років виявлено значні відмінності, які свідчать про вищий зріст, більшу вагу та більшу окружність грудної клітини спортсменів більш старшої групи. Результати вимірювання соматометричних показників, отримані у цих групах, аналізувалися у такі способи, як: а) оцінка рівня вираженості кожного показника шляхом порівняння з даними про норми відповідно до віку; б) порівняння даних у групах юних баскетболістів з різними типами постави всередині певної вікової категорії; в) визначення відмінностей між спортсменами різного віку з однаковим типом постави.

***Ключові слова*:** юні спортсмени, баскетболісти, постава, порушення, соматометричні показники, спортивна підготовка.

Introduction. Laying the fundamental basis for the development of physical qualities, technical fitness, and functional state is important at the initial stage of long-term improvement in modern sport [16; 20]. The growth and strengthening of the bones and muscular system of young athletes continue at this stage of preparation [2; 15]. Since the final ossification has not yet occurred, there is a risk of improper locomotorium formation of young athletes. Changes in the values of physiological curves of the spinal column [2], hypermobility of joints [7], transverse and longitudinal platypodia [1; 11], etc. are signs of connective tissue dysplasias [7], which can lead to a significant overload of various parts of the locomotorium in athletes [13], and thus, to trauma and the diseases of the locomotorium and internal organs of the human body [8; 6].

The review of scientific and methodological literature and monitoring of the Internet information sources allowed us to present the problematic field of the issue under consideration:

– changes in the athletes' locomotorium at the initial stage of preparation occur mainly due to the development of long muscles that determine the speed and flexibility of movements [9];

– in children of this period of ontogenesis, the muscles of the upper and lower extremities develop well, unlike those of the back and trunk, which are not yet able to support the body in the required pose for a long time or keep the spine in a stable position, which can lead to the formation of postural disorders, in particular in young basketball players [9];

– long-term basketball training can lead to increased body posture asymmetry, which is most often manifested not only in an increase in the asymmetry of the pelvis placement in the transverse plane, asymmetry of the shoulder blades relative to the transverse plane, and a decrease in the thoracic kyphosis angle, but the deviation of the line of spinous processes, changes in the trunk inclination angle, violation of the norm of the shoulder blades location in the transverse plane and relative to the spine, etc. as well [20];

– posture assessment of young basketball players should be carried out to analyze the body morphology and control the formation of posture

disorders primarily in order to prevent them and injuries in further sports life [14].

The objective is to define the peculiarities of somatometric indices of young basketball players with different types of posture.

Materials and methods. Experimental studies were conducted at the Department of Theory and Methods of Physical Education of Vasyl Stefanyk Precarpathian National University in the period from September 2022 to August 2023. 66 basketball players aged 9–10 years old from the children's and youth sports school of Ivano-Frankivsk were involved in the experiment, having previously received the consent of their parents to analyze data from clinical records. The studies were conducted in compliance with the requirements of the World Medical Association's Declaration of Helsinki "Ethical Principles for Medical Research Involving Human Subjects". From September to December 2023, the accumulated materials were processed, analyzed, and interpreted, and general conclusions were drawn.

The implementation of the tasks set in the work envisages the involvement of a complex of such methods as *theoretical methods* – for studying and substantiating the fundamental provisions of the research, outlining its problematic field; e*mpirical methods* – pedagogical observation as a method of the empirical level of research for familiarization with the process of educational and training classes organization. To determine the types of posture the "Torso" program [4] was used; pedagogical experiment; *statistical methods*. In the process of mathematical processing the following statistical characteristics were calculated:

– to describe the primary statistics, the arithmetic mean (M), standard error of the mean (m), standard deviation (s), coefficient of variation (V), median (Me), quartiles of distribution (P_25, P_75) were calculated, and the Shapiro-Wilk test (W) was used to check the distribution of results for normality;

– to compare the results of the study with certain age-appropriate normal values a one-sample t-statistics, and in cases of different normative data (such as somatometric norms of the WHO and the Ministry of Health of Ukraine), to assess their consistency – Cohen's kappa coefficient (k);

– to compare independent samples – Mann-Whitney U-test, Student t-test, and in the case of multiple comparisons – analysis of variance using Fisher's F-test followed by post hoc analysis based on Tukey's test for honestly significant difference.

The statistical processing of the findings was performed using IBM SPSS Statistics 21, MedCalc 22.016 software; the graphical material was prepared in MedCalc and Microsoft Excel.

The results of the study and their discussion. The anticipated by the proposed study ascertaining experiment was designed to determine the type of posture in young basketball players in the age range of 9–10 years. The analysis of their clinical records data revealed the presence of posture disorders in some of them. It was established that among 9-year-old children 18.18% (n = 12) had normal posture, stoop back, and scoliotic posture, whereas among basketball players aged 10 years old, 15.15% (n = 10) had normal posture, stoop back, or scoliotic posture.

The results of measuring somatometric indices obtained in these groups were analyzed in the following ways: a) assessment of the expression level of each index by comparing with the data on norms according to age; b) comparison of data in groups of young basketball players with different types of posture within a certain age category; c) determination of differences between athletes of different ages with the same type of posture.

The results of body length (Table 1) showed that the values of the height index of the 9-year-olds ranged from 135 to 142 cm with a mean value of 139.36 cm (95% confidence interval (C.I.) 138.74–139.98) and a standard deviation of 1.82 cm (V = 1.31%). Similarly, nine-year-old young basketball players exceed the average norms for boys of this age provided by the Ministry of Health of Ukraine (M=135.96) [10] by 3.5 cm, and this excess is also statistically significant ($t=11.21$; $p<0.0001$).

It should be noted that when comparing these primary statistics with the normative average value provided by the WHO [17] for this age

Table 1

Basic statistics and distribution quartiles of height indices (cm) of athletes for their different types of posture

Age	Groups	n	Basic statistics					Distribution quartiles		
			min	max	M	m	s	P_{25}	Me	P_{75}
9-year-old	Norms provided by the World Health Organization	–	–	–	132.57	0.05	6.01	128.5	132.6	136.6
	Norms provided by the Ministry of Health of Ukraine	–	126	146	135,96	0,50	5,06	–	–	–
	Normal posture	12	135	142	139.17	0.65	2.25	138	139.5	141
	Stoop back	12	137	142	139.33	0.50	1.72	138	139.5	141
	Scoliotic posture	12	137	142	139.58	0.45	1.56	138	140	141
	All athletes	36	135	142	139.36	0.30	1.82	138	140	141
10-year-old	Norms provided by the World Health Organization	–	–	–	137.78	0.05	6.37	133.5	137.8	142.1
	Norms provided by the Ministry of Health of Ukraine	–	127	153	138.9	0.62	6.34	–	–	–
	Normal posture	10	143	149	145.5	0.58	1.84	143	146	146
	Stoop back	10	144	149	145.6	0.48	1.51	145	145	146
	Scoliotic posture	10	144	149	146.1	0.55	1.73	145	145.5	147
	All athletes	30	143	149	145.7	0.30	1.66	145	145.5	146

Note. Here and further: n – the number of athletes in the group; min – the lowest value; max – the highest value; M – arithmetic mean value; m – standard error of the arithmetic mean; s – standard deviation; Me, P_25, P_75 – median and distribution quartiles.

(M=132.57), it appears that the representatives of the study sample are taller on average by 6.79 cm, which is a statistically significant difference (t=22.39; p<0.0001).

If we look at the primary statistics obtained in groups of children with different types of postures, we can see that they also have certain differences from the WHO normative values. For instance, among the 9-year-old subjects with normal posture, height ranged from 135 to 142 cm, with a mean value of 139.17 cm (95% CI 137.74–140.6), standard deviation of 2.25 cm, and a coefficient of variation of 1.62%.

Compared to the normative average height value for this age provided by the World Health Organization, these children were on average 6.6 cm taller (t=10.16; p<0.0001), whereas compared to the average body length expression for this age in Ukraine, they were 3.21 cm taller (t=4.92; p<0.001).

The body length of young athletes with a stoop back ranged from 137 cm to 142 cm and averaged 139.33 cm (95% C.I. 138.24–140.42). In view of the lower variability than in the previous group (s=1.72; V=1.23%), it becomes clear that their excess in height over the WHO (by 6.76 cm; t=13.62; p<0.0001) and the Ministry of Health of Ukraine (by 3.37 cm; t=6.79; p<0.0001) standards was also significant. The same index in nine-year-old children with scoliotic posture is distributed in the range from 137 cm to 142 cm with a mean value of 139.58 cm (95% CI 138.59–140.57) and the lowest variation (s=1.56; V=1.12%), and the one-sample t-statistic confirms that their height is 7 cm higher than the WHO data (t=15.57; p<0.0001) and 3.62 cm higher than the standards of the Ministry of Health of Ukraine (t=8.04; p<0.0001).

These data indicate that nine-year-old basketball players are taller than the norms for their age, and this excess is observed in both children with normal and impaired posture.

As for the research findings of the height of 10-year-old basketball players, their height ranged from 143 to 149 cm, with a mean value of 145.7 cm (95% C.I. 144.51–146.89) and a standard deviation of 1.66 cm (coefficient of variation 1.14%). Their mean body length was 7.92 cm (t=15.09, p<0.0001) and 6.8 cm (t=12.95, p<0.0001) higher than the World Health Organization normative values for this age (M= 137.78), and the norms provided by

the Ministry of Health of Ukraine (M=138.9), respectively.

Analysis of the height of children with different types of posture allows us to conclude that they practically have no significant variations in height. For instance, children with normal posture have an average height of 145.5 cm (95% C.I. 144.18–146.82), which exceeds WHO standards by 7.72 cm (t=13.27; p<0.0001) and those of the Ministry of Health of Ukraine by 6.6 cm (t=11.34; p<0.0001). Children with stoop posture have an average height of 145.6 cm (95% C.I. 144.52–146.68), and their excess of WHO and the Ministry of Health of Ukraine standards constitutes 7.82 cm (t=16.38; p<0.0001) and 6.7 cm (t=14.03; p<0.0001), respectively. The average height of young athletes aged 10 years with scoliotic posture constitutes 146.1 cm (95% C.I. 144.86–147.34), which exceeds the WHO and the Ministry of Health of Ukraine standards by 8.32 cm (t=15.21; p<0.0001) and 7.2 cm (t=13.16; p<0.0001), respectively. That is, basketball players aged 10 years, as well as athletes from the previous age group, regardless of the type of posture, have a higher height than the WHO and the Ministry of Health of Ukraine standards for their age. Since height is an important criterion for achieving optimal results in this sports event, this fact should be taken into account while designing training programs and assessing the physical development of young basketball players.

The data on the weight of athletes (Table 2) indicated that at the age of 9 years, it ranged from 28 to 32 kg with a mean value of 30.25 kg (95% C.I. 29.89–30.61), and a standard deviation of 1.05 kg (V = 3.46%).

It should be noted that while comparing these primary statistics with the normative average value provided by the World Health Organization (WHO) for this age (M=28.11), the representatives of our study sample have an average weight of 2.31 kg, which is a statistically significant difference (t=13.2; p<0.0001). At the same time, nine-year-old basketball players are 1.3 kg underweight compared to the average norms for boys of this age provided by the Ministry of Health of Ukraine (t=7.43; p<0.0001). If we consider the primary statistics obtained in groups of children with different types of posture, we can see that 9-year-old athletes with normal posture weigh from 28 to 32 kg, with a mean value of 30.42 kg (95% C.I. 29.5–31.33), standard deviation of 1.44 kg, and a coefficient of variation of 4.7%. Compared to the normative average weight according to the WHO standard,

Table 2

Basic statistics and distribution quartiles of weight indices (kg) of athletes for their different types of posture

Age	Groups	n	Basic statistics					Distribution quartiles		
			min	max	M	m	s	P_{25}	Me	P_{75}
9-year-old	Norms provided by the World Health Organization	–	–	–	28.11	0.15	–	25.4	28.1	31.3
	Norms provided by the Ministry of Health of Ukraine	–	23	41,4	31.55	0,4	4,18	–	–	–
	Normal posture	12	28	32	30.42	0.42	1.44	30	30	32
	Stoop back	12	29	32	30.17	0.24	0.83	30	30	30.5
	Scoliotic posture	12	29	32	30.17	0.24	0.83	30	30	30.5
	All athletes	36	28	32	30.25	0.18	1.05	30	30	31
10-year-old	Norms provided by the World Health Organization	–	–	–	31,16	0,16	–	28.0	31.2	34.9
	Norms provided by the Ministry of Health of Ukraine	–	24	45.6	32.67	0.47	4.84	–	–	–
	Normal posture	10	30	36	33.3	0.62	1.95	32	33	35
	Stoop back	10	31	35	33.2	0.49	1.55	32	33	35
	Scoliotic posture	10	31	35	33.2	0.49	1.55	32	33	35
	All athletes	30	30	36	33.2	0.3	1.63	32	33	35

these children on average weighed 2.31 kg more ($t=5.56$; $p<0.001$), whereas compared to the data on the average weight at the age of 9 in Ukraine, they weighed 1.13 kg less ($t=2.72$; $p<0.05$). The weight of athletes with a stoop back and scoliotic posture ranged from 29 to 32 kg and averaged 30.17 kg (95% C.I. 29.64–30.7) with a standard deviation of 0.83 kg (V=2.75%). They exceeded the WHO standards by 2.06 kg ($t=8.6$; $p<0.0001$), however, their weight was 1.38 kg lower than the standards in Ukraine ($t=5.76$; $p<0.0001$).

Hence, nine-year-old basketball players have a greater weight than the WHO standards for their age, regardless of posture type. However, weight may vary depending on the type of posture and may be bigger or lower than the Ukrainian weight standards for this age.

The results obtained regarding the weight of basketball players at the age of 10 demonstrated that their weight was in the range of 30–36 kg, with a mean value of 33.2 kg (95% C.I. 32.59–33.81), a standard deviation of 1.63 kg, and a coefficient of variation of 4.9%. Compared to the normative average weight for this age provided by the World Health Organization (M=31.16 kg) and the data of the Ministry of Health of Ukraine, they weighed on average 2.04 kg ($t=6.86$; $p<0.0001$) and 0.57 kg more (M=32.67), respectively, and this difference was not significant.

The weight of athletes of this age according to the types of posture is bigger in all groups than the established standards for age. For instance, children aged 10 years with normal posture weighed from 30 to 36 kg, which averaged 33.3 kg (95% C.I. 31.91–34.7) with a standard deviation of 1.95 kg and a coefficient of variation of 5.9%. Their mean weight was 2.14 kg ($t=3.47$; $p<0.01$) and 0.63 kg more than the WHO standards and standards for Ukraine ($t=1.02$; $p>0.05$), respectively. Concerning children with stoop back and scoliotic posture, their weight ranged from 31 kg to 35 kg, and averaged 33.2 kg (95% C.I. 32.09–34.31) with a standard deviation of 1.55 kg (V=4.67%). They exceeded the WHO standards and those for Ukraine by 2.04 kg ($t=4.16$; $p<0.01$) and 0.53 kg ($t=1.08$; $p>0.05$), respectively. Therefore, basketball players aged 10 years on average have a bigger weight than the WHO standards for their age. However, the weight varied depending on the type of posture and did not exceed Ukrainian standards. These data are important for developing training programs and determining the optimal physical development of younger basketball players.

It is important to note that the medians and interquartile ranges in the study groups differ significantly from the WHO norms only at the age of 9 years, where the medians in each group exceed the limit of the third quartile of the distribution. In ten-year-old athletes, the median distributions correspond to the second quartile according to the WHO, i.e., they are in the range between the 50th and 75th percentiles. If we compare the individual data of each basketball player with the WHO centile tables and the data of the Ministry of Health of Ukraine (Table 3), we can conclude that the weight of majority of 9-year-old athletes (83.3%) corresponded to the WHO average standard (P_25–P_75), and only 16.7% had a weight that is considered to be above the average level according to the distribution parameters of the WHO (P_75–P_90). If their weight is compared with the sigmal standards of the Ministry of Health of Ukraine, then all athletes of this age had an average weight (M±s). A similar distribution is peculiar for athletes aged 10 years. According to the WHO standards, the majority of them (66.7%) had an average weight, and the rest (33.3%) fell into the interval of higher-than-average values according to the WHO standards (P_75–P_90). According to the standards of the Ministry of Health of Ukraine, all of them corresponded to the average level. As we can see, most children aged 9 and 10 years old were of average weight, and there were fewer children whose body weight was considered above average according to WHO standards. That is, the difference in weight standards between the WHO and the Ministry of Health of Ukraine is less noticeable because using both standards, most participants were placed in the same level groups. To prove the above, we present the calculated values of Cohen's kappa coefficient of agreement for body weight according to the WHO classification and

Table 3

Distribution of research participants 9–10 years old with different types of posture by weight levels according to norms the World Health Organization and the Ministry of Health of Ukraine

Age	Compared groups	Physical development levels; number of athletes (%)						
		very low	low	below average	average	above average	high	very high
9-year-old	centile scale provided by the World Health Organization							
	Centile groups	$<P_3$	$P_3 – P_{10}$	$P_{10} – P_{25}$	$P_{25} – P_{75}$	$P_{75} – P_{90}$	$P_{90} – P_{97}$	$P_{97}>$
	Centile groups` intervals (kg)	before 21.6	21.6–23.38	23.39–25.44	25.45–31.26	31.27–34.62	34.63–38.56	38.57 and above
	Normal posture (n=12)	–	–	–	8 (66.7%)	4 (33.3%)	–	–
	Stoop back (n=12)	–	–	–	11 (91.7%)	1 (8.3%)	–	–
	Scoliotic posture (n =12)	–	–	–	11 (91.7%)	1 (8.3%)	–	–
	Beyond sigma deviations (the Ministry of Health of Ukraine)							
	Levels` intervals (kg)	–	before 23.2	23.2–27.3	27,4–36,1	36,2–40,2	40.3 and above	–
	Normal posture (n=12)	–	–	–	12 (100%)	–	–	–
	Stoop back (n=12)	–	–	–	12 (100%)	–	–	–
	Scoliotic posture (n=12)	–	–	–	12 (100%)	–	–	–
10-year-old	centile scale provided by the World Health Organization							
	Centile groups` intervals (kg)	before 23.6	23.6–25.6	25.7–28	28,1–34,9	35–39	39.1–43.9	44 and above
	Normal posture (n=10)	–	–	–	6 (60%)	4 (40%)		–
	Stoop back (n=10)	–	–	–	7 (70%)	3 (30%)		–
	Scoliotic posture (n=10)	–	–	–	7 (70%)	3 (30%)		–
	Beyond sigma deviations (the Ministry of Health of Ukraine)							
	Levels` intervals (kg)	–	before 23	23–27.7	27.8–37.9	38–42.7	42.8 and above	–
	Normal posture (n=10)	–	–	–	10 (100%)		–	–
	Stoop back (n=10)	–	–	–	10 (100%)		–	–
	Scoliotic posture (n=10)	–	–	–	10 (100%)		–	–

Note. P_i is the i-th percentile value.

the data of the Ministry of Health of Ukraine, which constituted 0.62 (95% CI 0.34 to 0.86) and 0.19 (95% CI 0.06 to 0.32) for the age of 9 and 10, respectively. Hence, we have a good consistency in the estimates of weight of 9-year-old athletes according to different standards and a weak level of consistency in the estimates of 10-year-old children. Thus, according to mean values the weight of young athletes at the age of 9 years significantly exceeded the average standard for their age, as defined by WHO standards, but was lower than the standards of the Ministry of Health of Ukraine. In ten-year-old basketball players, this physical development parameter on average exceeded the WHO standards but met Ukrainian ones.

As far as the assessment standards of the WHO and the Ministry of Health of Ukraine were well and poorly coordinated for the ages of 9 and 10 years, respectively, the majority of athletes of 9 and 10 years old according to the WHO standards and the norms of the Ministry of Health of Ukraine were those with an average weight.

Moving on to the analysis of chest circumference (CC) measurements of the subjects, we should note that the relevant WHO standards were not found in the available literature. Therefore, we will determine the level of physical development by CC focusing on national standards only [10]. The study data (Table 4) showed that children aged 9 years had a CC in the range

Table 4

Basic statistics and distribution quartiles of chest circumference (cm) of athletes for their different types of posture

Age	Groups	n	Basic statistics					Distribution quartiles		
			min	max	M	m	s	P_{25}	Me	P_{75}
9-year-old	Norms provided by the Ministry of Health of Ukraine	–	58	77	64.57	0.38	3.83	–	–	–
	Normal posture	12	59	63	61.08	0.4	1.38	60	61	62
	Stoop back	12	59	62	60.25	0.36	1.22	59	61	61
	Scoliotic posture	12	59	62	60.25	0.36	1.22	59	61	61
	All athletes	36	59	63	60.53	0.22	1.30	59	61	62
10-year-old	Norms provided by the Ministry of Health of Ukraine	–	60	80	66.59	0.46	4.65	–	–	–
	Normal posture	10	60	71	65.3	1	3.16	64	64	68
	Stoop back	10	60	70	65.1	0.91	2.88	64	64	67
	Scoliotic posture	10	60	70	65.1	0.91	2.88	64	64	67
	All athletes	30	60	71	65.17	0.53	2.88	64	64	67

from 59 to 63 cm with a mean value of 60.53 cm (95% C.I. 60.09–60.97) and a standard deviation of 1.3 kg (V = 2.15%). Compared to the normative average value provided by the Ministry of Health of Ukraine (M=64.57), they have a 4.04 cm smaller CC (t=18.65; p<0.0001). Regarding groups of children with different types of posture, it was determined that the chest circumference of 9-year-old athletes with normal posture ranges from 59 to 63 cm, with a mean value of 61.08 cm (95% CI 60.2–61.96), standard deviation of 1.38 cm, and a coefficient of variation of 2.26%.

In comparison with the average value according to the norms in Ukraine, they lagged in terms of CC by 3.49 cm (t=8.76; p<0.0001). In basketball players with a stoop back and scoliotic posture, these dimensions ranged from 59 to 62 cm and averaged 60.25 cm (95% CI 59.48–61.03) with a standard deviation of 1.22 cm (V=2.02%).

Compared to the average norm in Ukraine, their mean CC was 4.32 cm lower (t=12.27; p<0.0001). That is, the nine-year-old basketball players generally have lower CC than the Ukrainian standards for this age.

In this study, the indices of the chest circumference of 10-year-old basketball players showed that they were equal to or greater than 60 cm and did not exceed 71 cm. The mean value in the sample constituted 65.17 cm (95% C.I. 64.1–66.25), and the standard deviation was 2.88 cm (V=4.42%). Compared to the normative mean values according to the Ministry of Health of Ukraine (M=66.59), their CC was 1.42 cm less (t=2.7; p<0.05). According to the types of posture, the chest circumference index did not vary significantly. For instance, in ten-year-old basketball players, it was distributed in the range from 60 to 71 cm, and constituted on average 65.3 cm (95% C.I. 63.04–67.56) with a standard deviation of 3.16 cm (V=4.8%). These dimensions were 1.29 cm lower on average than the norms for Ukraine, but such differences were not considered statistically significant (t=1.29; p>0.05). As for children with stoop back and scoliotic posture, their indices of CC ranged from 60 cm to 70 cm, with a mean value of 65.1 cm (95% C.I. 63.04–67.16) and a standard deviation of 2.88 cm (V=4.42%). These values were lower than the average norm in Ukraine by 1.49 cm, but not lower enough to become statistically significant (t=1.64; p>0.05). That is, the data on the chest circumference of basketball players aged 10 years indicate that this index has a rather limited range of fluctuations. On average, they showed moderate physical development according to the CC, compared to Ukrainian norms, however, the overall level of chest circumference development in these children can be considered as corresponding to the average norms for their age in Ukraine.

The analysis of the subjects' individual data by comparing them with the norms for Ukraine (Table 5) showed that the CC index of more than

Table 5

Distribution of research participants 9–10-years-old with different types of posture by chest circumference levels (cm) according to norms the Ministry of Health of Ukraine

Age	Compared groups	Physical development levels; number of athletes (%)				
		low	below average	average	above average	high
9-year-old	Levels` intervals (cm)	before 56.9	56.9–60.6	60.7–68.7	68.8–72.5	72.6 and above
	Normal posture (n=12)	–	4 (33.3%)	8 (66.7%)	–	–
	Stoop back (n=12)	–	6 (50%)	6 (50%)	–	–
	Scoliotic posture (n =12)	–	6 (50%)	6 (50%)	–	–
10-year-old	Levels` intervals (cm)	before 57.3	57.3–61.8	61.9–71.6	71.7–76.3	76.4 and above
	Normal posture (n=10)	–	1 (10%)	9 (90%)	–	–
	Stoop back (n=10)	–	1 (10%)	9 (90%)	–	–
	Scoliotic posture (n=10)	–	1 (10%)	9 (90%)	–	–

half of the 9-year-olds (55.6%) met the norm for the average level of physical development. The remaining children were defined as having chest circumference indices below the average level.

More concentrated within the average norm were the results of measurements in athletes aged 10 years, which in 90% of cases corresponded to the CC of children of each type of posture. Only 10% of basketball players of this age had this parameter below the average level. That is, most children aged 9 and 10 years had an average CC, and there were fewer children with CC lower than the national average.

The data presented afford ground to stress that in general, most children in both age groups have average or close to average values of CC. However, in the group of 9-year-old children, a more significant deviation from the average norms is observed, indicating less chest development compared to national standards. In the group of 10-year-old children, this deviation is less pronounced, most athletes have average indices. That is, the CC in some children of the younger age group may require attention and exercises to improve this parameter of physical development. The situation is better in older children; most of them have average values of CC, which correspond to the average norms for Ukraine.

To compare somatometric indices in athletes with different types of posture, it is important to define criteria by which it will be carried out. For this purpose, the obtained results were checked for normality of distribution (Table 6).

Generalized age groups of athletes were compared by average values. Accordingly, to

Table 6

Assessment of the normality of somatometric indices distribution for young basketball players 9–10-year-old with different types of posture

Age	Group	High		Weight		Chest circumference	
		W	p	W	p	W	p
9-year-old	Normal posture (n=12)	0,937	p>0.05	0.845	p<0.05	0.925	p>0.05
	Stoop back (n=12)	0.914	p>0.05	0.843	p<0.05	0,.816	p<0.05
	Scoliotic posture (n =12)	0.932	p>0.05	0,843	p<0.05	0.816	p<0.05
	All athletes (n=36)	0.934	p>0.05	0.865	p>0.05	0.866	p>0.05
10-year-old	Normal posture (n=10)	0.924	p>0.05	0.894	p>0.05	0,.936	p>0.05
	Stoop back (n=10)	0.862	p>0.05	0.887	p>0.05	0.941	p>0.05
	Scoliotic posture (n=10)	0,.848	p>0.05	0.887	p>0.05	0.941	p>0.05
	All athletes (n=30)	0.902	p>0.05	0.917	p>0.05	0.915	p>0.05

Notes: W – value of the Shapiro-Wilk criterion; p – level of reliability of distribution differences from normal; W_{table} (10; 0.05)=0.842; W_{table} (12; 0.05)=0.859; W_{table} (30; 0.05)=0,9; W_{table} (36; 0.05)=0.912.

check the level of statistical significance of the revealed differences in height and for all indices in the combined age groups, the Student's t-test was used, whereas for weight and CC for groups of athletes of different ages with the same type of posture the Mann-Whitney U test was utilized. The results showed that the height of athletes aged 10 years old with normal posture was on average higher than that of nine-year-olds by 6.33 cm, and such a difference turned out to be significant during statistical check (t=7.13; p<0.001). Similarly, 10-year-old basketball players with a stoop back and scoliotic posture were 6.27 cm (t=9.1; p<0.001) and 6.52 cm taller (t=9.28; p<0.001), respectively. Accordingly, if we turn to the measurements in the groups combined by age, the difference between them in terms of height, which averaged 6.34 cm, was also significant at the 0.1% confidence level (Table 7).

Let us analyze in a similar fashion the differences by the index of weight where in all groups of children of 10 years old the median was 3 kg higher than in nine-year-old athletes which was statistically confirmed by values of the Mann-Whitney criterion, which for the compared age samples with normal posture made 15.5 points that is less than a critical value of the criterion for samples of 10 and 12 subjects U_{cr}(10; 12; 0.01)=21, and thus confirmed the regular nature of the differences at the 1% level of statistical significance.

For children with a stoop back and scoliotic posture, the significance of the differences was also high (U=4.5; p<0.01). It is understood that in groups that included all basketball players of similar age, the difference in weight, which averaged 2.95 kg, was also significant (t=8.62; p<0.001).

The analysis of the chest circumference of the subjects demonstrated that in all groups at the age of 10 years, the median was 3 cm larger than in children aged 9 years. This difference was statistically confirmed by the values of the Mann-Whitney test when comparing age samples with normal posture (U=10; p<0.01), a stoop back, and scoliotic posture (U=6.5; p<0.01). In general, in all groups of children, regardless of the type of posture, the difference in the CC was significant; in children aged 10 years, this circumference was on average 4.64 cm larger than in nine-year-old athletes (t=8.16; p<0.001).

Discussion. The problem of locomotorium functional disorders in young athletes [1; 5] is one of the major challenges in the context of a health-saving approach in the system of sports training [3]. According to the research data [12], the most widespread posture disorders among young basketball players are the type of round concave back, scoliotic posture, flat-concave back, and stoop. The results of our research supplement the information of the above-mentioned specialist on the peculiarities of posture disorders in young basketball players.

Among individual peculiarities of an athlete's body of great interest are the morphological indices [6; 18]. Some of them influence the manifestation of different sports abilities in basketball, in

Table 7

Statistically significant differences in the expression of somatometric indices of physical development for basketball players 9–10-year-old (n=66)

Age	n	Basic statistics		Distribution quartiles			Differences` validity	
		M	s	P_{25}	Me	P_{75}	t	p
High, cm								
9-year-old	36	139.36	1.82	138	140	141	14.85	p<0.001
10-year-old	30	145.7	1.66	145	145.5	146		
Weight, kg								
9-year-old	36	30.25	1.05	30	30	31	8.62	p<0.001
10-year-old	30	33.2	1.63	32	33	35		
Chest circumference, cm								
9-year-old	36	60.53	1,3	59	61	62	8.16	p<0.001
10-year-old	30	65.17	2.88	64	64	67		

Notes: t – the Student's t-test value; t_kr (64; 0.001)=3,46.

particular physical work capacity, technical and tactical skills [9]. The conducted studies allowed us to supplement the information base concerning the morphological profile of young basketball players.

The spatial orientation optimization of the body of young athletes [20], who are engaged in such asymmetric sports events as basketball should provide a more full-fledged in functional terms interposition of individual body segments and increase the functional strength of the spine, which in turn will contribute to the prevention of injuries and reduce the risk of relevant functional disorders of the locomotorium [8]. The conducted studies indicate the need for constant morphobiomechanical control over the effect of physical loads on the functional state of young athletes' locomotorium, during the period of their musculoskeletal system formation and development [4; 19].

In the course of previous studies, we managed to establish the basic prerequisites for the development of a strategy for the correction and prevention of posture disorders, which obviously became a scientific basis for further studying the conceptual foundations of training young basketball players and combining them with modern approaches to the correction and prevention of posture disorders in young athletes.

Conclusions. Based on the analyzed data, the following conclusions on the physical development of young basketball players aged 9 and 10 years old can be drawn. Firstly, the majority of children in both age groups have a height that exceeds the average norm for their age and a normal weight in general. As for the CC of athletes, it generally corresponds to the general norms. However, there are individual variations, especially among 9-year-olds, who require increased attention and correction to reach the normative values. Secondly, the type of posture is not a determining factor for the physical development of basketball players, since children with any type of posture have similar somatometric characteristics, and small variations are rather due to individual peculiarities of physical development. Thirdly, significant differences were found between children aged 9 and 10 years, indicating higher height, weight, and CC of athletes of the older group.

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Отримано: 20.02.2024
Прийнято: 14.03.2024
Опубліковано: 29.04.2024

Received on: 20.02.2024
Accepted on: 14.03.2024
Published on: 29.04.2024