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Anthropometric Characteristics of Elite Basketball Players Aged 12, 13 and 14

Características Antropométricas de Jugadores de Baloncesto de Élite de 12, 13 y 14 Años

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SUMMARY: Anthropometric characteristics, encompassing body dimensions and composition, are crucial for assessing athletes' physical readiness and performance, with certain traits often linked to success in specific sports. This study aimed to describe and compare the anthropometric profiles of elite basketball players aged 12, 13, and 14 years. A total of 108 young athletes were evaluated and divided into three groups: G1 (age 14, N=37), G2 (age 13, N=28), and G3 (age 12, N=43). Twenty anthropometric parameters were measured, including six lengths, two breadths, five circumferences, body mass, and six skinfolds. Data analysis employed descriptive statistics, ANOVA with LSD post hoc tests, and normality checks. Findings revealed that body lengths, breadths, circumferences, and mass were highest in the 14-year-old group, whereas skinfold thickness values peaked among the youngest players. Growth in height was more pronounced than increases in body mass in G1 and G2 compared with G3. Breadths demonstrated a slower growth trend, while subcutaneous fat tissue values generally remained within average ranges, showing a slight decrease with age. All longitudinal dimensions were more evident in older groups, with the most pronounced developmental increase occurring between ages 13 and 14. These results indicate significant differences in anthropometric characteristics across the studied age groups, particularly regarding stature and arm span. Such traits, strongly associated with basketball performance, highlight the importance of incorporating anthropometric assessment into the early selection process of preadolescent athletes, as they represent key predictors of success during this critical stage of athletic development.

KEY WORDS: Stature; Arm span; Growth trend; Training; Selection.

INTRODUCTION

Anthropometric characteristics in athletes include various body dimensions and proportions which are frequently used in order to assess their physical readiness, maturity and abilities. In most sports, anthropometric measurements of athletes considerably influence overall success or certain motor abilities (Monsma & Malina, 2005; Sarvestan *et al*., 2019). Athletes usually have specific, desirable anthropometric measurements, body composition and certain type of build characteristic for their particular sport (Carter *et al*., 2005; Kontic *et al*., 2025), which also applies to young athletes (Damsgaard *et al*., 2001).

Basketball is a sport in which anthropometric characteristics of players are directly connected with their positions and tasks in the game (Gryko *et al*., 2019), but also with their success (Ljubojevic *et al.*, 2020). Basketball players are mostly of stature above average (Karalejic & Jakovljevic, 2022) and this is why one's stature is usually the first and most important criterion during the process of selection of young basketball players. In countries with developed basketball tradition children can start training as early as at the ages of 9 or 10. However, the real selection of young basketball players begins at the age of 12, when first real competitive teams are formed (Karalejic & Jakovljevic, 2022). The second selection usually occurs at the age of 14 and it is based on anthropometric characteristics and certain motor and cognitive abilities (Karalejic & Jakovljevic, 2022). This is a very sensitive process for 14-year-olds since that is when the first peak height velocity (PHV) occurs, accompanied by the increase in certain motor and functional abilities (Ramos *et al*., 2021). It is well-known that certain anthropometric characteristics (stature, length and breadth measurements) have high genetic predisposition, which means they cannot be significantly increased by training (Silventoinen *et al*., 2023).

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Analyses of anthropometric characteristics in athletes of various ages were presented in numerous studies (Canli, 2017; Gryko *et al*., 2018; Gryko *et al*., 2019; Matulaitis *et al*., 2019; Ljubojevic *et al*., 2020; Ramos *et al*., 2023). However, there are not many studies in the available literature solely devoted to anthropometric and morphological characteristics of preadolescent athletes (Rinaldo *et al*., 2020; Toselli *et al*., 2021; Ramos *et al*., 2023). The development of anthropometric characteristics of basketball players in the age of puberty is a key aspect when evaluating their physical abilities and potential for further progress in sport (Rinaldo *et al*., 2020). Stature is often one of the key factors in basketball, since taller players usually have advantage in jumps, blocks and at scoring points, especially when playing on center or power forward positions (Cumming *et al*., 2017). Body mass is also important when evaluating physical abilities, since a higher percentage of muscle mass can increase strength and explosiveness while higher body mass can decrease agility and mobility (Malina *et al*., 2024). Preadolescent basketball players often face challenges in the process of building up muscle mass, especially during puberty when hormonal changes occur (Malina *et al*., 2024). On the other hand, a healthy percentage of body fat is important in order to maintain optimal physical abilities, since it is usually connected with better athletic performances, while excessive body mass can decrease stamina and mobility (Ramos *et al*., 2023). This is especially important when boys reach puberty, since at that age increased body mass triggers hypothalamus-pituitary-testicular axis and, with it, increased production of testosterone. Increased level of this hormone influences muscle power production (Mah & Wittert, 2010). Body proportions are also essential for basketball skills (Shamim, 2020).

The aim of this study was to describe and compare the anthropometric characteristics of elite basketball players aged 12, 13 and 14. The hypothesis was that there would be significant differences among these three groups of preadolescent players in all anthropometric variables, and that older players' variables, which are important for basketball, would be more advantageous.

MATERIAL AND METHOD

Participants. This study used a cross-sectional method. The sample consisted of young basketball players (N=108) aged from 12 to 14 divided into three groups: Group G1 – aged 14 (N=37), Group G2 – aged 13 (N=28) and Group G3 – aged 12 (N=43). Subjects were chosen by the experts from the Basketball Federation of Serbia as promising, based on their anthropometric characteristics, motor abilities and technical skills. All players were in good health and they voluntarily agreed to participate in the research. Ethical clearance was taken from the Ethics Committee of the University of Belgrade - Faculty of Sport and Physical Education. The study was conducted as per declarations of Helsinki.

Variables. There were 20 independent variables obtained directly from the anthropometric measurements. Measurements were assessed by an experienced anthropometric technician in accordance with the standards set by the International Society for the Advancement of Kinanthropometry. The following variables were measured: stature, sitting height, lower limb, upper limb and foot lengths, arm span (GPM anthropometer, Siber Hegner, Switzerland); biacromial and bitrochanteric breadths (GPM caliper); trunk, arm, forearm, thigh and calf circumferences (Holtain anthropometric tape, Crymych, UK); and upper arm, forearm, thigh, calf, chest and abdominal skinfolds (Harpenden Skinfold Caliper, British Indicators, West Sussex, UK); body mass was measured with Tanita BC-418 device (Amsterdam, The Netherlands).

Statistical analysis. Prior to the procession of the data, the normality of data distribution was checked. Basic parameters of descriptive statistics were calculated: arithmetic means (M), standard deviations (SD), as well as maximal (Max) and minimal (Min) values. Differences between groups were established by using analysis of variance (ANOVA) and LSD post hoc test. The least significance of differences was set at the level of 0.05. All statistical analyses were performed using the Statistical Package for the Social Sciences (SPSS, Version 25; IBM Corp., Armonk, NY, USA).

RESULTS

In Table I we presented mean values of all anthropometric variables, standard deviations, as well as minimal and maximal values for three groups of subjects. Results showed that the values of lengths and breadths, as well as body mass and circumferences were the highest in subjects aged 14, while skinfold values were the highest in the youngest subjects.

The results showed that statures of 12- and 13-year-old players were around 97th percentile when compared to young Americans, while 14-year-old subjects were above 97th percentile in comparison with the American population of the same age (Malina *et al*., 2024). The body mass of 12-year-olds was between the 75th and 95th percentile, 13-year-olds were at the 75th percentile, while 14-year-olds were somewhat below the 95th percentile (Malina *et al*., 2024). In comparison with the 12- to 14-year-old boys in the Republic of Serbia, young basketball players were taller and heavier in all age categories and the differences got higher with age (Milanovic & Radisavljevic Janic, 2015).

Table I. Descriptive statistics.

Variable	G1 (14 years old)			G2 (13 years old)			G3 (12 years old)		
	Mean±SD	Min	Max	Mean±SD	Min	Max	Mean±SD	Min	Max
Stature (cm)	184.27± 9.32	163.00	205.00	173.00±8.59	156.00	191.00	166.67±10.51	149.00	187.00
Body mass (kg)	67.68± 10.24	47.00	88.00	58.75±6.77	40.00	73.00	51.84±10.73	37.00	82.00
Sitting height (cm)	91.55±5.43	80.50	102.00	86.34±4.12	79.00	96.00	82.36±4.93	73.50	95.00
Lower limb height (cm)	98.08±5.88	87.00	112.00	93.11±5.00	82.50	103.50	90.03±6.26	79.50	101.50
Upper limb height (cm)	81.31±4.37	73.90	90.00	77.14±4.48	66.50	88.00	73.01±4.99	65.50	83.00
Foot length (cm)	27.50±1.52	25.00	31.00	26.63±1.62	23.00	29.70	26.18±2.03	23.00	31.00
Arm span (cm)	186.79±9.47	165.00	206.00	176.46±10.28	153.00	200.00	167.45±10.88	150.00	189.50
Biacromial breadth (cm)	41.47±2.48	36.00	47.00	38.23±2.32	34.00	43.50	38.52±2.45	33.50	45.50
Bitrochanteric breadth (cm)	31.03±2.21	26.00	36.20	29.75±2.05	25.50	33.30	28.71±2.64	23.50	35.00
Trunk circumference (cm)	71.89±5.22	63.90	84.50	68.37±2.77	63.50	73.50	68.13±7.17	60.00	94.00
Arm circumference (cm)	24.12±1.95	21.00	28.50	22.23±1.81	19.00	26.00	22.27±2.30	18.00	29.50
Forearm circumference (cm)	24.32±1.47	21.50	27.00	22.51±1.75	20.00	26.00	21.81±1.62	18.50	26.50
Thigh circumference (cm)	50.81±3.93	44.00	61.00	44.75±4.08	37.50	54.00	47.23±5.22	38.00	61.50
Calf circumference (cm)	34.97±2.43	30.50	41.00	33.35±2.32	28.00	38.50	32.41±3.06	28.00	41.00
Upper arm skinfold (mm)	8.62±2.70	4.30	14.50	8.23±2.42	5.20	15.60	10.74±3.99	5.20	28.20
Forearm skinfold (mm)	5.57±1.04	3.60	8.00	5.33±0.88	4.00	7.00	7.01±2.67	3.50	17.50
Thigh skinfold (mm)	11.36±3.78	6.60	20.00	11.59±3.72	4.80	23.00	14.98±5.63	5.14	29.30
Calf skinfold (mm)	7.54±2.70	3.80	17.50	8.60±2.23	3.20	13.30	11.64±4.02	4.90	20.20
Chest skinfold (mm)	5.54±1.83	3.50	12.60	4.96±1.37	3.20	9.40	7.43±3.97	3.00	23.00
Abdominal skinfold (mm)	8.90±3.82	4.90	22.20	5.90±2.53	2.00	13.00	10.87±6.52	3.70	31.30

Results of ANOVA showed high values of F-test (F=5.133 – 35.323) in all statistically significant variables. Based on these results, the difference between age groups was analyzed using LSD post hoc test for all variables (Table II). The results showed that age groups significantly differed in most variables, with the level of significance 0.01 and fewer variables differed on the level of significance of 0.05. Group G1 (aged 14) differed from Group G2 (aged 13) in all variables, except foot length and skinfold variables (apart from abdominal skinfold where the difference was statistically significant), and it differed from G3 (aged 12) in all variables. Group G2 differed from Group G3 in all variables except: foot length, biacromial and bitrochanteric breadth, and in all circumferences except thigh circumference where the recorded difference was statistically significant.

Table II. Differences between groups.

Variable	G1 to G2		G1 to G3		G2 to G3	
	Mean Difference	Sig.	Mean Difference	Sig.	Mean Difference	Sig.
Stature (cm)	11.27	0.001	17.59	0.001	6.33	0.001
Body mass (kg)	8.92	0.001	15.83	0.001	6.91	0.004
Sitting height (cm)	5.21	0.001	9.20	0.001	3.98	0.001
Lower limb height (cm)	4.96	0.001	8.05	0.001	3.08	0.032
Upper limb height (cm)	4.17	0.001	8.30	0.001	4.13	0.001
Foot length (cm)	0.88	0.051	1.32	0.001	0.45	0.301
Arm span (cm)	10.32	0.001	19.33	0.001	9.01	0.001
Biacromial breadth (cm)	3.24	0.001	2.94	0.001	-0.31	0.608
Bitrochanteric breadth (cm)	1.28	0.032	2.32	0.001	1.04	0.072
Trunk circumference (cm)	3.51	0.015	3.75	0.004	0.24	0.860
Arm circumferences (cm)	1.88	0.001	1.84	0.001	-.043	0.931
Forearm circumference (cm)	1.81	0.001	2.51	0.001	0.70	0.075
Thigh circumference (cm)	6.05	0.001	3.57	0.001	-2.48	0.026
Calf circumference (cm)	1.62	0.017	2.56	0.001	0.93	0.153
Upper arm skinfold (mm)	0.38	0.630	-2.12	0.004	-2.50	0.002
Forearm skinfold (mm)	0.23	0.617	-1.44	0.001	-1.67	0.001
Thigh skinfold (mm)	-0.23	0.838	-3.62	0.001	-3.38	0.003
Calf skinfold (mm)	-1.06	0.189	-4.09	0.001	-3.04	0.001
Chest skinfold (mm)	0.58	0.408	-1.88	0.003	-2.47	0.001
Abdominal skinfold (mm)	2.99	0.016	-1.97	0.073	-4.97	0.001

DISCUSSION

Stature and other anthropometric characteristics have been researched in many countries, and each country tries to obtain reference standards, i.e. growth and development graphs. In the USA researches were conducted by the US Department of Health and Human Services, Centers for Disease Control and Prevention (Kuczmarski, 2000), also in India (Majumder *et al*., 2024), while in Serbia the analyses of growth and development were conducted by Serbian Institute of Sport and Sports Medicine and Faculty of Sport and Physical Education (Milanovic & Radisavljevic Janic, 2015).

In our study, all longitudinal dimensions were above average for boys aged 12, 13 and 14, and the difference increased with the age of subjects when compared with the research of Malina *et al*. (2024), as well as Milanovic & Radisavljevic Janic (2015). In Figure 1 (a) linear trends of increase in height and mass in male basketball players aged 12 to 14 are shown (linearly interpolated piece wise), which indicates that there are significant differences between G1, G2 and G3. Growth trend was more prominent between the ages of 13 and 14 which indicates that maximal increase in height and body mass has begun which is in accordance with the significant development of longitudinal dimensionality in ratio to lean body mass. Figure 1 (b and c) presents the growth trend of certain longitudinal dimensionalities of basketball players aged between 12 and 14 (linearly interpolated piecewise). It can be concluded from the shape of the curve that the increase of longitudinal dimensionalities is more distinct between the ages of 13 and 14 when compared with the ages of 12 and 13, especially stature and arm span. Growth rates of leg and arm lengths and sitting body height are almost constant at the ages between 12 and 14. Based on the results and somatotyping of body composition it can be concluded that male basketball players of the researched ages (12 to 14) belong to ectomorphic somatotype, which is in accordance with the data from literature (Gryko *et al*., 2018; Malina *et al*., 2024). Our subjects belong to a highly selected population of children, and it is therefore implied that their longitudinal dimensionalities would be at high percentile, since that is one of the basic conditions of selection of young players in basketball.

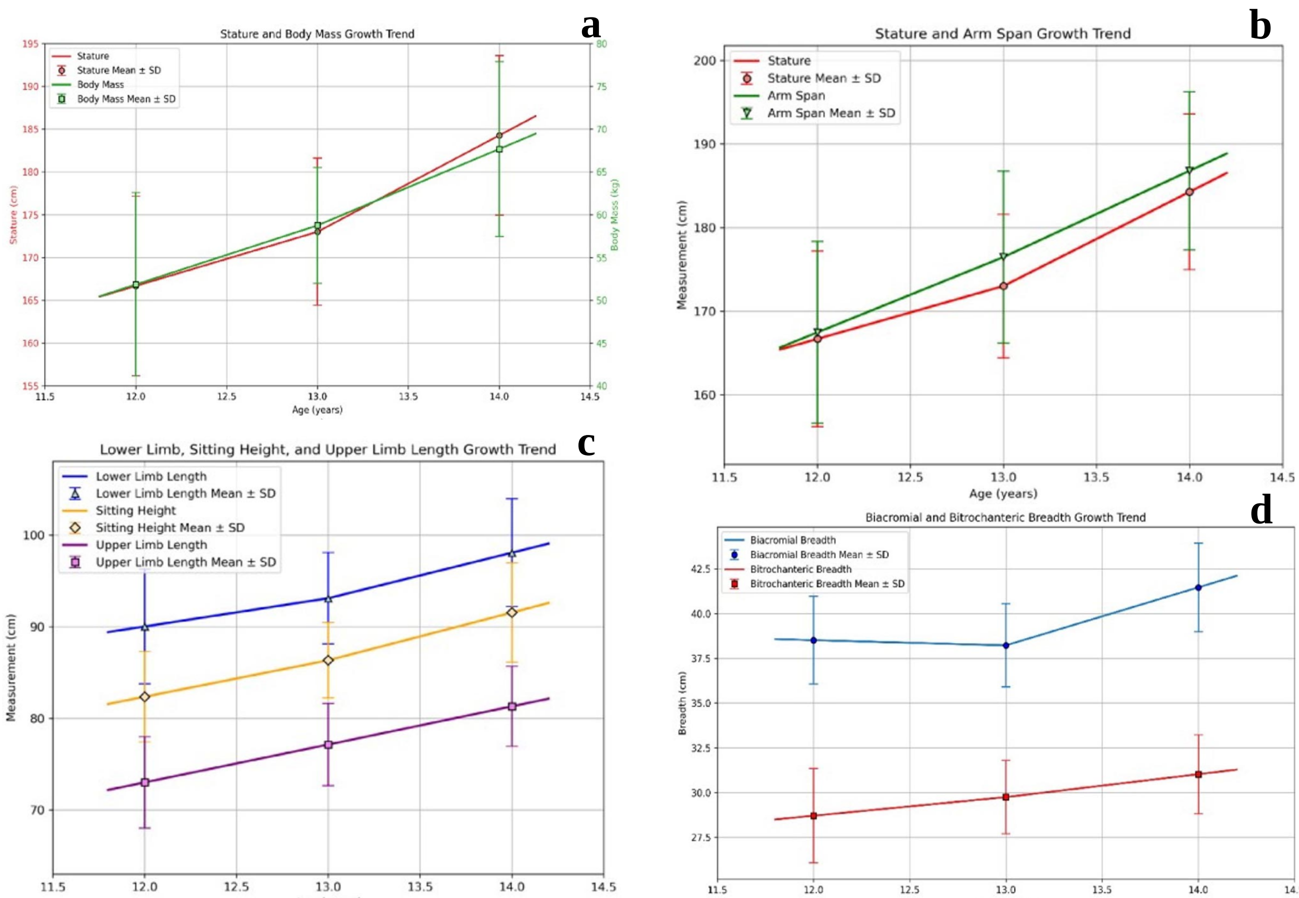


Fig. 1. Stature, body mass (a) stature, arm span (b), lower limb length, sitting height, upper limb length (c), biacromial and bitrochanteric breadth (d) grow trend.

When breadth dimensionalities are concerned (biacromial breadth and bitrochanteric breadth), their values were also above the average values of their peers (Malina *et al*., 2024), but the differences in comparison with the boys of the same age did not increase with age. Also, Figure 1 (d) presents the growth trend of transversal dimensionalities through biacromial and bitrochanteric breadth. Based on it, it can be concluded that the growth trend of biacromial breadth was more distinct only between the ages of 13 and 14 (the difference in this case was statistically significant). Concerning bitrochanteric breadth, there was a statistical significant difference only between the ages of 12 and 13, while between the ages between 13 and 14 the difference existed but was not statistically significant.

Circumferences were within the limits of average values for boys of the same age in comparison with the results of Malina *et al*., (2024). In Figure 2 (a, b and c), where growth trends of chest, arm and leg circumferences are presented, it can be noticed that there was a stronger growth trend during the age between 13 and 14 for all circumferences (without statistically significant difference for chest and shin circumferences). Since circumferences indirectly indicate the quantity of muscle tissue (fat-free mass), it can be concluded that the population of preadolescent male basketball players develops in a very similar pattern as the general male population of the same age concerning growth curves for fat-free mass (Malina *et al*., 2024).

The quantity of subcutaneous fat tissue (skinfolds) had similar values and decreased with age, which is in accordance with the trend of decline of its average values in their peers from the generalpopulation (Addo & Himes, 2010; Malina *et al*., 2024). Also, Figure 2 (d and e) presents the thickness of arm skinfolds (upper arm and forearm), leg skinfolds (thigh and calf) (left), chest and abdomen (right). The trend of the decrease of skin-fold thickness can be observed between the ages of 12 and 13, which is also the period of growth, i.e. increase of longitudinal dimensionalities (when statistically significant difference in the thickness of all skinfolds can be noticed), while during the period between 13 and 14 stabilization in the thickness of skinfolds occurs (there is no statistically significant difference in the thickness of any skinfolds), with a slight increase of abdominal skinfold. Since skinfolds indirectly indicate the quantity of fatty tissue, it can be concluded that the population of young male basketball players develops in a very similar pattern as the general population, mainly concerning growth curves for fat mass, and especially concerning relative fatness where pre-puberty overweightness can be noticed before the age of 12, after which a sharp decline followed by stabilization of fat percentage occurs (Malina *et al*., 2024).

After analyzing all data, we noticed that in basketball players aged 12 to 14 longitudinal dimensionalities are developed dominantly, especially during the period between 13 and 14 years of age. Concerning circumferences, their growth trend is more distinct between the ages of 13 and 14, which indicates gaining muscle mass, considering that skinfold thickness does not increase during the same period (Table II). Muscle mass is in accordance with the development of boys in the general population of the same age, which is similar to the results of other research (Gryko *et al*., 2018; Damsgaard *et al*., 2001; Malina *et al*., 2024).

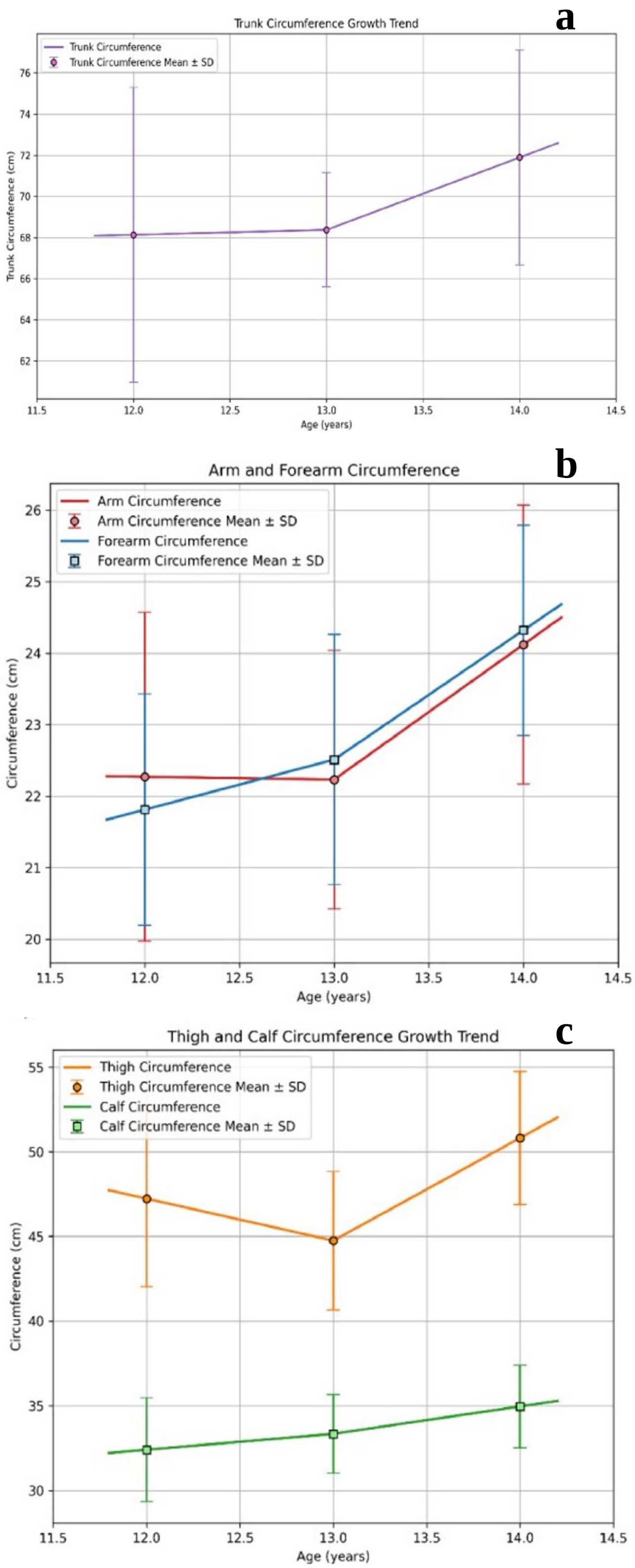
Unlike the studies conducted on elite preadolescent basketball players in 2016 (Jakovljevic *et al*., 2016), in which biological age was considered, in this research, players were divided into subgroups based on their chronological age alone. The results in this research differ from the results of the study conducted in 2017 on basketball players aged 12 to 14 (Canli, 2017), since, apart from humerus diameter, no other statistically significant differences in anthropometric characteristics were found. This could be the result of the fact that in our research subjects were highly selected, and our sample was considerably larger (108 compared to 41 in the research from 2017). It can be assumed that the developmental differences that were found could have been influenced by other factors, such as the genotype and phenotype of preadolescent players.

The analysis of the results indicates that practicing basketball has a positive influence on body composition, since a higher percentage of muscle tissue and physiologically optimal quantity of fatty tissue were measured in our subjects in comparison with their peers who do not practice basketball, i.e. it has an overall positive influence on their health status.

CONCLUSION

The findings of this study indicate that all participants predominantly exhibit characteristics consistent with the ectomorphic somatotype. This outcome aligns with existing literature and expectations, given the anthropometric demands of basketball. The results support the notion that anthropometric parameters—particularly stature and longitudinal body dimensions—play a critical role in the talent identification and selection process for preadolescent basketball players. These attributes appear to be key predictors of athletic potential at this developmental stage.

The anthropometric data obtained in this study contribute to the establishment of normative reference values for identifying and monitoring talented youth athletes in basketball. These standards can aid coaches, talent scouts, and sports scientists in both the selection process and in tracking physical development throughout the training continuum.



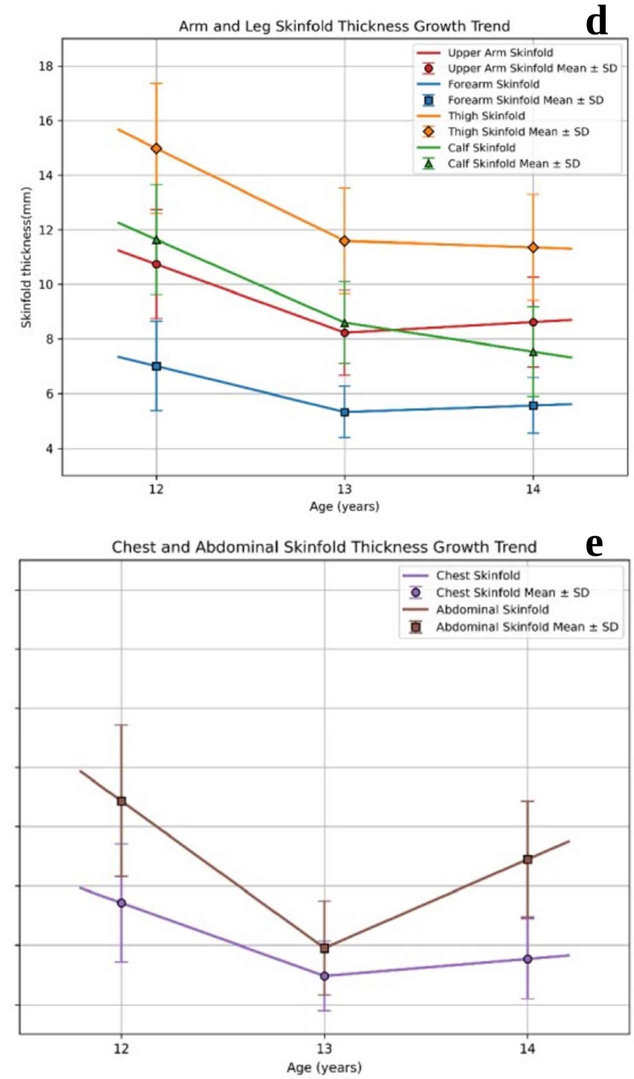


Fig. 2. Trunk (a) arm and forearm (b), thigh and calf(c), circumferences: arm and legg (d) and chest and abdominal skinfold growth trend (e).

Additionally, the results reinforce the notion that participation in basketball training exerts a beneficial influence on the somatic development and overall health status of preadolescents. Compared to reference values established by the World Health Organization (WHO), the Centers for Disease Control and Prevention (CDC), and national standards of the Republic of Serbia, the sampled athletes demonstrated superior anthropometric profiles, suggesting favorable deviations attributed to systematic training.

This study expands the existing database on the anthropometric characteristics of elite youth basketball players, thereby enhancing the precision of somatotype profiling and informing evidence-based selection practices.

Future longitudinal research is recommended to better understand the growth patterns and developmental trajectories characteristic of basketball athletes across different stages of biological maturation and training exposure. Such studies would provide deeper insights into how somatic changes influence athletic performance and may further refine selection criteria for elite youth basketball programs.

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RESUMEN: Las características antropométricas, que abarcan las dimensiones y la composición corporal, son cruciales para evaluar la preparación física y el rendimiento de los atletas, y ciertos rasgos suelen estar vinculados al éxito en deportes específicos. Este estudio tuvo como objetivo describir y comparar los perfiles antropométricos de jugadores de baloncesto de élite de 12, 13 y 14 años. Se evaluó a un total de 108 atletas jóvenes, divididos en tres grupos: G1 (14 años, N=37), G2 (13 años, N=28) y G3 (12 años, N=43). Se midieron veinte parámetros antropométricos, incluyendo seis longitudes, dos anchuras, cinco circunferencias, masa corporal y seis pliegues cutáneos. El análisis de datos empleó estadística descriptiva, ANOVA con pruebas post hoc LSD y comprobaciones de normalidad. Los hallazgos revelaron que las longitudes, anchuras, circunferencias y masa corporal fueron más altas en el grupo de 14 años, mientras que los valores de grosor de los pliegues cutáneos alcanzaron su punto máximo entre los jugadores más jóvenes. El crecimiento en altura fue más pronunciado que los aumentos en la masa corporal en G1 y G2 en comparación con G3. Las anchuras demostraron una tendencia de crecimiento más lenta, mientras que los valores de tejido graso subcutáneo generalmente se mantuvieron dentro de los rangos promedio, mostrando una ligera disminución con la edad. Todas las dimensiones longitudinales fueron más evidentes en los grupos de mayor edad, y el aumento de desarrollo más pronunciado ocurrió entre los 13 y los 14 años. Estos resultados indican diferencias significativas en las características antropométricas entre los grupos de edad estudiados, particularmente con respecto a la estatura y la envergadura. Estos rasgos, estrechamente asociados con el rendimiento en baloncesto, resaltan la importancia de incorporar la evaluación antropométrica en el proceso de selección temprana de atletas preadolescentes, ya que representan predictores clave del éxito durante esta etapa crítica del desarrollo atlético.

PALABRAS CLAVE: Estatura; Envergadura; Tendencia de crecimiento; Entrenamiento; Selección.

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