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EXPLORING OF CHANGES OF ANTHROPOMETRIC STRUCTURES AND ATHLETIC PERFORMANCES OF 8-13 YEAR-OLD MALE BASKETBALL PLAYERS

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Abstract:
In the study, it was aimed to determine how the anthropometric structure and athletic performance elements of male basketball players changed in terms of age levels. The research group consists of male athletes between the ages of 8-13 who are licensed in the basketball. All athletes completed the anthropometric tests (stature, body weight, arm span, abdominal and triceps skinfold thickness and athletic performance tests (standing long jump, countermovement jump, maximum vertical jump, modified sit and reach, alternate wall toss, 20-m sprint and pro-agility). A significant difference was determined in the comparison of stature, body weight, arm span in terms of age groups in the research group. [respectively = $F_{(3-72)}$ = 71.954; 23.505; 63.109 $p<0.05$]. A significant difference was found between the vertical jump, hand-eye coordination, speed, anaerobic power performances of the participants in terms of age levels. [respectively= $F_{(3-72)}$ = 19.871; 22.939; 16.253; 37.579, $p<0.05$]. There was no significant difference between the groups in the flexibility variable in terms of age level ($p>0.05$). The significant difference between the age groups in terms of broad jump ($x^2_{(2)} = 13.340$), maximum vertical jump ($x^2_{(2)} = 24.087$) $p<0.017$) and agility $x^2_{(2)} = 7.022$, $p<0.017$) are due to the 8-9 age groups and the 12-13 age groups. In conclusion, the change in the anthropometric structures of basketball players such as stature, body weight, and arm span increases in proportion to the increase in age levels. In addition, it is seen that all athletic performance parameters, except flexibility, increase with the increase in age level. From this point of view, especially the trainers working in the infrastructure should design their training programs by taking into account the developmental characteristics of the athletes.

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Keywords: anthropometric structure, athletic performance, basketball player

1. Introduction

Basketball is characterized by a pattern of intermittent, dynamic, and skilful movement activities, as well as complicated demands that necessitate a combination of individual talents, team plays, strategies, and motivating elements (Trninic and Dizdar, 2000). During a basketball game, players perform a range of multi-directional, intensive, and brief motions such as sprinting, dribbling, shuffling, and leaping (Crisafulli et al., 2002). Many young players participate in structured basketball activities; during childhood, children acquire a range of essential motor abilities. The development rates of a variety of physiological and physical performance indicators evaluated in young team and sports athletes have been found to peak around the same time as they achieve peak height velocity (Philippaerts et al., 2006). At this point, coaches need to know the characteristics of the players well and design training plans suitable for their development so that they can get a high level of efficiency from their work and create a well-trained team technically and motorically. The trainings that are not designed in accordance with the age, gender and developmental characteristics of the players may cause the athletes to overtrain. Improper training applied to younger age groups may cause children to experience a sense of failure and to distance themselves from sports (Kilinc et al., 2011). Especially in recent years, it is seen that unsuccessful results have been obtained in the youth basketball national teams. It is thought that this situation may be caused by the trainings made without considering the age-specific developmental characteristics of young basketball players.

There are very few studies in the literature that compare the physical and athletic performance components of male basketball players by age level. There have also been studies on male basketball players that are quite close in age. For example, Canlı (2017), in its study on male basketball players aged 12-14, revealed that there was no difference between the groups in terms of stature, body weight, diameter, circumference and skinfold thickness. It was determined that the bicondular diameter variable was statistically different only between 12-year-old basketball players and 14-year-old basketball players. In the comparison of biomotoric performance elements, it was determined that the vertical jump and anaerobic power variables were statistically different in favor of 14-year-old basketball players. There are studies showing that the anthropometric structures of athletes in similar age groups are similar in a different sports branch such as soccer (Polat, Cinar and Sahin 2009). At the same time, it is known that there are studies that have determined that athletic performance elements increase with the increase in age (Matavulj et al., 2001; Mero et al., 1990).

The assessment of anthropometric and physiological profiles can help in the identification of success criteria for young basketball players (Hoare, 2000). While following the developing profiles of young basketball players, general and particular modifications should be observed in terms of the athlete's body structure, athletic fitness level, and physical development alterations produced by rapid frequent sportive training (Cimen, Cicioglu and Gunay, 1997). At this point, it is thought that the trainings planned according to the developmental characteristics of basketball players will positively improve their physical, athletic and skill characteristics. In the research, determining the anthropometric characteristics and athletic skill elements related to the basketball and keeping the age range quite wide are the factors that increase the importance of the research. At the same time, determining how the male basketball players in the youth sport organization differ in terms of anthropometric structure and athletic performance elements in terms of age levels may contribute to the design or update of the training programs of the coaches. From this point of view, it is aimed to determine how the anthropometric structure and athletic performance elements differ in terms of age ranges in male basketball players.

2. Materials and methods

2.1 Subjects

The research group consists of male athletes between the ages of 8-13 who are licensed in the basketball. In order for the athletes to be included in the research, they must meet conditions. They must not have an orthopaedic, cardio logical or neurological disease that will prevent the movements to be made during the measurements and tests, they must not engage in strenuous physical activity before the measurements, and they must not to use painkillers or sleep-inducing drugs the day before the measurements. In addition, not participating in training for various reasons (injury, illness, etc.) for more than three (3) months caused the athletes to be excluded from the study. Prior to participating in the study, players and their parents signed an informed consent form. The frequency and percentage distributions of the subjects according to their age levels are detailed in Table 1.

Table 1: Distribution of subjects by age groups

Independent variable		**f**	**%**
Age groups	8 – 9 age	25	34.7
	10 – 11 age	30	41.7
	12 – 13 age	17	23.6

2.2 Study design

All athletes completed the anthropometric and athletic assessments at the same time. Tests were performed on consecutive days, between 17:00 and 19:00 on both days, and in the following order: day 1) anthropometric measurements; standing long jump test; countermovement jump test; maximum vertical jump test; day 2) modified sit and reach test; alternate wall toss test; 20-m linear sprint and pro-agility test. Prior to the tests, on both days, athletes performed a standardized warm-up protocol including general (i.e., running at a moderate pace for 10-min followed by active lower and upper limb stretching for 3-min).

2.3 Procedures

2.3.1 The anthropometric measurements

Anthropometric measurements were taken in accordance with techniques accredited by the International Biological Program (Lohman, Roche & Martorel, 1988). and the International Association for the Development of Kinanthropometry (Ross & Marfell-Jones, 1991). Stature, body weight, arm span, skinfold thickness (triceps, abdominal) of basketball players were measured. Body height and sitting height were measured using a calibrated stadiometer (0.1 cm, Mesilife 13539 brand portable stadiometer). In addition, body weight was assessed using a digital balance scale (0.1 kg, Tanita, BC 545N). Body height and body weight values were used to calculate Body Mass Index (BMI in kg/m^2). Arm span was evaluated using a fiberglass measuring tape. Holtain brand skinfold caliper (Holtain Ltd, Crosswell, Crymych, UK) was used for skinfold thickness measurements.

2.3.2 Athletic performance measurements

a. Modified sit and reach

The athlete sits on the floor with their back and head against a wall, legs fully extended with the bottom of their feet against the box. The athlete places one hand on top of the other, reaches forward to the ruler while keeping their back and head against the wall. The assistant adjusts the ruler so that the tip of the athlete's fingers touches the edge of the ruler and secures the ruler with tape. The athlete slowly bends forward and reaches along the top of the ruler as far as possible. The assistant records the distance reached (cm) (Mackenzie, 2003).

b. Counter movement jump

The counter movement jump (CMJ) was performed to estimate explosive leg power. The athletes performed three single jumps with arm swing recorded with an myotest device accelerometer (Myotest S.A., İsviçre) and the highest of three jumps was used for further analysis (0.1 cm) (Nygaard Falch et al., 2020). Anaerobic power values were determined automatically by the myotest device as a result of entering the necessary information into it.

c. Alternate wall toss

Alternate wall toss test is used for measuring coordination, in which a ball is thrown from one hand in an underarm action against the wall at a certain distance from the wall and is attempted to be caught with the opposite hand. The total number of repetitive actions for 30 s is recorded. In this study, distances were set to 2.0 and 1.2 m and which was the basis for division into two groups. First, the ball was thrown with the right hand and caught with the left hand, and then thrown with the left hand and caught with the right hand; this was recorded as a single action (Cho, Yun and So, 2021)

d. 20-meter sprint

The subjects performed a 20-m sprint and the time was recorded using a photocell gate (Newtest Powertimer 300-series, Oy, Finland). The test started with the subject in a standing position and with the front foot placed 0.2 m from the first photocell gate (Hernández-Davó et al., 2021).

e. Broad jump

The athlete stands behind a line marked on the ground with feet slightly apart. A two-foot take-off and landing is used, with swinging of the arms and bending of the knees to provide forward drive. The subject attempts to jump as far as possible, landing on both feet without falling backwards. Three attempts are allowed. The measurement is taken from take-off line to the nearest point of contact on the landing (back of the heels). Record the longest distance jumped, the best of three attempts (Wood, 2008).

f. Max Touch

The athlete stands 15 feet away from a Vertec. The athlete is given a significant amount of freedom in choosing how to jump: with one or two feet and any number of steps before the jump. As the athlete approaches the Vertec, they jump and touch the Vertec fingers that record the height of the jump. Record the 'touch' height above the court floor. The max jump height is recorded as a distance from the ground, to the nearest 1 cm or 1/2 inch (Wood, 2008).

g. Agility

The test started with the subject in a neutral stance. Thereafter, the subject was instructed to sprint to either the dominant or non-dominant side first and touch a cone that was placed 4.57 m away from the starting point. Subsequently, they were asked to run to the opposite side, touch the farthest cone at 9.14 m, and perform a 4.57-m sprint towards the finish line (Hernández-Davó et al., 2021). Time was recorded using photocell gates (Newtest Powertimer 300-series, Oy, Finland).

2.4 Statistical analysis

In order to determine whether the data of the study were normally distributed, kurtosis, skewness measures and Shapiro-Wilk values were examined. The values obtained according to the Kurtosis and skewness results have been found to be between -1.5 and +1.5, and studies have shown that the data show normal distribution, and the values outside these measurements do not show normal distribution (Tabachnick and Fidell, 2013). When the normality distributions of the research data are controlled; It was determined that there was a normal distribution in the variables of stature, weight, BMI, arm span and abdominal skinfold thickness, flexibility, vertical jump, hand-eye coordination, speed, anaerobic power, horizontal jump, max.; there was a non-normal distribution in triceps skinfold thickness, broad jump, max. vertical jump and agility variables. For the age group, which is the independent variable of the research, one-way variance (Anova) analysis test was used to compare the variables with normal distribution, and the Kruskal Wallis analysis test was used to compare the variables that did not have normal distribution. In order to determine the source of differentiation in the tests with statistically significant differences as a result of the analyzes, Tukey and LSD from post hoc tests were used in the Anova test, and Mann Whitney-U test was performed separately for each subvariable in the Kruskal Wallis test. Finally, eta-square (effect size) (η^2) and r coefficients were used to calculate the strength of the relationship between the variables in the designs of the tests with significant differences (Buyukozturk et al., 2008).

3. Results

A significant difference was determined in the comparison of stature in terms of age groups in the research group. [$F_{(3-72)} = 71.954$, $p<0.05$]. It was determined that there was a significant difference between the 8-9 age group and both the 10-11 age group and the 12-13 age group. In addition, a significant difference was found between the 10-11 age group and the 12-13 age group. It was determined that the age of the participants had a low effect on their stature (eta-square (η^2) = 0.210). A significant difference was determined in the comparison of body weights in terms of age groups. [$F_{(3-72)} = 23.505$, $p<0.05$]. It was determined that the differentiation was caused by the 8-9 age group and the 12-13 age group. It was determined that the age variable had a large effect on the body weight ($\eta^2 = 0.605$). A significant difference was determined in the comparison of arm span in terms of age groups [$F_{(3-72)} = 63.109$, $p<0.05$]. It was determined that the differentiation was caused by the 8-9 age group and the 12-13 age group. It was determined that the age variable had a large effect on the arm span variable ($\eta^2 = 0.631$). There was no significant difference between BMI and abdominal skinfold thickness variables in terms of age range in the study group (p>0.05). (Table 2). It was determined that the age variable did not have a statistically significant effect on the triceps skinfold thickness (p>0.05) (Table 3).

Table 2: Comparison results of anthropometric structure and parametric variables in terms of age groups of the subjects

Variables		N	Mean	Sd.	Sum of Squares	df	Mean square	F	p	Source of Difference	Impact value
Stature	8 – 9 age	25	138.92	5.88	156.543	2	4526.238	71.954	0.00*	8 – 9 age / 10 – 11 age (-10.58) 12 – 13 age (-29.84)	0.210
	10 – 11 age	30	149.50	8.14	3367.901	69					
	12 – 13 age	17	168.76	9.95	3524.444	71	62.904				
Body weight	8 – 9 age	25	39.64	6.90	1685.688	2	3007.826	23.505	0.00*	8 – 9 age / 12 – 13 age (-24.30)	0.605
	10 – 11 age	30	47.96	12.11	2926.756	69					
	12 – 13 age	17	63.94	14.63	4612.444	71	127.966				
BMI	8 – 9 age	25	20.45	2.75	36.959	2	17.685	1.447	0.242	-	-
	10 – 11 age	30	21.51	3.91	279.005	69					
	12 – 13 age	17	22.27	3.67	315.964	71	12.218				
Arm span	8 – 9 age	25	140.24	7.38	972.790	2	5297.178	63.109	0.00*	8 – 9 age / 12 – 13 age (-32.17)	0.631
	10 – 11 age	30	150.63	9.14	1463.085	69	83.937				

	12 – 13 age	17	172.41	11.34	2435.875	71					
Abdominal ST	8 – 9 age	25	18.61	11.86	3.817	2	41.680	0.311	0.734	-	-
	10 – 11 age	30	20.99	11.64	8.103	69					
	12 – 13 age	17	19.22	11.01	11.921	71	134.108				

p<0.05*

Table 3: Comparison results of anthropometric structure and nonparametric variables by age groups of the subjects

Variables		**N**	**Mean Rank**	**X²**	**df**	**p**	**Source of Difference**	**Impact value**
Triceps ST	8 – 9 age	25	33.64	0.885	2	0.64	-	-
	10 – 11 age	30	38.97					
	12 – 13 age	17	36.35					

Table 4: Comparison results of parametric variables of athletic performance by age groups of subjects

Variables		**N**	**Mean**	**Sd.**	**Sum of Squares**	**df**	**Mean square**	**F**	**p**	**Source of Difference**	**Impact value**
Flexibility	8 – 9 age	25	15.96	6.34	156.543	2	78.272	1.604	0.209	-	-
	10 – 11 age	30	14.00	5.87	3367.901	69					
	12 – 13 age	17	14.22	9.35	3524.444	71	48.810				
Vertical jump	8 – 9 age	25	27.84	4.85	1685.688	2	842.844	19.871	0.00*	8 – 9 age / 10 – 11 age (-4.42) 12 – 13 age (-12.86)	0.604
	10 – 11 age	30	32.26	6.67	2926.756	69					
	12 – 13 age	17	40.70	8.17	4612.444	71	42.417				
Hand-eye coor	8 – 9 age	25	5.44	3.29	972.790	2	486.395	22.939	0.00*	8 – 9 age / 10 – 11 age (-4.29) 12 – 13 age (-9.79)	0.631
	10 – 11 age	30	9.73	5.07	1463.085	69					
	12 – 13 age	17	15.23	5.33	2435.875	71	21.204				
Speed	8 – 9 age	25	4.50	0.37	3.817	2	1.909	16.253	0.00*	8 – 9 age / 10 – 11 age (0.35) 12 – 13 age (0.59)	0.565
	10 – 11 age	30	4.15	0.31	8.103	69					
	12 – 13 age	17	3.91	0.33	11.921	71	0.117				
Anaerobic power	8 – 9 age	25	46.11	8.65	19107.493	2	9553.747	37.579	0.00*	8 – 9 age / 10 – 11 age (-14.18) 12 – 13 age (-43.23)	0.722
	10 – 11 age	30	60.29	18.00	17541.732	69					
	12 – 13 age	17	89.34	19.91	36649.226	71	254.228				

*p<0.05

A significant difference was found between the vertical jump performances of the participants in terms of age levels. [$F_{(3-72)} = 19.871$, $p<0.05$]. According to the results of the post hoc test; It was determined that all age groups had significant differences with each other. The effect size was calculated as eta-square (η^2) = 0.604. This result shows that the age levels of the participants have a high level effect on vertical jump. A significant difference was determined between the hand-eye coordination variable in terms of age level [$F_{(3-72)}$ = 22.939, p<0.05]. According to the results of the post hoc test; It was determined that all age groups had significant differences with each other. It was determined that the effect size of this differentiation (η^2 = 0.631) was high. It has been determined that speed, which is one of the other athletic performance characteristics, differs significantly in terms of age groups. [$F_{(3-72)}$ = 16.253, p<0.05]. This distinction results from the separation of the 8-9 age group from both the 10-11 age group and the 12-13 age group. This difference has a high impact value (η^2 = 0.565). In the anaerobic power variable, it was determined that all age groups had significant differences with each other. [$F_{(3-72)}$ = 37.579, p<0.05]. The effect size was also determined at a high level (η^2 = 0.722). There was no significant difference between the groups in the flexibility variable in terms of age level (p>0.05). (Table 4).

Table 5: Comparison results of athletic performance nonparametric variables by age groups of subjects

Variables		N	Mean Rank	X^2	df	p	Source of Difference	Impact value
Broad jump	8 – 9 age	25	27.02	13.340	2	0.01*	8 – 9 age / 12 – 13 age	0.520
	10 – 11 age	30	36.17					
	12 – 13 age	17	51.03					
Mak. ver. jump	8 – 9 age	25	22.94	24.087	2	0.00*	8 – 9 age / 12 – 13 age	0.672
	10 – 11 age	30	37.23					
	12 – 13 age	17	55.15					
Agility	8 – 9 age	25	06.92	7.022	2	0.03*	8 – 9 age / 12 – 13 age	0.395
	10 – 11 age	30	05.67					
	12 – 13 age	17	04.69					

*p<0.05

The Mann-Whitney-U test was used to determine from which groups the differences between age groups originated. Because conducting three Mann Whitney-U tests for each variable's sub-variables would increase the amount of type 1 error, the Bonferroni adjustment [α= (0.05/3)=0.017] was used. The significant difference between the age groups in terms of broad jump ($x^2_{(2)}$=13.340, p<0.017) is due to the 8-9 age groups and the 12-13 age groups. The effect size of the difference was determined as r = 0.520. It was determined that the significant difference between the ages of the participants and the maximum vertical jump test values ($x^2_{(2)}$=24.087, p<0.017) was caused by the 8-9 age group and the 12-13 age group. This difference (r = 0.672) has a high effect value. The difference between agility, the last variable of athletic performance, and age groups is due to the difference between the 8-9 age group and the 12-13 age group ($x^2_{(2)}$=7.022, p<0.017). The effect size was determined as r = 0.395 (Table 5).

4. Discussion

In the study, it was aimed to determine how the anthropometric structure and athletic performance elements of male basketball players changed in terms of age levels. In the study, it was determined that there were significant differences between all age groups in terms of stature variable. It has been determined that the height of the basketball players changes positively with the increase in age. Body weight and arm span also increase with increasing age. However, there is a statistically significant difference between aged 8-9 and aged 12-13. It was determined that BMI, abdominal and triceps skinfold thickness values did not show a significant difference between age groups. Mengütay (1999) stated that the development of physical capacity will continue in parallel with the increase in age or category in children and young athletes. In the comparison of stature and body weight among male basketball players aged 14-17, it was determined that these values increased with increasing age. In this study, it was also interpreted that the increase in stature and weight in parallel with the increase in age is an expected result, since the research group, which is at the advanced adolescent level, continues the physical development (Savucu et. al, 2004). In the study conducted by Canlı (2017) on male basketball players aged 12-14, no significant difference was found in terms of age levels in triceps skinfold thickness values. This result is in parallel with our research finding. Again, in a study on 12-14 year-old basketball players, the 14-year-old group had high scores in all other anthropometric parameters except BMI. Only the total skinfold thickness measurements of the 14-year-old group were lower than the 12-year-old group (Karalejic, Jakovljevic and Macura, 2011). Research on the anthropometric or physical characteristics of male basketball players is very limited in the literature. Generally, researches focused on the effects of different training methods applied on sports performance on basketball players (Kilinc, Erol and Kumartaşli, 2011; Kilinç et al., 2011; Pamuk and Ozkaya, 2017) or their comparison with athletes in different branches (Peña et al., 2018; Toselli et al., 2021). Therefore, it is thought that this research will contribute to the literature on the topic.

In the comparison of the research athletic performance parameters in terms of age groups; It was determined that all age groups differed from each other in vertical jump, hand-eye coordination and anaerobic power parameters, while the 8-9 age group differed with both the 10-11 age group and the 12-13 age group in the speed variable. In broad jump, maximal vertical jump and agility parameters, it was determined that the scores increased as the age groups increased, but the statistically significant difference was between the 8-9 age group and the 12-13 age group. In the flexibility parameter, there was no significant difference between age groups. As a result of the findings obtained in terms of athletic performance parameters in the research, it is seen that the athletic performance scores of the male basketball players increase with the increase in their age levels. When the literature is examined, it is seen that there are studies with similar results with our research findings. Applied to basketball players in the junior boys and mid boy categories; according to the results of 20 meters speed, shuttle run, vertical jump and sit and reach test, it was seen that the athletes in the mid age group reached higher average values, while when the push-up and balance test averages were examined, it was found that the athletes in the younger age group achieved high results. It has been stated that strength, speed and endurance skills are expected to increase with age. It is thought that there may be a decrease in flexibility as age increases. The fact that mid boys were found to be higher in the sit-and-reach test and junior boys in the push-up test was evaluated as an unexpected result. (Cetinkaya, 2019).

In the flexibility comparison between junior-mid and young boy categories; No significant difference was found between the junior boys and the young boys. Significant differences were determined between mid boys and young boys in favor of mid boys, and between junior boys and mid boys in favor of mid boys. (Savucu et al., 2004). According to Taser et al. (2002) found a significant difference in the flexibility values of elite basketball players aged 15–16. The findings obtained from these studies do not show similar with the findings of our study. The flexibility values of the groups in our study were found to be quite close to each other. In the 20-m sprint parameter, there are studies that found increases in sprint performance as age or category increases (Savucu et al., 2004). Kukolj et al. (1999) found significant age-related differences in 15–30 m sprint values. Loko et al. (2000) examined the sprint values for the 14-16 age groups and found significant decreases in sprint scores in parallel with the increase in age. A study comparing the 20-m, 30-m, and 50-m running performances of 12-14-year-old basketball players by Jakovljevic et al. (2012); stated that the 14-year-old group had better scores in all running distances and that this difference between the two groups was significant. There are studies indicating that vertical jump and anaerobic power performances of basketball players and early adolescent and advanced adolescent level athletes in different sports branches increase with the increase in age group or age level (Matavulj et al., 2001; Savucu et al., 2004; Mero et al., 1990; Polat and Saygın, 2003). It was determined that the scores in favor of the 14-year-old basketball player group were better in the zig zag agility and t agility test measurements of the 12-14 year old basketball players. It is thought that this may be due to the fact that the 14-year-old players increased their motor potential and improved their speed and agility performance during their additional 2 years of training (compared to 12-year-old players). (Jakovljevic et al., 2012). Similar results regarding the agility parameter were also presented by Gamble (2008). No research has been found in the literature comparing the hand-eye coordination, horizontal jump and maximal vertical jump parameters related to the age levels of basketball players. Therefore, the fact that the findings obtained at this research point will bring new information to the literature increases the importance of the study even more.

5. Conclusion

The change in anthropometric structures such as stature, body weight, and arm span of basketball players, who constitute our sample group, increases in proportion to the increase in age levels. In addition, it is seen that all athletic performance parameters, except flexibility, increase with the increase in age level. In this regard, trainers working in youth sport organization, in particular, should construct their training programs with the athletes' developmental qualities in mind.

Conflict of Interest Statement

The authors declare no conflicts of interests.

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References

Buyukozturk, Ş., Cakmak, E.K., Akgun, Ö.E., Karadeniz, S., & Demirel, F. 2016. Scientific Research Methods. 21st Edition. Ankara: Pegem Academy

Canli, U. 2017. Comparison of anthropometric characteristics, biomotorical performance and skill levels of 12-14 years old basketball players. European Journal of Physical Education and Sport Science

Cetinkaya, C. 2019. Comparison of some engine specifications of the basketballs in different infrastructure categories with the age and gender. Master Thesis. Institute of Health Sciences, Istanbul Gelisim University, Istanbul.

Cho, E.H., Yun, H.J., & So, W.Y. 2020. The validity of alternative hand wall toss tests in Korean children. J Mens Health, 16 (1), e10-e18. https://doi.org/10.15586/jomh.v16i1.166

Çimen, O., Cicioğlu, İ., & Günay, M. 1997. Physical and physiological profiles of male and female Turkish young national table tennis players. Journal of Physical Education and Sports Sciences, 2(4): 7-12

Crisafulli, A., Melis., F, Tocco., F, Laconi., P, Lai., C, & Concu., A. 2002. External mechanical work versus oxidative energy consumption ratio during a basketball field test. J Sports Med Phys Fitness 42: 409–417

Gamble, P. 2008. Approaching physical preparation for youth team-sports players. Strength Cond J 30: 29–42

Hernández-Davó, J. L., Loturco, I., Pereira, L. A., Cesari, R., Pratdesaba, J., Madruga-Parera, M., ... & Fernández-Fernández, J. 2021. Relationship between Sprint, change of direction, jump, and hexagon test performance in young tennis players. J Sports Sci Med, 20(2), 197. https://doi.org/10.52082/jssm.2021.197

Hoare D.G. 2000. Predicting success in junior elite basketball players-the contribution of anthropometric and physiological attributes. Journal of Science and Medicine in Sport, Sports Medicine Australia, 3 (4): 391-405.

Jakovljevic, S.T., Karalejic, M.S., Pajic, Z.B., Macura, M.M., & Erculj, F.F. 2012. Speed and agility of 12-and 14-year-old elite male basketball players. The Journal of Strength & Conditioning Research, 26(9), 2453-2459

Karalejic, M., Jakovljevic, S., Macura, M. 2011. Anthropometric characteristics and technical skills of 12 and 14 year old basketball players. The Journal of Sports Medicine and Physical Fitness, 51(1):103-110. PMID: 21297570

Kilinc, F., Erol, A.E., & Kumartasli, M. 2011. The effects of combined technics training on some physical strength and technical features that is applied to basketball players. International Journal of Human Sciences, 8(1), 213-229

Kilinc, F., Koc, H., Erol, A.E., Pulur, A., & Gelen, E. (2011). Male stars camp period biomotoric of basketball and the intense training applied technical effects on performance. International Journal of Human Sciences, 8(1), 1071-1081

Kukolj, M., Ropret, R., Ugarkovic, D., & Jaric, S. 1999. Anthropometric, strength, and power predictors of sprinting performance. Journal of Sports Medicine and Physical Fitness, 39(2), 120

Lohman, T.G., Roche, A.F. & Martorel, R. 1988. Anthropometric standardization reference manual. Illinois: Human Kinetics Books Champaign

Loko, J., Aule, R., Sikkut, T., Ereline, J., & Viru, A. 2000. Motor performance status in 10 to 17-year-old Estonian girls. Scand J med Sci Sports, 10(2):109-13

Mackenzie, B. 2003 Modified Sit and Reach Test [WWW] Available from: https://www.brianmac.co.uk/sitreachmod.htm [Accessed 7/10/2021]

Matavulj, D., Kukolj, M., Ugarkovic, D., Tihanyi, J., & Jaric, S. 2001. Effects of plyometric training on jumping performance in junior basketball players. J Sports Med Phys Fitness, 41(2): 159-64

Mengutay, S. 1999. Movement development and sports in preschool and primary schools. 2nd edition, Tutibay Publications

Mero, A., Kauhanen, H., Peltola, E., Vuorimaa, T., & Komi, P.V. 1990. Physical performance capacity in different prepubescent athletic groups. J Sports med Phys Fitness, 30(1): 57–66

Nygaard Falch, H., Guldteig Rædergård, H., & Van den Tillaar, R. 2020. Relationship of performance measures and muscle activity between a 180 change of direction task and different countermovement jumps. Sports, 8(4), 47. https://doi.org/10.3390/sports8040047

Pamuk, Ö., & Ozkaya, Y.G. 2017. The impact of resistant plyometric training on sprint and agility performance of 15-17 years old male basketball players. Journal of Sportive Performance Researches, 1(1), 1-13.

Peña, J., Moreno-Doutres, D., Coma, J., Cook, M., & Buscà, B. 2018. Anthropometric and fitness profile of high-level basketball, handball and volleyball players. Revista Andaluza de Medicina del Deporte, 11(1), 30-35

Philippaerts, R.M., Vaeyans, R., Janssens, M., Van Renterghem, B., Matthys, D., Craen, R., Bourgois, J., Vrijens, J., Beunen, G., & Malina, R.M. 2006. The relationship between peak height velocity and physical performance in youth soccer players. J Sports Sci 24: 221–230

Polat, Y., Cinar, V., Sahin M. 2009. Determining the anthropometric properties and somatotypes of football player children. e-Journal of New World Sciences Academy, 4(4): 256-265

Polat, Y., & Saygin, O. 2003. Investigation of age-related development of some health-related physical fitness parameters of football players aged 12-14. IX. National Sports Medicine Congress

Ross, W.D., & Marfell-Jones, M.J. 1991. Physiological testing of the high performance athlete. In J. D. MacDougall, H. A. Wenger, H. J. Green (Eds.), Kinanthropometry (pp. 230- 264). Illinois: Human Kinetics Books

Savucu, Y., Polat, Y., Ramazanoğlu, F., Karahüseyinoğlu, M.F., & Biçer Y.S. 2004. The investigation of some physical fitness parameters of basketball players in the substructure, F.U. Journal of Health Sciences, 18(4), 205-209

Tabachnick, B.G., & Fidell, L.S. 2013. Using Multivariate Statistics. 6. Baskı. Boston: Allyn and Bacon.

Taser, H., Güvenc, A., Aslan, A., & Karli, Ü. 2002. Examination of the physical profile and some motoric features of 15-16 years old elite basketball players by comparing them according to the positions they play. III. International Mediterranean Sports Sciences Congress

Toselli, S., Campa, F., Maietta Latessa, P., Greco, G., Loi, A., Grigoletto, A., & Zaccagni, L. 2021. Differences in maturity and anthropometric and morphological characteristics among young male basketball and soccer players and non-players. International Journal of Environmental Research and Public Health, 18(8), 3902

Trninic, S., & Dizdar, D. 2000. System of the performance evaluation criteria weighted per positions in the basketball game. Colleg Antropol 24: 217–234

Wood, R. "Max Touch Test." Topend Sports Website, 2008, https://www.topendsports.com/testing/tests/jump-max-touch.htm, Accessed 07.10.2021

Wood, R. "Standing Long Jump Test." Topend Sports Website, 2008, https://www.topendsports.com/testing/tests/longjump.htm, Accessed 07.10.2021