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COMPARISON OF ANTHROPOMETRIC CHARACTERISTICS, BIOMOTORICAL PERFORMANCE AND SKILL LEVELS OF 12-14 YEARS OLD BASKETBALL PLAYERS

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Abstract:
In this study, it was aimed to compare the anthropometric characteristics, somatotype profiles, some biomotorical performances and basketball-specific skill levels of basketball players who were at different age levels, in adolescence period and were training with the same training methodology. The participants were 41 basketball players who were in the age range of 12-14 years, regularly trained and played basketball in the local youth setup leagues. The participants' body height, body weight, vertical jump, 1-mile run, aerobic power, anaerobic power, skinfold thickness (triceps, subscapula, suprailiac, calf), circumference (biceps flexion, calf), diameter measurements (humerus bicondylar, femur bicondylar) were made. Basketball-specific skills were determined using the Harrison Basketball Skill Test while the somatotype characteristics were determined according to the Heath-Carter method. Kolmogorov-Smirnov and Shapiro-Wilk tests were used to determine whether the data were suitable for normal distribution. One-Way ANOVA test was used to examine the differences between the variables and Tukey test was used to investigate the cause of differences. Normality tests and other statistical analyses were performed at the significance level of 0.05. A significant difference was noted in humerus bicondylar diameters according to the age levels of basketball players and a statistical difference was detected in the data of vertical jump and anaerobic power in terms of biomotorical performance ($p < 0,05$). The cause of this difference was found to be due to the fact that the humerus diameter, vertical jump and anaerobic power values in the age group of 14 age years were higher than the values of the other two age groups. No difference was found when the

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somatotype profiles and basketball-specific skill levels were compared according to age levels (p> 0,05). In conclusion, in our study group, we did not find any difference among other anthropometric characteristics, somatotype profiles, and basketball specific skills except humerus diameter. We suggest that the difference in the vertical jump and anaerobic power values of biomotorical performance is due to the increase in the strength ratio along with the increase in age level.

Keywords: anthropometric, basketball, biomotorical, skill

1. Introduction

Basketball started with the success of our national team in our country and achieved to create fanbases by increasing its popularity when the club teams joined the European leagues, provided the necessary investments and organizations and became successful. With increasing popularity and interest, parents canalized their children to this sport while the desire to play basketball among young students also gradually increased. As basketball sport contains all the basic biomotorical skills in itself, it is observed that the physical characteristics specific to the basketball player also make a difference of this sports branch.

It is not possible to attain the desired performance level unless the possessed physical structure is suitable for the performed sports branch. The physical structure is only one of the indicators that an athlete can perform at a high level and affects the performance of athlete positively by combining with the motorical characteristics (Ozkan et al., 2005; Senel et al., 2009). Motor development is a process that continues during all stages of human life, even if at different speeds or in different forms. (Megep, 2007).

Nowadays, orientation to sports at early ages and achieving success in elite sports increasingly at younger ages entailed training for long years and getting elite in children sports. However, it was seen that the reactions of children to their training load differed from those of adults, the reasons of this situation was directly related to growth and development. Under the influence of growth and development, training that were determined in parallel with different growth periods are divided into the stages of starting, general preparation, special preparation, and yield. Responses to training vary depending on the functional and biological characteristics of each stage (Acıkada, 2004). It is known that there is a unique character of the child and youth training since the content of child and youth training does not have the characteristics of a limited adult training. It is performed in accordance with its own conditions and rules The training process of children and young people should be supportive while taking the conditions of development process into account (structural and functional development of child), also, they have systematically and incrementally developed goals in terms of educational knowledge and these goals are aimed at training good people and good athletes in the long term. It should be able to respond to the systematically evolving expectations of the sports branch in question (Hahn, 1982).

The aim of this study is to observe the changes in growth and development characteristics and to emphasize their contribution to the development process of training by determining the differences among the basketball players between the ages of 12-14 years in terms of physical, biomotorical and skill levels. Its aim is also to create a database for comparison of basketball players that are of both our country and other countries.

2. Materials and Methods

2.1 Participants

The sample of the study included 41 volunteer male basketball players who was in the varying age range of 12-14 years, who had a sport history of three years, who had a mean trainees of 2.8 per week and who participated in the competitions in local youth setup leagues.

2.2 Procedures

2.2.1 Anthropometric and Somatotype Measurements

The body height measurements were taken when the participants were barefeet, their body weights were evenly distributed to both feet, the heels were joined together and were in contact with the stadiometer, the head was positioned in the Frankfort plane, the shoulders were relaxed with the arms by sides. Participants' body weights were measured using electronic platform scales, as barefeet and with only shorts, t-shirts on. (Ozer, 2009). Circumference measurements were taken at right angles to the long axis of the body or its parts. (Tamer, 2000). Two measurements were carried out in each participant and the mean was calculated. If the difference between these two measurements was more than 7 mm, then the test was repeated (Koz, no date is available). Of the participants, the circumferences of calf and biceps during flexion were measured. During diameter measurements, the result of measurement was ensured to be more reliable by using the sliding caliper so as to apply as much pressure as possible to the soft tissue. (Tamer, 2000). Each measurement was performed twice. Humerus and femur epicondylar diameters of the participants were measured. Skinfold measurements were made on the right side of the body. Folding procedure was carried out with the thumb and index finger so that no muscle tissue would be left behind the folded skin. Each measurement was performed twice. The measurement of triceps, subscapula, suprailiac, and medial calf skinfold thickness of the participants were carried out. The somatotype values of the participants were determined by the Heath-Carter somatotype method.

2.2.2 Biomotorical Measurements and Basketball Specific Skill Measurement

In the vertical jump test, the distance between the body height where the participant can reach while standing and the point where he touches by jumping was measured in cm. This test was repeated three times with rest intervals and the best score was recorded. Before the start of test, the subjects were made to perform warm up and stretch training (Kamar, 2008). For the 1-mile run-walk test, the starting and finish points of 1609 meters in the stadium were remarked by cones. The participants were asked to run the entire distance but were allowed to walk if they could not complete one mile by running. The test result was recorded in the measurement form in terms of minutes and seconds (Ozer, 2015). Maximal oxygen consumption (MaxVO_2) was calculated using the following formula according to the result of 1 mile run-walk test.

MaxVO_2 (ml/kg/min) = 100.5 + (8.344 * Gender) – (0.1636 * Weight) - (1.438 * Time) - (0.1928 * Heart rate)

The value of '1' is entered in the form for the male participants while the value of '0' is entered for the female participants (George et al., 1993). The anaerobic power was measured using the vertical jump test and entering the values in the form below. (Fox et al., 2012). P (kg-m/sec) = $\sqrt{4.9}$ (Weight) . $\sqrt{\text{Vertical jump distance}}$

Basketball Skill Test: Harrison developed a four-item basketball test for 12-14 years old male students. These four items consist of scoring, passing to each other, dribbling and rebounding. Performance duration of each item is 30 seconds. At the end of two trials given during the test, the highest score was recorded (Kamar, 2008).

2.3 Statistical Analyses

In order to provide information about the participating athletes, the arithmetic mean and standard deviation of the data obtained from the athletes were calculated. Kolmogorov-Smirnov and Shapiro-Wilk tests were used to determine whether the data were suitable for normal distribution. The distribution of all variables showed suitability for normal distribution in both tests. One-Way ANOVA test was used to examine the differences between the variables and Tukey test was used to investigate the cause of differences. Normality tests and other statistical analyses were performed at the significance level of 0.05.

3. Results

Table 1: Descriptive data of anthropometric characteristics, biomotorical performance and skill levels of basketball players according to age level

Variables	12 Ages (n=12)		13 Ages (n=14)		14 Ages (n=15)	
	Mean	Sd.	Mean	Sd.	Mean	Sd.
Body height (cm)	155,50	5,46	155,40	14,05	162,72	12,31
Body weight (kg)	55,78	11,89	53,02	19,85	57,50	10,78
Biceps circumference (cm)	26,48	3,33	25,27	4,75	26,36	2,35
Calf circumference (cm)	34,32	4,03	32,25	5,85	34,10	3,23
Humerus width (mm)	6,09	,28	6,05	,60	6,46	,45
Femur width (mm)	9,67	,67	9,30	,91	9,68	,58
Triceps skinfold (mm)	19,27	8,11	15,60	8,04	13,81	5,39
Subscapula skinfold (mm)	18,72	9,12	12,65	9,75	11,63	6,16
Suprailiac skinfold (mm)	19,38	10,59	14,22	10,13	12,49	5,77
Calf skinfold (mm)	21,80	9,49	16,14	8,74	14,28	6,18
Endomorphy	5,73	2,36	4,32	2,19	3,96	1,68
Mesomorphy	4,95	1,30	4,32	1,57	4,50	1,54
Ectomorphy	1,70	1,50	2,35	1,54	2,54	1,71
Vertical jump (cm)	29,33	8,23	31,85	5,15	40,00	9,38
1 mile run-walk (min)	10,61	,99	9,67	2,13	9,07	1,34
Anaerobic power (kg.m/sec)	65,52	13,55	64,89	20,62	80,19	17,84
Aerobic power (ml/kg/min)	50,57	4,92	51,87	7,00	51,46	4,45
Basketball skill test (score)	118,58	11,62	119,00	9,47	114,86	18,10

The measurement data of body height, body weight, circumference, diameter and skinfold thickness of basketball players are given in Table 1. The somatotype components obtained from anthropometric data, the values of some biomotorical characteristics and the values of Harrison basketball test that determine the basketball-specific skill are also demonstrated in the table.

Table 2: ANOVA results of anthropometric characteristics of basketball players according to age level

Variables	Source	Sum of squares	df	Mean square	F	Sig.
Body height (cm)	**Between groups**	502,803	2	251,401	1,902	,163
	Within groups	5021,593	38	132,147		
	TOTAL	5524,396	40			
Body weight (kg)	**Between groups**	146,846	2	73,423	,336	,717
	Within groups	8309,455	38	218,670		

	TOTAL	8456,300	40			
Biceps circumference (cm)	**Between groups**	12,004	2	6,002	,461	,634
	Within groups	494,356	38	13,009		
	TOTAL	506,360	40			
Calf circumference (cm)	**Between groups**	35,508	2	17,754	,874	,425
	Within groups	771,627	38	20,306		
	TOTAL	807,135	40			
Humerus width (mm)	**Between groups**	1,514	2	,757	3,353	**,046***
	Within groups	8,577	38	,226		
	TOTAL	10,091	40			
Femur width (mm)	**Between groups**	1,267	2	,633	1,152	,327
	Within groups	20,896	38	,550		
	TOTAL	22,162	40			
Triceps skinfold (mm)	**Between groups**	202,566	2	101,283	1,951	,156
	Within groups	1973,129	38	51,924		
	TOTAL	2175,696	40			
Subscapula skinfold (mm)	**Between groups**	377,310	2	188,655	2,671	,082
	Within groups	2684,391	38	70,642		
	TOTAL	3061,701	40			
Suprailiac skinfold (mm)	**Between groups**	332,715	2	166,358	2,083	,139
	Within groups	3035,075	38	79,870		
	TOTAL	3367,790	40			
Calf skinfold (mm)	**Between groups**	398,117	2	199,058	3,000	,062
	Within groups	2521,447	38	66,354		
	TOTAL	2919,564	40			

$p<0,05^*$

Examining Table 2, a significant difference was noted when humerus bicondylar diameters were compared according to the age levels of basketball players who were in the adolescence period. No significant difference was found when other anthropometric data were compared according to age levels.

Table 3: Tukey test results related to humerus diameters of basketball players according to age levels

I (Age)	J (Age)	Mean Difference (I-J)	Std.Error	Sig.
12	13,00	,04167	,18690	,825
	14,00	-,37500*	,18401	,049
13	12,00	-,04167	,18690	,825
	14,00	-,41667*	,17655	,024
14	12,00	,37500*	,18401	,049
	13,00	,41667*	,17655	,024

In Table 3, according to the results of the Tukey test which was performed to determine from which age group the significant difference between the humerus diameters of basketball players was derived, it was determined to be caused by the fact that the humerus diameters of the age group of 14 years were higher than the humerus diameters of basketball players of other age groups.

Table 4: ANOVA results of somatotype characteristics and biomotorical performance of basketball players according to age level

Variables	Source	Sum of squares	df	Mean square	F	Sig.
Endomorphy	**Between groups**	22,588	2	11,294	2,618	,086
	Within groups	163,911	38	4,313		
	TOTAL	186,499	40			
Mesomorphy	**Between groups**	2,658	2	1,329	,599	,555
	Within groups	84,343	38	2,220		
	TOTAL	87,000	40			
Ectomorphy	**Between groups**	5,076	2	2,538	,997	,378
	Within groups	96,732	38	2,546		
	TOTAL	101,809	40			
Vertical jump (cm)	**Between groups**	865,229	2	432,614	7,073	**,002***
	Within groups	2324,381	38	61,168		
	TOTAL	3189,610	40			
1 mile run-walk (min)	**Between groups**	15,794	2	7,897	3,135	,055
	Within groups	95,734	38	2,519		
	TOTAL	111,528	40			
Anaerobic power (kg.m/sec)	**Between groups**	2145,154	2	1072,577	3,394	**,044***
	Within groups	12008,995	38	316,026		
	TOTAL	14154,150	40			
Aerobic power (ml/kg/min)	**Between groups**	29,698	2	14,849	,872	,426
	Within groups	647,316	38	17,035		
	TOTAL	677,014	40			
Basketball skill test (score)	**Between groups**	148,862	2	74,431	,391	,679
	Within groups	7242,650	38	190,596		
	TOTAL	7391,512	40			

p<0,05*

In Table 4, when we examined whether the somatotype components of basketball players and their biomotorical characteristics were significantly different according to the age level, only a significant difference was detected in the comparison of vertical jump and anaerobic data according to age levels.

Table 5: Tukey Test Results of Vertical Jump of Basketball Players According to Age Levels

I (Age)	J (Age)	Mean Difference (I-J)	Std.Error	Sig.
12	13,00	-2,52381	3,07676	,417
	14,00	-10,66667*	3,02906	,001
13	12,00	2,52381	3,07676	,417
	14,00	-8,14286*	2,90637	,008
14	12,00	10,66667*	3,02906	,001
	13,00	8,14286*	2,90637	,008

According to the results of the Tukey test in Table 5, it was determined that the difference in the vertical jump variable was due to the fact that the mean values of the basketball players in the age group of 14 years were higher than the other two age groups.

Table 6: Tukey test results regarding anaerobic powers of basketball players according to age levels

I (Age)	J (Age)	Mean Difference (I-J)	Std.Error	Sig.
12	13,00	,62321	6,99348	,929
	14,00	-14,67283*	6,88505	,040
13	12,00	-,62321	6,99348	,929
	14,00	-15,29605*	6,60619	,026
14	12,00	14,67283*	6,88505	,040
	13,00	15,29605*	6,60619	,026

According to the results of Tukey test in Table 6, the difference in the anaerobic power variable was determined to be due to the fact that the mean values of the basketball players in the age group of 14 years were much higher than those of the other two age groups.

4. Discussion and Conclusion

The determination of anthropometric and physiological profiles can contribute to the selection of necessary criteria for achieving success in young basketball players (Hoare, 2000). While the developmental profiles of young basketball players are being followed, related to the body structure of the athlete, the sportive fitness level, the physical development changes caused by expedient regular sportive training, general and special changes can be observed (Cimen et al.,1997).

In our study, among the anthropometric values of basketball players who were in the age groups of 12-13-14 years, the only difference was detected between the humerus bicondylar diameters ($p<0,05$). It was determined that this difference was caused by high humerus bicondylar diameters of the basketball players in the age group of 14 years. In the study named the anthropometric characteristics and somatotypes of soccer players by Polat et al. (2009), no significant difference was found in the humeral diameter parameters between 9 and 10 years of age, but it was detected 11 years old players and 9 and 10 years old players. There was no difference between groups in terms of somatotype structures according to their age levels in our study ($p>0,05$). Again in the study of Polat et al. (2009), no significant difference was encountered between the groups according to the endomorphic component value, but a significant difference was found between the groups in terms of ectomorphic and mesomorphic components.

When we made a comparison of biomotorical data according to the age levels in our study group, the only significant difference was detected in the values of vertical jump and anaerobic power ($p<0,05$). This difference was also found to be due to the fact that the values of basketball players in the age group of 14 years were higher than the other age groups. In the study of Polat et al. (2003) named the physical fitness levels of footballer children, the values of vertical jump and anaerobic power in the age group of 11 years were higher than that of age group of 9 years whereas significant differences were not detected among the other age groups. While no significant difference at the level of $p>0,05$ was found in the parameters of vertical jump, anaerobic and aerobic power difference was detected between 11 and 10 years of age and between 10 and 9 years of age, a significant difference at the level of $p<0,05$ and $p<0,01$ level was found between 11 and 9 years of age. The results of the researchs which indicated that child athletes in the early adolescence and adolescence period may have a significant difference in the vertical jump and anaerobic power values supported the findings (Hoffman et al., 1995; Katie et al., 2003; Polat and Saygin 2003; Ziyagil et al., 1999). According to the results of the study by Saygin et al. (2011) it was determined that as the ages of the children aged between 11-14 years of age advanced, they showed significantly better performance in terms of anaerobic power values. Tekelioglu (1999) reported in his study that the vertical jump values of male children increased significantly with age. The results of the study by Matavulj et al. (2001) which showed that young age group basketball players had significantly improved vertical jump values supported our findings. The results found by Mero et al. (1990) suggesting the age-related differences in the anaerobic power values of adolescent athletes supported our study results.

Saygin et al. (2011) reported that the $MaxVO_2$ value of male children significatly increased with increasing age. The results of our study were in contradiction with the results of this study. The maximum values for males were attained only in the ages of 18-19 years (Cetin, 2000). In childhood, $MaxVO_2$ can be improved by endurance training. However, the level of trainability of aerobic training in healthy active children is limited (Temizisler, 1998). In the study by Savucu et al. (2004) significant differences were found at the $p<0.01$ level in VO_2max parameter as a result of comparison between groups. While a significant difference at the level of $p<0.05$ was found in favor of younger age group of male basketball players when compared to group of youngest men's basketball players, a significant difference at the level of $p<0,01$ was found in favor of group of young men's basketball players when compared to group of youngest men's basketball players and in favor of young basketball players when compared to younger basketball players. The results of the study by Smith et al. (2000) which found that male college athletes showed an increase in VO_2max values with age, and the results of the study by Petibois and Deleris (2003) which found significant age-depended differences in VO_2max values among young endurance athletes are in contradiction with the findings obtained in our study.

In a study by Pekel et al. (2006), they reported the results of 1-mile (1609 m) run-walk test for boys with the mean age of 11.5 years who engaged in athletics as 07: 49 ± 01: 00 sec. In the study by Rowland et al. (1999) on 40 children aged 12.2 ± 0.5 years, they reported the results of 1 mile (1609 m) run-walk test as 09.07 ± 04.05 sec. In the study conducted by Saygın (2012), the mean of 1-mile (1609 m) run-walk test for the athletes with the mean age of 13,12 years who were engaged in individual sports was reported as 7,64 ± 2,07 s and the mean of 1 mile (1609 m) run-walking test for the athletes with the mean age of 13,41 ± 0,63 years who were engaged in team sports was reported as 7,55 ± 1,31 s. When we compared the findings of these studies with the findings of our study, we see that our performance was lower.

No statistically significant difference was detected between the basketball-specific skill tests in our study ($p>0,05$). The reason for not finding a significant difference was considered to be due to the facts that the technical characteristics of the training programs that we have included in the training programs were similar and the number of weekly training sessions were same.

In conclusion, the anthropometric, somatotype, biomotorical characteristics and basketball-specific skill levels of the athletes in our study group were generally similar and the difference between the groups was determined as a significant difference only in the values of humeral diameter, vertical jump and anaerobic power. The study, while demonstrating the strong and weak sides of the athlete, is important for assessing training programs to achieve the desired performance levels by taking growth and development periods into account. A database also can be created in terms of comparing the characteristics of basketball players of the same age group abroad.

References

1. Açıkada C. (2004). Training in children. *Acta Orthop Traumatol Turc,* 38,1: 16-26.
2. Çetin N. (2000). *General Conditioning Training and Performance Control in Sport*. Tekten Publishing, Niğde.

3. 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.
4. Fox EL, Bowers RW, Foss ML. (2012). Trans: Mesut Cerit. *Physiological Basis* for *Exercise and Sport.* Sport Publishing, Ankara
5. George JD, Vehrs PR, Allsen PE, Fellingham GW, Fisher AG. (1993=. VO_2max estimation from a submaximal 1-mile track jog for fit college-age individuals. *Medicine and Science in Sports and Exercise,* 25: 401-406.
6. Hahn E. (1982). *Kindertraining.* Blv Sportwissen, München.
7. Hoare DG. (2000). Predicting success in junior elite basketball players-the contribution of anthropometic and physiological attributes. *Journal of Science and Medicine in Sport, Sports Medicine Australia,* 3 (4): 391-405.
8. Hofman JR, Stavsky H, Falk B. (1995). The effect of water restriction anaerobik power and vertical jumping height in basketball players. *Int J Sport Med,* 16 (4): 214-8.
9. Kamar A. (2008). *Talent, Skills and Performance Tests in Sports.* Nobel Publishing, Ankara
10. Katie MM, Brad SM, Joanne K, Linda DV, Terence JW. (2003). Contribution of timetabled physical education to total physical activity in primary school children: cross sectional study. *BMJ*, Volume, 327.
11. Koz, M. (n.d). Relation to body composition and sportive performance. *http://80.251.40.59/sports.ankara.edu.tr/koz/egz-fizII/vucut.kompz.egz.pdf*. Accessed 20 March 2017
12. 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.
13. Megep, 2007.(mesleki eğitim ve öğretim sisteminin güçlendirilmesi projesi). Child development and education psychomotor development. Republic of Turkey Ministry of National Education, Ankara.
14. Mero A, Kauhanen H, Peltola E, Vuorimaa T, Komi PV. (1990). Pysical performance capasity in different prepubescent athletic groups. *J Sports med Phys Fitness,* 30(1): 57–66.
15. Özer MK. (2015*). Physical Fitness (5th Edition),* Nobel Publishing, Ankara.
16. Özer MK. (2009). *Kinantropometry, Morphological Planning in Sports (2th Edition),* Nobel Publishig, Ankara.

17. Özkan A, Arıburun B, Kinişler A. (2005). Examination of some physical and somatotype features of american football players in Ankara. *Gazi Journal of Physical Education and Sports Sciences,* 10(2): 35-42.
18. *Pekel HA, Bağcı E, Güzel NA, Onay M, Balcı ŞS, Pepe, H. (2006).* The evaluation reliationship between some anthropometric characteristics and performance-related physical fitness test result in childeren athletes. *Kastamonu Education Journal,* 14(1): 299-308.
19. Petibois C, Deleris G. (2003). Effects of short and long-term detraining on the metabolic response to endurance exercise. *Int J Sports med,* 24(5): 320–5.
20. Polat Y, Çınar V, Şahin M. (2009). Determining the antropometric properties and somatotypes of football player children. *e-Journal of New World Sciences Academy,* 4(4): 256-265.
21. Polat Y, Çınar V, Şahin M, Yalçın R. (2003). The study of physical fitness level of children who football players. *İ.Ü. Journal of Sports Sciences,* 11(3): 196-199.
22. Polat Y, Saygın Ö. (2003). Investigation of age-related development of some physical fitness parameters related to health of 12-14 age group footballer children. *IX. National Sports Medicine Congress,* Nevşehir.
23. Rowland TW, Kline G, Goff D, Martel L, Ferrone L. (1999). One mile run performance and cardiovascular fitness in children. *ARCH Pediatr Adolesa Med,* 153(8):845-9.
24. Savucu Y, Polat Y, Ramazanoğlu F, Karahüseyinoğlu MF, Biçer YS. (2004). The İnvestigation of some physical fitness parameters of basketball players in the substructure. *Fırat University Medical Journal of Health Sciences,* 18(4): 205-209.
25. Saygın E, Karacabey K, Saygın Ö, 2011. İnvestigation of physical activity and physical fitness of children. https://www.jhumansciences.com/ojs/index.php/IJHS/article/viewFile/2010/815. Accessed 20 March 2017.
26. Saygın Ö, Özşaker M. (2012). The comparison of some physical fitness for individual and team athletes. *Niğde University Journal of Physical Education and Sports Sciences,* 6(2).
27. Smith DJ, Roberts D, Watson B. (2000). Physical, physiological and performance differences between canadian national team and universiade volleyball players. *J Sports Med,* 22(1): 67–70.
28. Şenel Ö, Taş M, Harmancı H, Akyüz M, Özkan A, Zorba E. (2009). Determination of relationship between body composition, anaerobic performance, leg and back force in wrestlers. *Gazi Journal of Physical Education and Sports Sciences,*14 (2): 13-22.

29. Tamer K. (2000). *Measurement and Evaluation of Physical-Physiological Performance of Sports.* Bagırgan Publishing, Ankara.
30. Tekelioğlu A. (1999). Physical Fitness of Girls and Boys Aged Between 11 and 13 Who Attend Public And Private Schools. *Gazi University, Institute of Health Sciences, Phd. Thesis.* Ankara.
31. Temizişler M. (1998). Physical and Physiological Development of Boys Aged 8-9 Participating in Summer Sports Schools. *Marmara University, Department of Physical Education and Sports, Master Thesis.* İstanbul.
32. Ziyagil MA, Zorba E, Bozatlı S, İmamoğlu O. (1999). Effects of age, sex and exercise habits on speed and anaerobic power in 6-14 years old children. *Celal Bayar University Journal of Physical Education and Sports Sciences,* 3(3).